

## **PART – II**

# **TECHNICAL SPECIFICATIONS**

## **GENERAL TECHNICAL SPECIFICATION**

For Specifications if not covered in tender document, execution of work shall be carried out in accordance with relevant CPWD Specifications & Guidelines. Further, if any specification(s) not available in technical specification as provided in the tender document or CPWD Guidelines, GOOD industrial practices and/or Manufacturer's catalogue are to be referred in consultation with Engineer and decision of Engineer is final & binding in this regard.

**TECHNICAL SPECIFICATIONS FOR INTERIOR & FURNISHING  
WORKS (GENERAL)**

**(SECTION-I)**

## SECTION – 1

### TECHNICAL SPECIFICATIONS FOR INTERIOR & FURNISHING WORKS-GENERAL

**1. General: -**

The scope of work covers execution of the Interior, Finishes, Services and Allied works for Corporate office Building Project at Sector-145, Noida, in accordance with the BOQ, Technical Specifications & drawings provided in the Tender Documents and to the satisfaction of the Engineer/DFCCIL.

Unless provided otherwise the work shall be executed as per CPWD specifications 2019 Volume I & II with up to date amendments, and correction. All relevant Indian Standard (IS) codes related to items of work shall be completely followed for execution.

**2. Drawings:**

Two sets of all drawings shall be furnished to the contractor for his own use to be kept at site office for reference & execution of works till the completion of the project in all respect. It shall be accessible at all reasonable times to the Engineer/DFCCIL and their representatives. All-important drawings are to be mounted on boards and placed in racks and indexed.

**3. Dimensions:**

Figured dimensions are in all cases to be followed & accepted in preference to scaled sizes. Large-scale details take precedence over small-scale drawings. In case of discrepancy the Contractor is to ask for clarification before proceeding with the work. The decision of Engineer/DFCCIL shall be final and binding.

**4. Contractor to inspect site:**

The contractor shall visit and examine the construction site and satisfy himself as to the nature of the existing roads or other means of communications, the extent and magnitude of the work and facilities for obtaining materials and shall obtain generally his own information of all matters affecting the execution of the project. Misunderstanding or incorrect information on any of these points or on expenses incurred by the contractor in connection with obtaining site data/information or efforts in compiling the tender shall be borne by the Tenderer/Contractor and no claims for reimbursement thereof shall be entertained.

**4.1 Access to Site:**

The Contractor is to include in his rates for making access to the site, with all-temporary gangways, access platforms etc. as required for execution and completion of the works.

**4.2 Setting Out:**

The Contractor shall set out the works in accordance with the plans. All grid/centre lines shall be pegged out to the satisfaction of the Engineer/DFCCIL. The Contractor shall be responsible for the correctness of lay out and any inaccuracies to be rectified at his own expense.

The Contractor shall construct and maintain proper benches at the intersection of all main walls, columns etc; in order that the lines and levels may be accurately checked at all times.

**4.3 Treasure Trove:**

Should any treasure, fossils, minerals, or works of art of antiquarian interest be found during excavation or while carrying out the works, the Contractor shall give immediate notice to the Engineer of any such discovery and shall hand over such finds to the DFCCIL immediately.

**4.4 Access for Inspections:**

The contractor is to provide at all times during the progress of the works and the Maintenance period proper means of access, with ladders, gangways etc. and the necessary attendance to move and adapt as directed for the inspection or measurement of the works by the Engineer/DFCCIL or their representatives.

**4.5. Attendance upon all Trades:**

It will be the responsibility of the main Contractor to attend on all Tradesman or Sub-contractors for other services not included in scope of contract i.e. for water supply, security Equipment, hardware, Telephone, Water bore well and other specialist Sub-Contractors. The rates quoted shall be inclusive of all attendance and also allow the other Contractors appointed by the DFCCIL for other contract packages.

**4.6 Gate Keeper and Watchmen:-**

- 4.6.1 The Contractor from the time of being placed in possession of the site must make arrangements for watching, lighting and protecting the work, all materials, workmen and the public during day and night on all days including Sundays and holidays at his own cost.
- 4.6.2 Before starting the work the contractor shall intimate to the Engineer/DFCCIL the number and names of works and other personnel together with a copy of each identity card with photograph along with a list of tools, tackles and construction materials for obtaining respective inward gate pass, in triplicate, one for the gate office, one for the Engineer representative and the other for the contractor. The contractor shall be permitted similar outward pass on completion of work and on submission of contractor's copy of same inward pass.
- 4.6.3 The contractor shall apply for gate passes for taking out any materials, tools, tackles etc. brought by him inside the DFCCIL premises based on contractor's copy of inward pass and also for his personnel going out of the DFCCIL premises.
- 4.6.4 The contractor shall be responsible for any unauthorized removal of materials, tools, tackles etc. from the DFCCIL premises.
- 4.6.5 DFCCIL gate office norms to be followed.

**5. Storage for Materials:-**

The Contractor shall provide for all necessary sheds of adequate dimension for storage and protection of materials like cement, lime, timber and such other materials including tools and equipment which are likely to deteriorate by the action of sun wind, rain or other natural causes due to exposure in the open. For cement the contractor shall arrange for leak proof godown of sufficient size to store not less than 3 months requirement of cement.

All such sheds shall be cleared away and the whole area left in good order on completion of the contract to the satisfaction of the Engineer/DFCCIL.

All materials, which are stored on the site such as bricks, aggregates etc., shall be stacked in such a manner as to facilitate rapid and easy checking of quantities of such materials.

**6 Cost of Transporting:-**

The Contractor shall allow at his cost for all transporting, unloading, stacking and storing of supplier of goods and materials for this work on the site and in the places approved from time to time by the Engineer/DFCCIL. The Contractor shall consider in his price for transport of all materials controlled or otherwise to the site.

**7. W.C. and Sanitary Accommodation and Office Accessories and Accommodations:-**

The Contractor shall provide at his own cost and expense adequate water closet and sanitary accommodation complying in every respect to the rules and regulations in force of the Engineer/DFCCIL, for his workmen, for the workmen of sub-contractors, Architect and other Contractor's agents connected with this building project and maintain the same in good working order.

He shall arrange to provide a Dumpy level/Theodolite and at all times maintain in good working order at site, to enable the Engineer/DFCCIL to check the lines and levels of the work.

**8. Materials, Workmanship and Samples:-**

Samples of materials to be used with original/coloured catalogue with specification shall be brought by Contractor well in advance and shall be displayed and kept in separate sample room on site. Samples of all kind of material to be used shall be getting approved from Engineer/DFCCIL. Materials shall be of approved quality and the best of their kind available and shall generally conform to I.S. Specifications. The Contractor shall order all the materials required for the execution of work as early as necessary and ensure that such materials are on site well ahead of requirement for use in the work. The work involved calls for high standard of workmanship with accelerated progress to the entire satisfaction of the Engineer/DFCCIL.

**8.1 Rate to Include:-**

The Rates quoted shall be for all lead, heights and depths and for finished work complete in all respect and to the satisfaction of Engineer/DFCCIL until it is specifically mentioned in the item itself.

**8.2 To ascertain from Contractors for the other trades:-**

The Contractor shall ascertain from other Contractors as directed by the Engineer all particulars relating to their work with regard to the order of its execution and the position in which chases, pockets, holes and similar items will be required, before the work is taken in hand as no claims for extras will be allowed for cutting away work already executed in consequence of any neglect by the Contractors to ascertain these particulars beforehand.

**9. Foreman and Tradesman:-**

All Tradesmen shall be experienced men properly equipped with suitable tools for carrying out all the work of carpentry and joinery and other specialist trades in a first class manner and where the Engineer/DFCCIL deem necessary, the Contractor shall provide any such tools, special or ordinary, which are considered necessary for carrying out of the work in a proper manner.

All such tradesman shall work under an experienced and properly trained Foreman, who shall be capable of reading and understanding all drawing, pertaining to this work and the Contractor shall also comply with other conditions set out in the General Conditions of the Contract.

**10. Work Programme/Weekly Progress Report:-**

The Contractor shall prepare and submit to Engineer/DFCCIL for approval, a CPM chart showing the programme of construction of various items, fitted within the period stipulated for completion, within 30 days of the communication of the acceptance of Tender. The Contractor shall also furnish necessary particulars monthly progress reports in the form furnished by the Engineer/DFCCIL. Approved programme shall be the basis for monitoring the progress of work. The Contractors also should up date and re-analyze the CPM chart as often as required as per direction of Engineer/DFCCIL to assess and reassess the progress of work done and take corrective measures for making out any deficiency.

**11. Clearing of site:-**

The contractor shall immediately after completion of the work clear the site of all debris and left over materials at his own expense to the entire satisfaction of the Engineer/DFCCIL and Municipal or other public authorities. Before taking out any surplus material, reconciliation of materials shall be submitted by the contractor for approval. For taking out the materials, the contractor shall strictly follow the provisions laid down in General Specifications and/or any subsequent circulars that may be issued by DFCCIL.

**12. Photographs:-**

The Contractor shall at his own expense supply to the Engineer/DFCCIL with triplicate copies (including the soft copy) of large photographs not less than 25 Cm. x 20 Cm. (10" x 8") of the works taken from two approved portions of each building, in every month during the progress of the work, or at every important stages of construction.

**13. Preparation of Building for occupation and use on Completion:-**

The whole of the work shall be thoroughly inspected by the Contractor and all deficiencies and defects put right. On completion of such inspection, the Contractor shall inform the Engineer/DFCCIL in writing that he has finished the work and it is ready for the inspection.

On completion, the Contractor shall clean all windows and doors and all glass panes, including cleaning of all floors, skirting, dados, staircases and every part of the building including oiling all hardware. He will leave the entire building neat and clean and ready for immediate occupation and to the satisfaction of the Engineer/DFCCIL.

**14. Contractor to Provide Sign Board:-**

The Contractor shall provide notice on proper supports 3 m x 2 m (10' x 6') in a position approved by the Engineer/DFCCIL. He shall allow for painting and lettering stating name of work, name of Architect, Structural Consultants; General Contractor and Sub-Contractors, all letters except that of the name of the work shall be in letters to the approval of the Engineer/DFCCIL. He will also display safety notices as per requirement and direction of Engineer/DFCCIL.

**15. Vouchers:-**

The Contractor shall furnish the Engineer/DFCCIL with vouchers on request to prove that the materials are as specified in contract and for non tender items to indicate the rate at which the materials are purchased in order to work out the rate analysis of the non-tender items which he may be called upon to carry out.

**16. Protection:-**

The Contractor shall properly cover up and protect all work throughout the duration of work until completion, particularly masonry/finish, moulding, steps, terrazzo or special floor finishes,

staircase and balustrades, doors and window frames, plaster angles, lighting and sanitary fittings, glass, paint work and all finishing works.

**17. Workmanship: -**

- 17.1 The workmanship is to be the best possible and of a high standard. The contractor shall take all steps immediately to make up deficiency if any noticed by the Engineer/DFCCIL. Use must be made of special tradesmen in all aspects of the work and allowance must be made in the rates for the same.
- 17.2 Contractor shall maintain uniform quality and consistency in workmanship throughout the execution of the work.
- 17.3 The contractor shall be responsible for providing and maintaining temporary coverage required for the protection of finished work. He is also to clean out all wood shavings; cut ends and other waste from all parts of the works before covering of infillings are constructed.
- 18. The Engineer/DFCCIL shall have full powers and authority to issue such instructions as to the order of proceeding with or carrying out the work as he may deem necessary for the guidance of the Contractor and contractor shall be bound by such instructions of the Engineer/DFCCIL.
- 19. The levels and measurements of the existing site, as shown in the drawings, are believed to be correct, but the Contractor should verify them for himself. No claim or allowance whatsoever will be entertained hereafter on account of any errors or omission in the description of the site turning out different from what was expected or shown in the drawings.
- 20. All floors, paving, staircase, etc. are to be scrubbed, all glasses to be cleaned on both sides of windows/curtain wall including its members, screens, doors, sky-lights, roof lights, etc., all gulley, gutters, pipe heads, etc. to be cleaned out and the premises left clean, perfect and water tight upon completion. However, a proper care needs to be taken during such cleaning works that the original finishing such as polishing, painting, anodizing, powder coating etc. are not scratched/damaged. In case of any such damage, the contractor shall have to reinstate the same as original as per the instructions of Engineer/DFCCIL, without any cost to Employer.
- 21. Any loss or damage caused due to fault or negligence on the part of Contractors labours, staff etc. during working in the premises will be made good by contractor at no extra cost or the damage and repair cost will be reimbursed in full to the Employer.

**22. Completion Schedule: -**

- 22.1 The works shall be executed strictly as per time schedule mentioned in NIT. Contractor shall have to plan his construction programme and activities so as to complete the work in the stipulated period. The period of completion given includes the time required for mobilization as well as testing, rectifications, if any, re-testing and completion in all respects to the entire satisfaction of Engineer/DFCCIL.
- 22.2 The contractor shall furnish within 30 days of letter of award CPM network chart showing the mile stone and critical path for completion of work within the stipulated time and as per conditions of the contract. The programme should clearly include Manpower, Material and Machinery resources proposed to be deployed for achieving the targeted progress, justification



for same based on machinery output, the date from which each machinery shall be available at site in working condition etc. complete. The programme shall be subject to the approval of Engineer/DFCCIL who may order changes in the programme. The decision of Engineer/DFCCIL shall be final and binding in this regard.

- 22.3 Contractor is expected to mobilize and employ sufficient resources to achieve the progress within the broad frame work of accepted methods of working and safety. No additional payment shall be made to the contractor for any multiple shift work or other incentive methods contemplated by him in his work schedule even though the time schedule is approved by the Engineer/DFCCIL.
- 22.4 During the currency of the work the contractor is expected to adhere to the time schedule on mile stone and total completion and this adherence will be a part of Contractor's performance under contract.

**23. For Monitoring of Project: -**

- 23.1 The contractor shall submit the programme Network based on Critical Path Method using precedence Diagram method to complete the work within stipulated time schedule.
- 23.2 The agency shall submit month wise details of manpower and machinery to be deployed in project along with material procurement schedule for completion of work with in stipulated period based on programme Networking. The progress will be reviewed monthly with respect' to the programme/Net Work chart submitted by agency. The revised CPM chart with additional manpower/machinery/ labour deployment scheduled should also be submitted in case regular backlog is observed and revised programme is essential to complete the work within stipulated period.
- 23.3 The approval to the revised schedule resulting in a completion date beyond the stipulated date of completion shall not automatically amount to grant of extension of time to the Contractor.
- 23.4 Contractor shall submit monthly progress reports (2 copies) highlighting status of various activities and physical completion of work.
- 23.5 Contractor shall give every day report on category wise labour and equipment deployed in the proforma prescribed by the Engineer/DFCCIL.

## SECTION – 2

### TECHNICAL SPECIFICATIONS FOR INTERIOR AND FURNISHING WORKS

1.1 The Contractor shall furnish for approval, with reasonable promptness, samples of materials and workmanship as directed. The Engineer/DFCCIL shall check and confirm in consultation with Architect / Consultants, approval of such samples with reasonable promptness only to conform with the design concept of the Works and for compliance with the information given in the contract documents. The work shall be in accordance with approved samples. The procedure for submission and approval of samples shall be as follows; -

a) All material samples in duplicate shall be delivered to the Engineer-in-charge/ DFCCIL's office at the Contractor's cost. Samples shall be properly labeled with.

- Name of Project
- Name of Contractor
- Name Product
- Name of Manufacturer
- Reference No of Schedule of Quantities (BOQ)
- Date of Submission
- Date of fabrication / casting – if applicable

b) Samples shall be accompanied with technical specification / manufacturer's catalogue

c) In case the Contractor intends to keep an approved sample in his possession he shall submit one additional samples for the Engineer's/DFCCIL's approval.

d) Samples shall be furnished well in advance to give the Engineer/DFCCIL reasonable time for their consideration.

## 2. WOODEN FLOORING:

### 2.1 Material Properties: -

The material shall have a wear resistance surface abrasion resistance, impact resistance, indentation resistance, resistance to rolling castors, resistance to furniture legs, stain resistance, resistance to burning cigarettes, slip resistance and resistance to color fading. Apart from the above properties, the material shall have following additional properties: -

Dimensional Stability	:	Less than 0.9 mm
Surface Soundness	:	More than 0.8 N per sq. mm
Impact Resistance	:	IC 2 as per EN 13329
Thickness Swelling	:	Less than 12%.

### 2.2 Material Storage & Pre-requisites: -

The material shall be stored in unopened packages at normal room temperature at least 0.5 m away from the walls, for at-least 48 hours prior to the installation. The contractor shall ensure that the boards are undamaged

and free from any faults before installation. The contractor shall use felt pads and castor cups on furniture legs and provide external doormats inside all the external doorways to protect the floor at the time of handover. A maintenance guide of the approved company shall be made available any time and handed over to the client at the time of handover.

### **2.3 Installation**

The normal method of installation of laminated wooden flooring is in a random installation pattern taking into consideration the type of installation pattern desired for the purpose of aesthetics or any technical reasons. The joinery is tongue & grooved in an interlocking pattern including beading at the end. A teak moulding shall be provided and installed at the joinery junction of the wall and the floor as per the approved manufacturer's specifications. The quoted rate shall be inclusive of levelling and laying. Underlay shall be provided as per manufacturer specification.

It is important to ensure the sub floor on which the laminate is being laid is smooth, flat & hard & free from moisture, grease, etc. In case of uneven sub floor the same should be levelled if required by self-levelling compound to be paid separately. There should be no moisture or the moisture level present in the subfloor should be less than 10% before installation of the floor. The laminate shall have Unilin/click locking system. It is recommended to use underlay having water barrier of 250 microns and 2mm polyethylene foam under the planks. The installation shall be undertaken as per the manufacturer's installation instructions.

### **2.4 Measurements: -**

Length and breadth of superficial area of the finished work shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metres. The rate shall include the cost of the labour, T&P and materials involved in all the operations described above.

## **3. CARPET TILES**

Carpet tiles of Yarn type Eco Solution Nylon 6 only; Multi-Level Pattern Loop, manufactured using 100% solution dyeing process, Tiles of size approx 60 cms x 60 cms with Soil Protection treatment containing properties of Stain Repel, with 100% PVC Free / 100% Bitumen Free/ 100% Recyclable - backing system with recycled content, made from thermoplastic polyolefin compound with reinforcing layer high-performance environments requiring modular flooring, having tufted yarn weight of 18 oz and average yarn density of Minimum 7385 oz/cu. yd. or more, Nominal total thickness 5.79 mm minimum, Radiant Panel class I rated ( ASTM E648) , NBS smoke < 450, Pill test -Passed, Anti Static Property less Than 3.5 kv, Texture Appearance Retention Rating of 3.5 for Severe Use, Anti Microbial Treatment-Passes (AATCC-174). CRI Green Label Plus certified for indoor air quality, including fixing/ installation with Low/ Zero VOC content Adhesive. Impact Sound (ISO 10140-3) 20 dB & Sound absorption (ISO 354) 0.2 Class D.Environmental Certifications- Cradle to Cradle Silver Certified standard Version 4.0 +Declare LBC Compliant + LEED V4 compliance+ EPD + HPD+ NFS 140 Gold+ CRI Green Label Plus.

### **3.1 ENTRY MAT**

Entry Mat of approved make, shade and pattern with enhanced drainage system, to be laid on semi-wet areas and vestibular area with stone flooring. The entrance matting should be Heavy Duty and slow wearing with enhanced absorption. Construction to be looped pile carpet design with solid vinyl backing. The material of the looped pile to be Polypropylene and Nylon and the backing to be vinyl. Size to be measured at site and be pre-cut at source to fit at the site.

### **4. PVC VINYL FLOORING**

6mm thick PVC Vinyl flooring with foam backing, vinyl floor covering of size 1200 mm width x 6 metres length of weight 4400 g/m<sup>2</sup> with wear layer thickness of 1 mm. Wear layer should be treated with Protocol (UV cured Polyurethane surface treatment) which facilitates ease of maintenance and eliminates the use of acrylic emulsions. Residual indentation should be less than 0.25mm & should conform to EN ISO 24343-1(EN 433). The product should have antibacterial properties. The product should also fulfil dimensional stability (EN ISO 23999(EN 434) & effect of furniture (EN 424). It should also be suitable for under floor heating. The product should have excellent sound absorption of 24 dB and excellent shock absorbent behavior. The laid flooring shall confirm the fire rating Cfl-S1 class as per EN 13501-1.

### **5 Double Glazed Fixed Partition**

Slim Line Modular Aluminium Fixed partitioning frame of 100-105 mm x 25-30 mm which can accommodate 2 panels of glass of 10 mm thickness separated by 40-50 mm distance for better sound insulation and acoustic properties. The rate to include Design, Fabrication, Supply, and Installation & Handover of slim line fixed partition system. The fixed partition system should accommodate open able door on Hinges. Door to be paid separately. The system of fixed partition with open able door to be custom designed to withstand the design confirming to IS -875 part III. The system shall have two barrier gasket system to hold glasses.

Microwave cured EPDM gaskets to accommodate glass thickness as per structural requirement, weather sealants, and SS 310 grade screws of approved make, all in complete required to perform as per specification and drawing in conjunction with BOQ.

The extruded aluminium sections of Alloy 6063 T5 / T6 & tolerances confirming to DIN / EN standard, of approved architectural sizes, from approved extruder. The structural profiles shall have minimum 1 to 1.6mm wall thickness. All the internal visible surfaces shall have high Durability) / Super durable (Jotun) Powder coating of 60 - 80 micron confirming to ASTM E 283, ASTM E 331, ASTM E 330AAMA 2604 or anodizing shade as approved by Engineer with minimum 25 micron The non-visible aluminium surfaces shall have minimum chromatizing treatment.

Material shall be as per make list in tender document...

All shade approval shall be as per Architect's/Engineer Approval.

The system shall demonstrate performance for air seal / water seal / structural requirement. The system performance test shall be mandatory. The performance test shall be carried out at an accredited laboratory

having fully atomized data acquisition system with provision to capture all values in the test results sheet. The sequence of test and standard shall be ASTM E 283, ASTM E 331, ASTM E 330, and AAMA 501.1.

The quoted rate shall include all design, engineering & shop drawing approval.

Glass: 2 NO.10 mm clear Heat strengthened/ TOUGHENED Glass or as specified in BOQ.

Tolerance of 5 mm allowed in both dimension of the cross section of the slim line partition as per manufacturer's specification.

## **6 SLIM LINE MODULAR SINGLE GLAZED PARTITION**

Slim Line Modular Aluminium single glazed partition frame of 100-105 mm x 25-30 mm with in bottom and top channel with acoustic gasket as per specification.

The rate to include Design, Fabrication, Supply, Installation & Handover of Fixed partition frame. The fixed partition should accommodate 10mm heat strengthened glass. Sliding Door to be paid separately. The fixed partition to be custom designed to with stand the design confirming to IS -875 part III. The system shall have barrier gasket system to hold the glass.

Microwave cured EPDM gaskets to accommodate glass thickness as per structural requirement, weather sealants, and SS 310 grade screws of approved make, all in complete required to perform as per specification and drawing in conjunction with BOQ.

The extruded aluminium sections of Alloy 6063 T5 / T6 & tolerances confirming to DIN / EN standard, of approved architectural sizes, from approved extruder. The structural profiles shall have minimum 1 to 1.6mm wall thickness. All the internal visible surfaces shall have high Durability / Super durable (Jotun or approved equivalent) Powder coating of 60 - 80 micron confirming to AAMA 2604 or anodizing shade as approved by Engineer with minimum 25 micron The non-visible aluminium surfaces shall have minimum chromatizing treatment.

Material shall be as per make list in tender document.

All shade approval shall be as per Architect's/ Engineer Approval.

The system shall demonstrate performance for air seal / water seal / structural requirement. The system performance test shall be mandatory to verify performance test shall be carried out at an accredited laboratory having fully atomized data acquisition system with provision to capture all values in the test results sheet. The sequence of test and standard shall be ASTM E 283, ASTM E 331, ASTM E 330, and AAMA 501.1.

The quoted rate shall include all design, engineering as per drawing /approval.

Glass: 10 mm clear Heat strengthened/ Toughened or as specified in BOQ.

Tolerance of 5 mm allowed in both dimension of the cross section of the slim line partition as per manufacturer's specification.

## 6.1 HINGED DOOR

Door shutter for Modular Slim line Aluminium partitioning frame should be of 44mm x 70mm using outer frame of 100-105 mm x 25-30 mm vertical 2 top frame and 50mm x 25mm as outer frame. Hingable door width 0.90mt - 1.10mt as per drawing. Glass beads at horizontal top and bottom should accommodate glass 11.52 mm thick acoustic glass of combination (5mm + two layers of 0.76 mm thick acoustic PVB + 5mm) HS glass for optimum sound insulation wherever required. Microwave cured EPDM gaskets to the glass as per requirement. Door to function on hinges.

Tolerance of 5 mm allowed in both dimension of the cross section of the slim line partition as per manufacturer's specification.

## 6.2 SLIDING DOOR AND PARTITION SYSTEM

Slim Line Modular Aluminium single glazed SLIDING Door partition SYSTEM unit of total width size of slider door shall be 2.0 mt to 2.4mt as per site requirement with top outer frame of 46x76mm, shutter with top and bottom channel of 30mmx38mm and vertical channels of 18mmX38MM with acoustic gasket as per specification.

Slim Line Sliding door system sliding over the Fixed partition frame system unit Sliding Openable Door with acoustic glass should be on Sliding Mechanism which shall slide parallel to the single glass partition. The sliding mechanism shall be at the top and the Sliding Door should hang and slide on the top mechanism and should not require a guide or track on the floor. The Slim Line Sliding Door System Shall have smooth functioning and the system shall be so designed to carry the load of the acoustic glass in the Slim Line Sliding Door Partition System and the mechanical slider shall also be designed to take the load of the acoustic glass. fixed partition paid in another item. The system shall have barrier gasket system to hold the glass. Microwave cured EPDM gaskets to accommodate glass thickness as per structural requirement, weather sealants, SS 310 grade screws of approved make, all in complete required to perform as per specification and drawing in conjunction with BOQ. The system of Sliding door and fixed partition to be custom designed to withstand the design confirming to IS -875 part III.

The extruded aluminium sections of Alloy 6063 T5 / T6 & tolerances confirming to DIN / EN standard, of approved architectural sizes, from approved extruder. The structural profiles shall have minimum 1 to 1.6mm wall thickness. All the internal visible surfaces shall have high Durability / Super durable (Jotun or approved equivalent) Powder coating of 60 - 80 micron confirming to AAMA 2604 or anodizing shade as approved by Engineer with minimum 25 micron The non-visible aluminium surfaces shall have minimum achromatizing treatment.

Material shall be as per make list in tender document.

All shade approval shall be as per Architect's / Engineer Approval.

The system shall demonstrate performance for structural requirement. The system performance test shall be mandatory to verify the performance test shall be carried out at an accredited laboratory having fully automated data acquisition system with provision to capture all values in the test results sheet. The sequence of test and standard shall be ASTM E 283, ASTM E 331, ASTM E 330, and AAMA 501.1.

The quote rate shall include all design, engineering & shop drawing approval.

Specifications for Acoustic Glass: 11.52 mm thick acoustic glass of combination (5mm + two layers of 0.76 mm thick acoustic PVB + 5mm) HS glass for optimum sound insulation wherever required

Tolerance of 5 mm allowed in both dimension of the cross section of the slim line partition as per manufacturer's specification.

## **7. LACQUERED GLASS:**

6 mm and 10mm: 6 mm and 10 mm shall be Extra Clear Glass used for lacquered glass should be of Saint Gobain/ Asahi/ Pilkington and should be toughened in horizontal tempering line.

Lacquered glass to be made industrially (via air brushing process); opaque (if viewed against a support wall), coated with WATER BASED lacquer colour of brand Colour Spray AQUA by Regalead – United Kingdom Or Equivalent Brand ;Which is bound by Nano particle pure acrylic); Gloss Level – 40 ; where VOC < 1% ; highly durable ; humidity resistant (conforms to BS EN 1036 1999); environmentally friendly (no lead, no arsenic, no copper, no formaldehyde; compressive strength (1000 MPa) & tensile strength (40 MPa), same as float glass as per the detailed drawings and as approved by Architect/Engineer. Colour to be checked and tested via INDEX Colour shade card used worldwide as a colour choosing parameter.

### **7.1 INSTALLATION:**

Before fitting the glass as a wall covering/panelling requires checking the state of the walls to avoid any deterioration in the paint on the back of the glass • should be fixed on a plain, dry, and clean surface free of aggressive agents • the entire surface should be in a uniform colour or ply colour to ensure a uniform appearance after installation • Glass should not be fixed on the support directly; there should be some space between the and the support to ensure air circulation • Air circulation space should be gap of 1–2 mm between the edges of two glass panels • In case a frame is being used for fixing of the AIS Décor, ensure that the frame is dry and clean • Layout for installation should be prepared prior to installation of the glass • A neutral base Clear silicone (like Dow Corning or McCoy Soudol)/ Pentagon mounting tape, and ensure that the tape is pasted in a vertical direction Acid-based silicone should not be used to fix • In case glass is being fixed on plywood, ensure that the surface of the plywood is free from any chemical, lubricant, or moisture • it is recommended that installation on perfectly levelled 12 mm-thick water- proof marine plywood / MDF / Mineral fibreboard which is mounted on RCC wall / any other structure • If double-sided adhesive tape is used, mounting tape, and ensure that the tape is pasted in a vertical direction. If the glass is to be fixed in partition then the glass should be fixed in microwave cure EPDM gasket perfectly fitting in appropriate profile to ensure proper insulation.

In case to be fixed on a wooden frame with beading, ensure good air circulation by making slots or holes at the side of the frame • In case to be fixed on studs, ensure no metallic surface is in touch with the glass. Plastic spacers and sleeves can be used • In kitchens, do not allow the glass to come into direct contact with flames or strong heat source, e.g., ovens, cooker hobs, very hot utensils, or pans. If used near a heater, for example, the temperature of the wall must not exceed 65°C • Vertical gap between two adjacent sheets should be a minimum of 1 mm • Ensure that moisture is not allowed to collect behind the glass, either by allowing sufficient drainage and ventilation, or by sealing the area with suitable material • If the fitting is

done by using a frame or clip, we recommend the insertion of nonmetal spacer between the frame or clip and the glass • When fitting lighter colours using adhesive strips, it is important to ensure that light cannot penetrate through the sides of the glass as this could cause shadows from the adhesive strips to show up on the front • Always use Silicone / tape brands recommended by AIS and exactly follow the instructions given by the adhesive manufacturer (particularly regarding the quantities of adhesive to be used per square metre).

## **7.2 HANDLING AND CUTTING**

Always use clean gloves when handling decorative glass products • Lift the sheets one by one • When handling sheets with suction cups, apply cups to the flat, untreated surface. If this is not possible, extra care should be taken to ensure that proper vacuum is achieved. Be sure to keep the cups clean and free of dust • Regularly sweep the cutting tables with a stiff brush to control dust and to minimize any glass grit and particles which could scratch the glass • Individual sheets should be washed after cutting to reduce the chance of staining from cutting oil • Glass sheets are cut most easily by scoring the flat, untreated side. If not possible, increased cutting pressure may be required, and testing is recommended prior to cutting stock sheets • Never allow coolant or cerium oxide to dry on the glass, as it may become a permanent stain on a porous surface • Painted side of the lacquered glass should be placed on the table while cutting • Care must be taken to insert paper or cardboard spacers in order to avoid scratches.

## **8. ACRYLIC SOLID SURFACE SHEET PANELLING**

Wall cladding panels with 6mm solid, non-porous and homogeneous seamless, stain resistant, repairable, durable, hygienic environment friendly surfacing material acrylic solid surface sheet of or approved make with a minimum thickness 06 mm in color, design, fixing in customize design arrangement as per direction of architect/Engineer. acrylic solid surface sheet to be fixed on wall on top of 12 mm marine ply. adhesive of the same color to provide inconspicuous joints. grooves to be given at every 1mtr to give expansion & contraction movement to material. Thermoformable Acrylic solid surfaces should be used wherever required and shaped using heat. Acrylic solid surfaces should be as per requirement in relevant colour and should be developed as per design. The material / product used should be selected as per requirement and wherever it requires thermoforming, laying, etching, carving and shaping capabilities then thermoformable material /product should be used. The product should be selected according to its use. The final finished product should be seam less, joint less and shall maintain lustre and when etched it should have a smooth finish. The rate is inclusive of all operation, material and required pattern. cost of base like framework and 12mm thick ply will be paid under respective item.

**Durability performance & Design flexibility / Non-porous & Hygienic(Anti-bacterial)**

Acrylic solid surfaces should be tough and repairable. Acrylic solid surfaces should be solid all the way through, minor cuts, scratches or nicks can be quickly sanded out, restoring the surface to its initial appearance. solid surfaces should be long lasting.

Acrylic solid surfaces should be easy to clean and maintain. Acrylic solid surfaces should be stain and resistant and shall be non-porous.

Acrylic solid surfaces to be non-porous it should not support the growth of microbial growth. Acrylic solid surfaces should be workable and as per requirement it should be carve able, sandblasted, polished and cut-



out to create a one-of-a-kind look in a variety of shapes and finishes. Acrylic solid surfaces wherever required should also be thermoform able or shaped using heat. Acrylic solid surfaces should be as per requirement in relevant colour and should be developed as per design and the material / product used should be selected as per requirement and it may require thermoforming, laying, etching, carving and shaping capabilities. The material / product used should be selected as per requirement and wherever it requires thermoforming, laying, etching, carving and shaping capabilities then thermoformable material /product should be used. The product should be selected according to its use. The final finished product should be seam less, joint less and shall maintain lustre and when etched it should have a smooth finish. The product should be in the colour selected by the Architect/Engineer/DFCCIL. The final finished product should be seam less, joint less and shall maintain lustre and when etched it should have a smooth finish. Acrylic solid surface shall have Antibacterial certificate and TUV (Austria) FR grade certified.

#### Product Specifications

Property	FUNCTION INDEX SIGN	UNIT	TEST METHOD
Density	1.5 - 1.8	kg/dm <sup>3</sup>	DIN 52 102
Mass	16	kg/m <sup>2</sup>	
Barcol Hardness	55-70		DIN 68 861
Tensile Strength	25-60	N/mm <sup>2</sup>	DIN EN ISO 527
Flexural	30-60	N/mm <sup>2</sup>	EN 310
Modulus elasticity	5000 - 9000	N/mm <sup>2</sup>	EN 310
Ball Drop	170 - 280	N/mm <sup>2</sup>	DIN ISO 2039
Impact Strength	1.5 - 6.5	kJ/m <sup>2</sup>	Din EN ISO 179
Long/thermal Expansion	3.5 x 10	m/m'k	DIN 53 752
Water Absorption	<0.04	%(mass)	DIN 53 495/ASTMD 570
Light Fastness	Blue Scale 5-7,		DIN EN ISO 4892
	Grey Scale 4-5		
Fungi & Bacteria	No Infestation		ISO 846 A/C

Calotitic Value	Ca. 10	Mj/kg	DIN 51 900
Fire Behaviour	B2		DIN EN 13501-1
Chemical Resistant	1B		DIN 68 861-1
Specific Weight	1.55-1.74g/cm at 20 degree C		DIN ISO 1183
Young's modulus	10900 N/mm2		DIN 53457
Bending Strength (12 mm Panel)	60 + - 5 N/mm2		DIN 53452
Impact Strength (12 mm Panel)	6.5 kj/m2		DIN EN ISO 179
Impact Resistance (12 mm Panel)	No Break		ISO 19 712-2
Stability Of Glued Joint	60%-80% Of Material Stability		ISO 527
Barcol Hardness	65 + - 5		DIN EN 59
Scratch Resistance	0.6 N		DIN EN 438-2
Thermal Expansion (length)	5.05 x 10-5 K-1		ASTM D 696
Stability - Boiling Water	No Visible changes		DIN 53799
Stability - Dry Heat	No Visible changes		DIN 68861 T7
Cigarette Burn	No Visible changes		DIN 53799
Stain Resistance Requirement	Meets Requirements		ANSI Z 124.3 (5.2)
water Resistance requirements	Meets Requirements		ANSI Z 124.3 (6.0)

## 9. PARTICLE BOARD:

Pre -laminated medium density fibre board exterior grade (Grade-I) IS: 14587:1998 marked, to frame, backing or studding with screws etc. complete (Frames, backing or studding to be paid separately).

Pre-laminated with decorative lamination on both side exterior Grade - I MDF Board 12 mm thick conforming to IS: 14587

## 10. WOODEN FIRE RATED DOOR:

Wooden fire rated doors as per BS: 476 Part- 20 & 22 & IS 3614 part-2 for stability, integrity and thermal insulation. 03 Criteria Wooden door confirming to IS 277 with the following specification. Recommended fire door shall have doors tested at CBRI for maximum rating of 2hrs tested either with or without vision panel. Individual Test certificates should be available for glass used in vision lites confirming the required fire ratings. Any deviation in specification other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory. Approved manufacturer should be ISO Certified Company. Door leaf shall be minimum 52mm thick fully flush door with or without vision lite. 52mm thick shutter, comprising of 75mm x 44mm hardwood internal timber frame work, with infill of 48 kg/m<sup>3</sup>, ceramic fiber blankets, coated with FR intumescent coating on both sides for insulation. The coated insulation shall be sandwiched between maximum 12mm thick Calcium Silicate Boards on both sides (edge to edge on internal Hardwood frame) having a maximum density of 900 Kgs/ Cum, clad with 3mm ply commercial ply on both faces. (The same can be pasted with 1mm thick laminate (as per approved shade) or replaced with 4mm thick teak ply as per client's requirement at an extra cost) on both sides of the shutter, with 50mm x 10mm hard wood lipping all round the shutter. The door frame will be made out of Hardwood of maximum section 120 x 70mm and coated with Fire Retardant Primer. The rebate shall be of 20mm x 54mm in the Door Frame to accommodate the shutter. Fire seal of size 20x4mm on all the three sides of the except bottom.

The pasting of the ply/veneer/laminate should be done using automatic machine and should be free from any nails or perforations.

## **11.0 ECORESIN PANEL**

Eco resin translucent panel 10mm thickness floral or stone finished of approved make complete as per specification. These panels will be fixed to wall with SS studs/BB frame and maintain gap off 200mm from the wall. LED lights at the back as required includes supply and fixing of backlit ecoresin panel which includes Ecoresin panel, LED lights and necessary hardware for fixing of Ecoresin Panel. The item does not includes the provisioning electrical point which is a part of the Electrical BOQ.

## **12.1 FULLY AUTOMATIC GLAZED SLIDING DOOR: -**

### **12.1.1 General:-**

Automatic sliding door operator Automatic sliding door Set 1 operator as per approved dwg. Compliant with European standards. Product should be TÜV test certified for 1 Million cycles, tested according to the low voltage guidelines & operator unit power consumption not exceeding 100 W/Hr , fulfils DIN 18650 standards. The track profile should be flexible for both surface mounted & ceiling hung application with additional profile for vibration & sound dampening feature. It should includes micro processor controlled drive unit, with self learning mechanism, program selector with knob, motion detection sensor – 2 nos , 1 on each side , including passage safety combi-sensor on one side , mechanical components, toothed belt, cover profile not exceeding 110mm visible H, floor guide for frameless glass (02 nos), glass clamping rail (02 nos), Body finish : standard silver anodised operator profile electromechanical lock with 12 mm plain toughened frameless glass for complete elevation - 2 moving panels. UPS of 750 VA shall be provided by others, which will give power backup of 20 min. Only & if the duration of power cut to the operator is more than 30 min.,

then separate arrangement needs to be done for the same as automatic operator requires uninterrupted stabilized power supply. it should include wall corner Protection. (WCP)

All complete as per direction of Architect/Engineer/DFCCIL.

### 12.1.2 Installation:-

The track profile should be separate from the main profile for enabling reduction in vibration insulation. Microprocessor control, self-learning, reverses when obstruction is encountered. Microprocessor-controlled control unit. It should be Self-learning, with adjustable parameters for opening and closing speed, hold-open time and opening and closing force. Class of protection IP 20. The electric operating Mechanism shall be mounted and concealed within the Stainless Steel header and the Controller Unit shall be Micro Processor Based.

### 12.1.3 Technical Parameters: -

Parameter	
Drive Unit	Top mounted actuator
Travel Control system	Encoder
Capacity	90 kg each leaf maximum
Power Supply	< 100 W
Duty Class	5-very heavy duty
Intermittent operation	S3=100%
Opening speed	150-600 mm/s (Adjustable)
Closing Speed	100-550 mm/s (Adjustable)
Opening Time	0-9 Seconds (Adjustable)
Accessories Power supply	24V=0.5A
Manually adjustable functions	Drive force. Dwell time during opening 0-30 seconds. Partial opening.
Self-adjusting functions	Maximum opening closing limits Rotary programmer.
Safety devices	Combi Sensor(Microwave+ Infrared)/Built-in photocells
Control Switch	Pair of microwave radar for open & close operations

Std. Cable Length	5 Mtr - Motor to Radar & 5 Mtr - Motor to Sensor
Safety devices	Combi Sensors for passage safety/Built-in photocells
Test Certificate	1 million Cycle

**Features:-**

- F) CE marked according to the European Machinery Directive 2006/42/CE and type tested according to standard European Norm 13241-1.
- G) Extruded anodized aluminum profile sliding guide and casing, sliding on reinforce nylon wheels.
- H) Electronic control board with microprocessor.
- I) Built in electronic antic rush devise with encoder.
- J) Manual and automatic settings with trimmer and dipswitch.
- K) Automatic closing, reversal safety, obstacle detection, adjustment, automatic closer time.
- L) Test certification for the number of cycle tested.

**12.2 HARDWARE:****12.2.1 Digital****Lock:-**

Digital Lock without cut-out. Digital door lock to be stand-alone systems with an electronic control mechanism. The lock to be enable to be operated with all three modes with fingerprint + password + IC card from the list of specified make with necessary accessories. Should have a capacity of 10 administrators and more than 300 ordinary users. Should have minimum 2 cards. Cost of two cards included. Locks to operate either on alkaline batteries or rechargeable lithium-ion cell ones. In both cases, an alert or indicator should be there to indicate the level of battery level when batteries need to be replaced. Lock to have Speedy and accurate access with the optical finger print authentication. The fingerprint recognition to be robust against any dust or foreign materials.

**12.2.2 Hydraulic Door Closer: -**

Overhead cam action door closer with adjustable closing force EN2-4.

**12.2.3 Floor Spring: -**

Double action floor spring for door including cost of cutting floor required, embedding in floor and cover plates with pivot and single piece sheet cover box with side plates etc. as per direction of Architect/Engineer/DFCCIL.

Floor spring certified with std. spindle and cover plate. The floor spring with back check and adjustable closing speed. Non-hold open options As per EN 1154 and CE marked. Finish: satin stainless steel.

**12.2.4 Pull Handle: -**

SS Pull handle of 300 x 25mm size, CTC 212 mm with necessary fixing accessories, washers & screws etc. complete as per direction of Architect/Engineer/DFCCIL. A.150 Back to back with adjustable fixing for glass, wood and metal doors in satin stainless steel. The pull handles should have supporting washer with raised beveling on the outer surface. Length=171mm, 19mm dia, etc 152mm- SS304. 300 back to back with

adjustable fixing for glass, wood and metal door in satin stainless steel. The pull handles should have. Supporting washer with raised beveling on the outer surface. Length=300MM, 25MM DIA-SS304 supporting washer with raised beveling on the outer surface. Length=300MM, 25MM DIA-SS304

#### **12.2.5 Lever Handle with Lock: -**

Tubular lever handle with sash lock with back set, Foreend, Euro profile cylinder with one side key and other side knob operation with strike plate and fitting with necessary screws etc. complete

External trim lever type finish: silver. Complete set including spindle, screws & all fixing accessories.

pin euro profile half cylinder with one side key operation standard length 42mm in satin nickel plated finish with 3 keys. Optional master keying and grand master keying can be done on request.

Lever handle package consist of tubular lever handle sash lock with 55mm back set, CTC-72mm and 20 mm for end, euro profile cylinder with one side key and other side knob operation with 20 SS strike plate.

### **13. ABOVE FALSE CEILING GYPSUM PARTITION - FORMED OF GI FRAME WORK**

Partition from false ceiling level till true ceiling level

Framework - (2 layers of GI Ultra studs)

To be formed 2 layers of GI Ultra studs of size 48mm (0.5mm thk having one flange of 34mm and another flange of 36mm made of GI Steel), placed at 600mm centre to centre fixed on to the floor channels. The GI channels of size 50mm x 0.55mm (section thick) to be fixed on the floor to hold GI studs as per details. To have 5mm air gap between the 50mm frame work as per details. Infill -2 Layers of Fibre glass wool insulation - 1000gms/m<sup>2</sup>. As an acoustic requirement, contractor to affix 50mm thick 2 layers of Fibre glass wool insulation of density 1000gms/m<sup>2</sup>, of approved make wrapped in GI chicken mesh on both sides as per manufacturer's specifications, Cladding - First layer on both sides - Fibre cement board Density 1400kg/M<sup>3</sup>. The framework to be cladded on both sides with single layer of 12 mm thick (High Pressure Steam Cured) Fibre Cement Wall Board confirming to IS 14862: 2000 Category Type B are screw fixed on either side of the framework with 25mm fully threaded self drilling self tapping countersunk fibre cement screws at 300mm c/c. The joints of board are to be staggered to avoid through joints. Finally, the beveled edges of the board are to be jointed and finished so as to achieve flush finish, which includes Interior Jointing Compound & Paper tape as per the recommended practices. To have 3mm thick sound deadening membrane (Density 1800Kg/M<sup>3</sup>) as per details. Cladding - Second layer on both sides - Gypsum board Density 1000kg/M<sup>3</sup>. The Second layer to be cladded on both sides with single layer of Acoustic Rated Gypsum board which includes tapered edge 12.5mm thick Acoustic Rated Gyp board (conforming to IS 2095-1982 & 2542-1981) screw fixed with 35mm dry wall screw at 300mm c/c to Existing first skin of Partition. Care should be taken that the joint should be staggered to avoid sound leakage. Finally square and tapered edges of the boards are to be jointed and finished so as to have a flush look which includes filling and finishing with a jointing compound, joint paper tape and two coats of drywall top coat suitable for Gyp board (as per recommended practice of India Gypsum or equivalent). Rate shall be inclusive approved make Gypsum edge guard on edges of the partition and finished as per manufacturer's specifications. To have 3mm thick sound deadening membrane (Density 1800 Kg / M<sup>3</sup>) as per details.

## 14.0 MODULAR PANTRY

### 14.1 General: -

Kitchen Base Unit Box with BWP 18mm Water Proof Plywood's with Inside Quality 0.8mm laminate finish with Merino Lam or Green Lam Post form Sutter's Finish with Box Backside BWR 6mm Water Proof Plywood's with Box Backside applying 1Coat the Primer. With Quality Handles, Auto Hinges and all Doors Single Colors Finish.

#### Technical Specification and Materials Used in This Pantry

Finishing Materials : Laminated Kitchen

Structural Materials : 18mm Boiling Water Proof Plywood

Handle : G Profile Handle

Accessories : Plain Basket

Hardware : 0°Degree Hinges & 20" Channels, Glass Profile

Size of the Pantry : Approx. 2688mm / as per site

### 14.2 Material use Detail: -

BWP Plywood / Block board

Hardware

Trolly

Edge Bidding / Burma teak lipping

Frosted/Clear glass

## 15. PATCH DOOR

12 mm thick frameless toughened glass door shutter of approved brand and manufacture, including providing and fixing top & bottom pivot & spring type fixing arrangement and making necessary holes etc. for fixing required door fittings, all complete as per direction of Architect/Engineer/DFCCIL.

### Hydraulic Floor Spring

The hydraulic floor spring shall be heavy duty double action floor spring of make approved by the Architect/Engineer/DFCCIL suitable for door leaf of weight minimum 100 kg. The top cover plate shall be of stainless steel, flushing with floor finish level. The contractor shall cut the floor properly with stone cutting machine to exact size & shape. The spindle of suitable length to accommodate the floor finish shall be used.

## Measurements

All the door sections including snap beadings fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimetre. The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

### 16. FALSE CEILING

#### 16.1 Specification of Non DSR False Ceiling

##### 16.1.1 Acoustic wooden ceiling in melamine finish with big circular perforations

Acoustical wooden ceiling in melamine finish with custom perforation 595x1195x16mm, Square edge (T15 Grid System)

Acoustic wooden ceiling in melamine finish with big circular perforations of 50mm dia, melamine laminated finish, 5-test fire retardant grade/ Non FR, size 595x1195x16mm, Square edge, volume density of base board 800Kg/m<sup>3</sup>, weight 8.8Kgs/m<sup>2</sup> which is suspended by using 0.3mm thick metal grid system.

Metal grid system of 600x1200mm module includes wall angle with unequal flanges of 15/19mm, length 3000mm, fixed along the perimeter of walls with the help of nylon sleeves and suitable fasteners at 300mm centers. Then suspend the MainT with flange width 15mm, height 32mm and length 3600mm, from the soffit slab with help of soffit cleat and wire rod with leveling spring clip at 1200mm centres. CrossT with flange width 15mm, height 26mm and length 1200mm is interlocked into the pre-cut slots in the Main at 600mm centers in the perpendicular direction to the Main. Acoustical wooden ceiling in melamine finish 595x1195x12/16mm shall be placed into the grid size of 600x1200mm.

#### Technical Parameters

- Fire (Class) – 1 & P (For FR grade)
- Acoustics – NRC upto 0.85
- Thermal conductivity (W/mk)– na
- Climate (°C, RH) – 40, 70
- Light reflectance (%) – Colour Dependant
- Green (VOC, RC %) – Low, 25

##### 16.1.2 Stretch NRC Fabric Ceiling

Stretch NRC system consisting of FR Grade NRC fabric with high-performance integrated core and acoustically-transparent face covering of choice colour, size 1.7mx75m, stretched by using combination of strut Cross Channel and Strut Tracks, woodfiber 10mm wooden base, polyfiber 10x10 infill with requisite accessories.



The strut system includes strut Cross Channel, fully knurled, sectional thickness 0.55mm, length 3600mm, web 40, depth 10mm and equal flanges of 15mm is fastened to the wall @ 600mm centers. Wooden base 10mm is then installed on the strut along the marking lines with metal fasteners at 300mm centers. Strut tracks to be installed on wooden base, by first applying adhesive on both surfaces for a true and continuous secure grip, and heavy-duty fasteners at 150mm centers on one/both sides of strut tracks.

Inner Wood fiber square edge magnesite bonded pinewood fiber panels of size 600x1200x15mm having density 400kg/m<sup>3</sup>, weight 6kg which is fixed to Strut Cross Channel inbetween tracks. Long edge of panels should be perpendicular to length of Strut Cross Channel. Polyfiber 10x10mm pasted on woodfiber by using adhesive.

The stretch NRC acoustical fabric of width 1.7m is stretched and tucked into the strut tracks and secured to the locking jaws with purpose-specific tucking tools to obtain smooth, taut, wrinkle-free finish. Ensure the weft and weave of the fabric along with the surface are all oriented in one direction to achieve uniform shade. Note: Minimum 100mm additional fabric is required for tucking hence maximum module wall fabric width would be 1600mm. Frame work is not in this scope

#### Technical Parameters of fabric

- Fire (Class) – 1
- Acoustics – na
- Thermal conductivity (W/mk)– NA
- Climate (°C, RH) – 50, 90
- Light reflectance (%) – Colour Dependant
- Green (VoC, RC %) – Low, 25

#### Technical Parameters of Woodfiber

- Fire (Class) – 1 & P
- Acoustics – NRC 0.97 (For 40mm C50 Mounting)
- Thermal conductivity (W/mk)– 0.07
- Climate (°C, RH) – 50, 95
- Light reflectance (%) – 80
- Green (VoC, RC %) – Low, 30

### **16.1.3 Acoustical Wooden Ceiling In Melamine Finish With Slotted Perforations**

Acoustical wooden ceiling in melamine finish made of pinewood E1 grade fiberboard, with slotted perforations, melamine laminated finish, flame retardant grade, size 1200/600x600x16mm, tongue and

groove edge, volume density of base board 800Kg/m<sup>3</sup>, weight 9.3Kgs/m<sup>2</sup>(6R16), 10.4Kgs/m<sup>2</sup>(6R32), 10.3Kgs/m<sup>2</sup>(G5R16) installed by using strut framework system.

Strut framework system includes Strut aluminium core cross channel having thickness 0.55mm, length 3600mm, knurled web 40mm, depth 10mm and equal flanges 15mm is fastened to wall or framework behind vertically/horizontally at every 600mm c/c. Strut aluminium core cross channel, thickness 0.5mm, length 2400mm, web 15mm & 27mm, depth 18mm and flanges of 7mm with suitable edge & centre brackets is then fixed perpendicular to the Strut with the help of fasteners at every 300mm centers. Acoustical wooden ceiling in melamine finish of size 600x600x16mm is then fixed perpendicular to strut with suitable edge & centre brackets. Contractor to provide expansion joints of 3mm at every 4.8m bothways.

Panels are backlined with polyfiber 10x25 held in position with dab spots of adhesive.

#### Technical Parameters

- Fire (Class) – 1 & P (For FR grade)
- Acoustics – NRC upto 0.85
- Thermal conductivity (W/mk)– na
- Climate (°C, RH) – 40, 70
- Light reflectance (%) – Colour Dependant
- Green (VOC, RC %) – Low, 25

#### **16.1.4 LOOP Type 2 system**

Supply & Installation of LOOP Type 2 system formed as an open metal ceiling with an open area of more than 50% and to the flare [5mm] of the perforation pattern [RV-50-40] the ceiling has a three-dimensional visual effect and hides the insight into the plenum. Bypassing the perforation, the S-shaped sides of the LOOP interlock both the long and front side joint with a non magnetic suspension, the elements are installed with a circumferential 1 mm joint, thus compensating tolerances in X and Y direction. The non-magnetic suspension system effectuates a self-alignment of the elements [puzzle effect]. The module size 966x1115x1.0mm steel is perforated with 60mm deep drawn holes. The substructure consists of a form perforated L profile as a lateral grid which is suspended from the ceiling with nonius adjustable upper and lower parts or with threaded rods using official approved dowel plugs. The grid profiles are to be connected together at the ends by means of longitudinal connectors [screw fasteners]. The spacing of the grid profile is according to the requirements of DIN EN 13964. On profiles angles, C-band raster as secondary profiles are bolted on by means of C channel hanger bracket with threaded bolts. Only construction parts approved by the manufacturer may be used. Provide necessary supports, provisions as per the Architect/ Engineer Instructions. Tolerances according to TAIM, DIN EN 13964 and quality controlled to ISO 9001:2015 approved by SIS. Finish of ceiling is in RAL 9016 white/ RAL 9006 Silver grey powder coated with minimum 60 microns powder coating thickness. Visual perception of the ceiling to give seamless large perception and openness to area.

### 16.1.5 Braided Metal Open Compartment Ceiling

Braided metal open compartment ceiling. Braided metal open compartment ceiling is a decorative single blade open compartment ceiling system manufactured from 0.95mm thick perforated Aluminium blades pressed together, available in white, Black or other Non metallic RAL finish. The unique process in which the aluminium blades are punched creates a interwoven structure finish resulting in daylight reflecting off the exposed perforated edges producing a radiant effect which can be enhanced with illumination to create a reflected spacious modern ceiling. The ratio between cell dimension and cell height allows the technical elements of Braided metal open compartment ceiling to effectively disappear in the ceiling void which guarantees maximum transparency. The panel having cell size of 33.33 x 33.33 mm. The assembled Braided metal open compartment ceiling shall be in size of 600x1200 made out of single blades in 0.95mm (W) x 40mm (H) having perforation of QG 3.5 x 3.5mm and open area of appx 90 % . The ceiling panels are then clipped into secondary galvanized mild steel metal carriers, coated in black finished at 1200mm c.c. Wire clips shall hold the cell ceiling panels into the secondary galvanized mild steel metal carriers. Once the secondary galvanized mild steel metal carriers are installed then primary angles made out of galvanized mild steel metal, are cross connected to the secondary galvanized mild steel metal carriers at 1200mm c.c. for lateral bracing. The whole ceiling shall be suspended by threaded rods installed 1200mm c.c. The panels are fully downward demountable / hinged from the proprietary secondary galvanized mild steel metal carrier section using spring panels. The system should be in accordance with Material class A2-s1, d0 according to EN 13501-01 “non-combustible”, as per the Direction of Architect/Engineer. The system will meet fire retardant standards of BS 476: Part 6 & Part 7. Tolerances according to TAIM, DIN EN 13964 and quality controlled to ISO 9001:2015 approved by SIS, LEED certification by IGBC. Manufacturer shall have the fully automatic powder coating system with power and free conveyerize 3mtr/minute capacity. Powder coating plant shall be equipped with latest modern technology with fully automatic inline Pre-treatment using nano technology, Inline automatic water drying system after pretreatment.

### 16.1.6 Hanging Acrylic False Ceiling

Hanging false ceiling made of 12mm thick Acrylic solid surface. the ceiling could be in curve or could be in linear geometric shape as per the design requirement and the cost shall include all shapes and sizes. The acrylic solid surface could be of solid colour, pattern or could be translucent as per the requirement of design/drawing. The curvatures in the acrylic solid surface shall be made as flawless as possible to give even finish. The adhesive used for joining the acrylic solid surfaces shall be of the same manufacturer of the same colour so that the joints are not visible and shall be as seamless as possible in case they're not required to have grooves or end to end see-through slits. The frame shall be of Stainless Steel tube 40x40 mm minimum 3 mm thick with 3 mm thick 40x40 mm Stainless Steel Tube/flat minimum 3 mm thick over the MS tube frame as per requirement of stability and weight carrying capacity and its requirement for support. The support structure of Stainless Steel and MS shall be so sturdy so as to carry the weight of the Acrylic, lights and diffusers etc. as per site. The rate will not include the cost of framing. The Acrylic Surface has to be screwed over the Stainless Steel as per design requirement to ensure maximum stability and strength to structure and Acrylic surface shall touch only the Stainless Steel Structure. The edges of the Acrylic solid surface should be given a border of 50 to 100 mm in all edges. The entire Acrylic ceiling surface shall be joint less or shall have a grooves/slits as per design requirement. The joints at the edges should be joint less and seam less. The acrylic solid surface shall have cutouts for strip lights and other lights as per design. The hanging arrangement

shall be done as per the requirement of lights required as per the design and reflections of light as instructions of Architect/Engineer. Perforations shall be made for lights. The joints are to be treated to give a seamless and joint less finish as per the manufacturer's specifications. Acrylic solid surface shall have Antibacterial certificate and TUV (Austria) FR grade certified. The shapes could be elliptical, circular, curved in any design as per site, drawing or Architect/Engineer directions.

### Product Specifications

Property	FUNCTION INDEX SIGN	UNIT	TEST METHOD
Density	1.5 - 1.8	kg/dm <sup>3</sup>	DIN 52 102
Mass	16	kg/m <sup>2</sup>	
Barcol Hardness	55-70		DIN 68 861
Tensile Strength	25-60	N/mm <sup>2</sup>	DIN EN ISO 527
Flexural	30-60	N/mm <sup>2</sup>	EN 310
Modulus elasticity	5000 - 9000	N/mm <sup>2</sup>	EN 310
Ball Drop	170 - 280	N/mm <sup>2</sup>	DIN ISO 2039
Impact Strength	1.5 - 6.5	kJ/m <sup>2</sup>	DIN EN ISO 179
Long/thermal Expansion	3.5 x 10	m/m'k	DIN 53 752
Water Absorption	<0.04	%(mass)	DIN 53 495/ASTMD 570
Light Fastness	Blue Scale 5-7,		DIN EN ISO 4892
	Grey Scale 4-5		
Fungi & Bacteria	No Infestation		ISO 846 A/C
Calotitic Value	Ca. 10	Mj/kg	DIN 51 900
Fire Behaviour	B2		DIN EN 13501-1
Chemical Resistant	1B		DIN 68 861-1

### 16.1.7 Linear Hook-On Non Perforated Ceiling System With Graphic Digitally Print

Linear hook-on ceiling System. The non perforated panels are made to 2100(L)x300(W) or approved size manufactured out of minimum 0.6mm thick galvanized mild steel sheets and hooked onto the shorter side. Finish of the panels to be powder coated with graphic digitally printed UV cured woodgrain finish with minimum 60 microns base coating. All panels are hooked onto a secondary grid known as U1005 installed at shorter side of the panel to ensure individual demounting of panels for easy accessibility of services. A primary grid of perforated L- Angle in 30x30x1.2mm thick galvanized steel primary carriers in galvanized mild steel is installed perpendicularly to hook on profiles at maximum centers at 1200mm. The entire ceiling shall be suspended with threaded rod using Hilti fastener with minimum load of at least 0.5kn per anchor. The suspension system shall be as per manufacturer specification. The panels shall include the site cutting / making openings for services e.g. lights for information boards, smoke detectors, speakers, diffusers, grills etc. Measurement to be done on edge to edge basis without any deductions for AC grills or any other services integrated within the false ceilings. Tolerances according to TAIM, DIN EN 13964 and quality controlled to ISO 9001:2015 approved by SIS, LEED certification by IGBC. Manufacturer shall have the fully automatic powder coating system with power and free conveyerize 3mtr/minute capacity. Powder coating plant shall be equipped with latest modern technology with fully automatic inline Pre-treatment using nano technology, Inline automatic water Drying system after pretreatment.

### 16.1.8 NRC Clouds

Clouds NRC, square edge, FR grade NRC fabric (colour as per approved by the Architect/Engineer wrapped grassfire core panel of size 600x1200x25mm having volume density 120Kgs/m<sup>3</sup> and weight 3kg/m<sup>2</sup>. Each cloud is provided with 4 sets of accessories containing spring hooks, levelling clip and hanger wires. Springs to be rotated and anchored at back of each panel at four points to hold the panel stable. Supplied hanger wires to be first dropped from the beam/slab/truss to desired height with suitable cleats/anchor bolts. Subtex Clouds NRC panels are then suspended using spring hooks and hanger wires and levelled into position with supplied levelling clips.

#### Technical Parameters

- Fire (Class) – 1 & P
- Acoustics – NRC 0.9
- Thermal conductivity (W/mk)– 0.07
- Climate (°C, RH) – 49, 90
- Light reflectance (%) – Colour dependent
- Green (VoC, RC %) – Low, 25

### 16.1.9 Organic Metal Ceiling

Providing and fixing organic metal ceiling composed of elegant circles and/or organic shapes. The organic metal ceiling is to counterpoint the strict lines of conventional ceilings with a flowing, harmonious room

look. The ceiling should integrate the round lighting areas or round ceiling elements, which diameter determines the basic size of the different ceiling elements. Additionally, spot lights or LED lines should be integrated into the joints. The system should allow creation of individual ceiling configurations with only a few different parts. The dynamics of the ceiling can be influenced by the choice of the circles as well as by the possibility to choose the colour. The organic metal ceiling should have an option to be used as a closed ceiling or as a circular raft ceiling. The form elements made of sheet steel should be available in any RAL colours. Module size should be 1204mm×1204mm Joint width, 10mm Also available on request in the 600 or 900mm modules. Linear ceiling system Module size is to be 1204mm×1806mm and Joint width is 10 mm. The organic metal ceiling should be acoustically effective using perforated rectangular metal panels with acoustic fleece on the rear side.

The ceiling elements are to be fitted on the rear side with bolts and magnets and screwed on a rectangular ceiling system suspended in rail channels in the system. The organic metal ceiling elements at the butt of plates should be force-fitted. Security ropes prevent uncontrolled swinging down of the ceiling elements. The rail channels are to be tightened by means of screws to L-shaped primary carriers. The L-shaped primary carriers are to be used to enable lateral stiffening and should be suspended to the structural slab using patented suspension elements or threaded rods. The round area lightings are an integral part of the creative metal ceiling organic metal ceiling. The round shape should be in the diameter 600, 900, 1200mm and determines the basic size of the ceiling.

#### **16.1.10 Custom Made Triangular Hook On metal Ceiling**

Custom Made Triangular Hook On metal Ceiling system made out of 0.70 mm thick sheet. The ceiling panels are suspended form-fitting and tension-free by means of a special sub structure. Panels to be custom made perforated to 20x20x20mm Triangular CNC Punched Pattern @ 34.7mm Centres having sound absorption of approx. 0.70 with use of special acoustic tissue pasted at the back of panels. Panels to come in sizes 1000x1000x1000mm ( Can vary as per requirement). Panels to be powder coating win selected Non Metallic RAL finish with Coating thickness of appx 70-80 µm. Demounting is performed without tools. Tolerances and quality requirements according to TAIM, DIN EN 13964. Delivery and installation of a System substructure consisting of form punched angles as a lateral grid which is suspended pressure-rigid from the bare ceiling with threaded rods using official approved dowel plugs. The angles are to be connected together at the ends by means of longitudinal connectors. The spacing of the grid angles is according to the requirements of DIN 18168 and DIN EN 13964 as well as the loads of the system and are to be determined and checked by the contractor. On the grid angles A-Z shaped carrier profiles 1.50mm Galvanized steel are attached as longitudinal profile with threaded bolts [secured against loosening].

The longitudinal connection of the Z-shaped carrier profiles are made by means of profile connectors. The spacing of the Z-shaped carries profiles is to be matched exactly to the spacing of the hook-in sides of the metal panels so that panels rest tension-free in the system. Care is to be taken to ensure horizontal and flush alignment. It is only permissible to use structure components that have been approved by the manufacturer of the metal panels. All parts are made of galvanised steel. Substructure: Manufactureres specially designed hook on substructure, Threaded rods/fasteners, other fixing accessories included. The maximum suspension allowed is upto 2.0 mtr. No additional framing, bridging, lateral supports is to be a part of the quoted price by the contractor. The system should be in accordance with Material class A2-s1, d0 according to EN 13501-01 “non-combustible”, as per the direction of architect/Engineer. The system will meet fire retardant

standards of BS 476: Part 6 & Part 7. Tolerances according to TAIM, DIN EN 13964 and quality controlled to ISO 9001:2015 approved by SIS, LEED certification by IGBC. Manufacturer shall have the fully automatic powder coating system with power and free conveyerize 3mtr/minute capacity. Powder coating plant shall be equipped with latest modern technology with fully automatic inline Pre-treatment using nano technology, Inline automatic water drying system after pretreatment.

#### **16.1.11 Hingeable Open Compartment System With Cell Size Of 50mm**

50mm Hingeable open compartment ceiling with cell size of 50mm in X and Y direction made out of 0.4mm thick coil coated Aluminium. The assembled compartment ceiling panels shall be in size of 600x1200 made out of blades in 9mm (W) x 40mm (H). The assembled cell ceiling panels are then clipped into metal secondary carriers in galvanized mild steel, coated in black enamelled finished at 1200mm c.c. Wire clips shall hold the cell ceiling panels into the metal secondary carriers in galvanized mild steel carriers. Once the metal secondary carriers in galvanized mild steel carriers are installed then primary angles made out of galvanized mild steel, type primary angles are cross connected to the secondary carriers in galvanized mild steel carriers at 1200mm c.c. for lateral bracing. The whole ceiling shall be suspended by threaded rods installed 1200mm c.c. All panel modules must be hingeable through wire clips. The panels are fully downward demountable / hinged from the manufacturers specially designed secondary carriers in galvanized mild steel section using spring panels. The system should be in accordance with Material class A2-s1, d0 according to EN 13501-01 "non-combustible", as per the Direction of Architect/Engineer. The system will meet fire retardant standards of BS 476: Part 6 & Part 7. Tolerances according to TAIM, DIN EN 13964 and quality controlled to ISO 9001:2015 approved by SIS, LEED certification by IGBC.

#### **16.1.12 Perforated ceiling tile**

Perforated ceiling tile made out of 0.50 mm thick galvanized mild steel sheet with acoustic fleece. Tile composite system to be provided to improve sound absorption (in black or approved RAL colour). Perforation should be adequate to improve sound absorption. All panel modules must be fixed through wire clips or placed well supported. The panels are fully demountable from the manufacturers specially designed galvanized mild steel section. The perforation should be equal distance and both the surfaces shall be smooth.

#### **16.1.13 Backlit Acrylic Ceiling**

Backlit Ceiling in 12 mm acrylic solid surface sheet of approved make. Acrylic solid surface shall have Antibacterial certificate and TUV (Austria) FR grade certified, Ceiling Installation to be done in translucent glacier ice color, thickness (12 mm), design backlit provision as approved by Architect/Engineer. The material should be CNC cut to achieve the desired design as per architect/Engineer. The CNC cut Acrylic solid surface sheet to be fixed on ceiling. Adhesive of the same color. The material used shall be very translucent and the light shall pass through the acrylic solid surface enhancing the design and the lights passing should be very visible. The rate to exclude the framing, the frame should be of stainless steel or wood as per requirement of stability and weight carrying capacity and its requirement for support. The hanging/fixing arrangement and boxing shall be done as per the requirement of light translucency and reflection of lights required as per the design and instructions of Architect/Engineer. The backlit ceiling shall have the light passing and shall have translucency.

**Product Specifications**

Property	FUNCTION INDEX SIGN	UNIT	TEST METHOD
Density	1.5 - 1.8	kg/dm <sup>3</sup>	DIN 52 102
Mass	16	kg/m <sup>2</sup>	
Barcol Hardness	55-70		DIN 68 861
Tensile Strength	25-60	N/mm <sup>2</sup>	DIN EN ISO 527
Flexural	30-60	N/mm <sup>2</sup>	EN 310
Modulus elasticity	5000 - 9000	N/mm <sup>2</sup>	EN 310
Ball Drop	170 - 280	N/mm <sup>2</sup>	DIN ISO 2039
Impact Strength	1.5 - 6.5	kJ/m <sup>2</sup>	Din EN ISO 179
Long/thermal Expansion	3.5 x 10	m/m'k	DIN 53 752
Water Absorption	<0.04	%(mass)	DIN 53 495/ASTMD 570
Light Fastness	Blue Scale 5-7,		DIN EN ISO 4892
	Grey Scale 4-5		
Fungi & Bacteria	No Infestation		ISO 846 A/C
Calotitic Value	Ca. 10	Mj/kg	DIN 51 900
Fire Behaviour	B2		DIN EN 13501-1
Chemical Resistant	1B		DIN 68 861-1

Acrylic solid surface shall have Antibacterial certificate and TUV (Austria) FR grade certified. The cost of framing and boxing included.



## **16.2 Measurements:**

Length and breadth shall be measured correct to cm. Installed Ceiling area shall be measured in square meter nearest to two places of decimal. Openings for light fixtures shall not be deducted while measuring area. The rate shall include the cost of materials and labour required for all the operations described above.

## **17. WALL PANELLING:**

### **17.1 Perforated Zinc Titanium Cladding :**

Titanium zinc Interlocking wall cladding panels in Pre Patina BLUEGREY/GRAPHITE GREY Finish. The wall cladding system shall comprise of the following described 0.8/1 mm interlocking panels of 250-300 mm width and max 1000 mm length. The interlocking panels are to be fixed using necessary accessories as proposed by suppliers standard methodology and connected end to end. Screws should be of SS Grade 410. Rivets powder coated in same finish as the sheets and made of Aluminium. The substructure should be erected using Aluminium box sections of 25/30 x 50/60 dimensions. The Zinc sheets shall be as per EN 988 standards and must have TUV Certifications. The sheets should be purely natural without addition of any pigmentations.

Perforation : Custom CNC punching as per approved drawings . Circular perforation of varying diameters shall be done as per approved drawings to meet the façade intent .

### **17.2 Lacquered Glass**

6 mm Extra Clear Glass used for lacquered glass should be of Saint Gobain/ ASAHI/ Pilkington and should be toughened in horizontal tempering line. Lacquered glass could be fixed with (Dow corning - 789) / Pentagon double sided tape @2-3 per Sqm) on a perfectly leveled 12mm thick water proof marine plywood / MDF / Mineral fiber board which is mounted on the RCC wall/any other structure Or installed using Stainless Steel Patch fitting Or Stainless Steel studs Or Aluminum frame. (Ply, MDF, MFB, SS Fitting, Aluminum Frame etc. to be paid separately) Lacquered glass to be made industrially (via air brushing process); opaque (if viewed against a support wall), coated with WATER BASED lacquer colour of brand Colour Spray AQUA by Regaled – United Kingdom Or Equivalent Brand ;Which is binded by Nano particle pure acrylic; Gloss Level – 40 ; where VOC < 1% ; highly durable ; humid resistant (conforms to BS EN 1036 1999); environmentally friendly (no lead, no arsenic, no copper, no formaldehyde; compressive strength (1000 MPa) & tensile strength (40 MPa), same as float glass as per the detailed drawings and as approved by Architect/Engineer. Colour to be checked and tested via INDEX Colour shade card used worldwide as a colour choosing parameter.

### **17.3 Green Wall**

Green Wall will include planting media of organic fertilizer like crop residue, vermin compost, wood ash, poultry manure ,cow urine etc., lighter than the soil, with good moisture capacity and used to ensure that load on vertical wall is minimized in Kg/Sqft.

UV Stabilized polypropylene planters of nominal size 19.6 Inches(Length)X6.2 inches(Height)X9 inches (Wide) of each module or equivalent make, specially designed to keep the centre of gravity of growing plants

with in the planters with suitable Geo-Textile separator to separate the planting media with water reservoir and keep the perforation holes unclogged. The installation of planter will be such that to make it theft proof.

Plants of minimum height 152mm(5 plants for each planter) such as Interim, Lal sag, Alternanthera Chlorophytum variegated, Jade, Schafflera, etc. selected on the basis of temperature, incidence of sun light and humidity on site ;in pattern finalised in consultation with as per direction of Architect/Engineer.

Drip Irrigation - with BIS approved 50 mm CPVC pipes, inlet supply of water, outlet pipe for distribution of water with 25mm Dia pipe and grid of dripper with 15mm Dia pipe with dripper. Nozzles can unscrewed and cleaned in case of clogging. The installation shall be without pump set. The watering should be as per Gravitational

Force i/c fixing. The suitable pressure compensating device, valve, elbow, end cap and all other accessories required to complete the

### **17.3.1 Irrigation system.**

Mild Steel pipe frame grouting in RCC of mix 1:2:4, @ 51cm center to center embedded with vertical MS square pipe size 2.5cmX2.5cm with MS rectangular Pipe of 5cmX 2.5cm of border frame with MS Flats 25mm(W)X 2.3mm thick weight not less than 2.5 kg per mtr. 15cm center to center horizontally and with MS flats to hang the planter, with or without connecting plate on supporting wall or standalone including cutting, hoisting, fixing in position, welding etc. & frame painted with 2 coats of Black ate-corrosive bitumastic paint in all complete as per site requirement.

Complete maintenance of vertical garden with supply of water for irrigation through pump set/water tanker including watering through drip irrigation, cleaning/replacement of dripper, replacement of dripper, change of pot pattern after 15 days interval or as per requirement of site complete. T&P shall be provided by the Contractor. The cost of casualty of plants 25% as natural casualty for the first three years and also refilling of cup inside covered by Geotextile cloth of 250 GSM in bottom and further fill up 1:2 ratio with coco peat and soil rite mixture all complete.

### **17.3.2 Pump set for Green Wall**

Single phase submersible motor pump set - suitable HP, in underground tank with starter panel completer in all respect (KSB, Kirloskar, Techno, Texmo, Taro, Calama, Pluga, Crompton Greaves etc.) Note : motor pump shall be able to cover upto area of 1000 sqft comprising of 10 normal/standard panel of size 10ft x10ft =100ft each.

### **17.4 Fabric Wrapped Sculpted Pinewood Fiber Panel**

Square edge, fabric wrapped pinewood fiber panel of size 600x1200x20mm sculpted in as per drawing and design as per the instruction of the Architect/Engineer, density 400 kgs/m<sup>3</sup>, weight 8kg/m<sup>2</sup> installed using Strut framework system with non-visible fasteners using Strut H-Spline.

The Strut framework systems includes strut 50mm Cross Channel having thickness 0.7mm, length 3600mm, knurled web 50, depth 50mm and equal flanges 15mm is fastened to wall positioned horizontally in a regular manner at 600mm c/c. Strut H-Spline having sectional thickness 2mm and length 2400mm to be fixed

perpendicular to the Strut 50mm Cross Channel at 600mm centers. The kerfed edge fabric wrapped panels shall be then inserted into the Strut H-spline along their long edges of 2400mm against framework to perfect fit with staggered short edges.

Note: Thickness is given for bare Panels

The system is backlined with the acoustical infill of polyfiber

Technical Parameters

- Fire (Class) – 1 & P
- Acoustics – NRC 0.95 (For 25mm C50 Mounting)
- Thermal conductivity (W/mk)– 0.08
- Climate (°C, RH) – 50, 90
- Light reflectance (%) – colour dependant
- Green (VOC, RC %) – Low, 30

### **17.5 Acoustic panels with slotted perforations**

Acoustic melamine panels made of pinewood E1 grade fiberboard, with slotted perforations, melamine laminated finish, flame retardant grade, size 1200/600x600x16mm, tongue and groove edge, volume density of base board 800Kg/m<sup>3</sup>, weight 9.3Kgs/m<sup>2</sup>(6R16), 10.4Kgs/m<sup>2</sup> (6R32), 10.3Kgs/m<sup>2</sup>(G5R16) installed by using Strut framework system on walls .

Strut framework system includes Strut aluminium core cross channel having thickness 0.55mm, length 3600mm, knurled web 40mm, depth 10mm and equal flanges 15mm is fastened to wall or framework behind vertically/ horizontally at every 600mm c/c. strut aluminium core cross channel, thickness 0.5mm, length 2400mm, web 15mm & 27mm, depth 18mm and flanges of 7mm with suitable edge & centre brackets is then fixed perpendicular to the Strut with the help of fasteners at every 300mm centers. Acoustic melamine panels of size 600x600x16mm in then fixed perpendicular to with suitable edge & centre brackets. Contractor to provide expansion joints of 3mm at every 4.8m bothways.

Panels are backlined with polyfiber 10x25 held in position with dab spots

Technical Parameters

- "• Fire (Class) – 1 & P (For FR grade)
- Acoustics – NRC upto 0.85
- Thermal conductivity (W/mk)– na
- Climate (°C, RH) – 40, 70

- Light reflectance (%) – Colour Dependant
- Green (VOC, RC %) – Low, 25

### **17.6 Fabric Wrapped Pinewood Fiber Panel Sculpted**

Square edge, fabric wrapped pinewood fiber panel sculpted as per design requirement of size 600x2400x20,25,30,40,50mm, density 400 kgs/m<sup>3</sup>, weight 8,10,12,16,20kg/m<sup>2</sup> installed by using Strut framework system with non-visible fasteners using H-Spline.

The Strut framework systems includes Strut Cross Channel having thickness 0.7mm, length 3600mm, knurled web 50, depth 50mm and equal flanges 15mm is fastened to wall positioned horizontally in a regular manner at 600mm c/c. Strut H-Spline having sectional thickness 2mm and length 2400mm to be fixed perpendicular to the Strut CC50 Cross Channel at 600mm centers. The Kerfed edge fabric wrapped panels shall be then inserted into the Strut H-spline along their long edges of 2400mm against framework to perfect fit with staggered short edges.

#### **Technical Parameters**

- Fire (Class) – 1 & P
- Acoustics – NRC 0.95 (For 25mm C50 Mounting)
- Thermal conductivity (W/mk)– 0.08
- Climate (°C, RH) – 50, 90
- Light reflectance (%) – colour dependant
- Green (VOC, RC %) – Low, 30

### **17.7 Acoustical Wooden Perforated Board With Big Circular Perforations**

Acoustical melamine finish wooden perforated board made of pinewood E1 grade fiberboard, with big circular perforations of 50mm dia, melamine laminated finish, Flame retardant grade, size 600x1200x16mm, Square edge, volume density of base board 800Kg/m<sup>3</sup>, weight 8.8Kgs/m<sup>2</sup> installed by using Strut framework system and Z bar.

Strut framework system includes Strut having thickness 0.55mm, length 3600mm, knurled web 35, depth 20mm and equal flanges 15mm is fastened to wall positioned vertically in a regular manner at 600mm c/c. Z-bar having 40mm height, thickness 1mm is first fixed behind the panels by using suitable fasteners. Another length of Z-bar are then installed over Strut horizontally at spacing so as to match with Z-bar at rear of acoustical melamine finish wooden perforation panels. Acoustical melamine finish wooden perforation panels of size 600x1200x16mm are then slid into the Z-bar fixed on Strut. Long edges of panels should be perpendicular to Z-bar and Short edges of the panel are staggered.

Panels are backlined with polyfiber 10x25 held in position with dab spots of approved adhesive

#### Technical Parameters

- Fire (Class) – 1 & P (For FR grade)
- Acoustics – NRC upto 0.85
- Thermal conductivity (W/mk)– na
- Climate (°C, RH) – 40, 70
- Light reflectance (%) – Colour Dependant
- Green (VOC, RC %) – Low, 25

### 17.8 Acoustical Wooden Wall Panelling With Groove Perforated Slats

Acoustical wooden wall panelling made of pinewood E1 grade fiberboard, melamine laminated finish, groove perforated slats L8-2 - (2mm grooves @ 8mm centers) / L16-2 - (2mm Slats @ 16mm pitch) / L32-2 - (2mm grooves @ 32mm centers) / L64-2 - (2mm grooves @ 64mm centers) / L128-2 - (2mm grooves @ 128mm centers), backlined with acoustical fleece, tongue-groove edge for a seamless look, Flame retardant Grade, size 128x2440x16mm, volume density of base board 800Kg/m<sup>3</sup>, weight 8Kgs/m<sup>2</sup> (L16), 10.5Kgs/m<sup>2</sup> (L32), 11Kgs/m<sup>2</sup> (L64) installed by using Strut framework system.

Strut framework system includes Strut aluminium core cross channel having thickness 0.55mm, length 3600mm, knurled web 40mm, depth 10mm and equal flanges 15mm is fastened to wall or framework behind vertically/horizontally at every 600mm c/c. Strut CC18 aluminium core cross channel, thickness 0.5mm, length 2400mm, web 15mm & 27mm, depth 18mm and flanges of 7mm with suitable edge & centre brackets is then fixed perpendicular to the Strut Cross channel with the help of fasteners at every 400mm centers. Slats of size 128x 2440x16mm in then fixed perpendicular to struts with suitable edge & centre brackets. Short edges of the panel are staggered. Contractor to provide expansion joints of 3mm at every 4.88m length wise and 4.992m width wise.

Panels are backlined with polyfiber 10x25 held in position with dab spots of approved adhesive

#### Technical Parameters

- Fire (Class) – 1 & P (For FR grade)
- Acoustics – NRC 0.77 (For E300\* Mounting)
- Thermal conductivity (W/mk)– na
- Climate (°C, RH) – 50, 70
- Light reflectance (%) – 75 (Maple Arce)
- Green (VOC, RC %) – Low, 25

### **17.9 Screwable Magnesium Board**

Magnesium board of thickness 12mm having density 1000kgs/m<sup>3</sup>, weight 12kg/m<sup>2</sup> fixed on the either side of metal framework.

Technical Parameters of magnesium board:

- Core - Magnesia
- Fire – upto 150 minutes
- Acoustics – STC upto 44-50
- Climate (OC RH) – 50, 99
- Termite resistance – Yes
- Moisture Absorption - 6.8% after 2hrs and 11.3% after 24hrs soaking
- Metal framework not included
- Wet Expansion - < 0.02% from ambient to saturation
- Dry Contraction - ≤ 0.02% from evaporation
- Moisture Movement - 0.02%
- Light reflectance – 80 %
- Green (RC %) – 30
- Hygiene (VoC, Clean room) – Low, Class 1
- Strength – Antisag
- Impact - 4kg hammer 175mm

### **17.10 Wall Paneling with 3D engraving**

Wall Paneling with 3D engraving in 18mm thick acrylic solid surface sheet of approved make or as approved by architect basic white color. Design & fixing arrangement as per direction of Architect/Engineer. The material should be CNC 3D cut to achieve the desired design. The CNC cut Acrylic solid surface sheet to be fixed in a box frame or on a frame or on a flat surface as per the drawing and design and as per the instructions of the architect/Engineer. The material used shall be very translucent and the light shall pass through the acrylic solid surface enhancing the design and the lights passing should be very visible. The cost shall include the framing and Boxing of wood / plywood and the frame should be of stainless steel or wood as per requirement of stability and weight carrying capacity and its requirement for support. The 3D shall be done as per the requirement of light translucency and reflection of lights required as per the design and instructions of Architect/Engineer. The backlit ceiling shall have the light passing and shall have translucency. Acrylic solid surface shall have Antibacterial certificate and TUV (Austria) FR grade certified.

### **17.11 Paneling with acrylic solid surface.**

Wall cladding panels with 6mm acrylic solid surface, non-porous and homogeneous seamless, stain resistant, repairable, durable, hygienic environment friendly surfacing material acrylic solid surface sheet of or approved make with a minimum thickness 06 mm in color, design, fixing in customize design arrangement as per direction of Architect/Engineer. Acrylic solid surface sheet to be fixed on wall on top of 12 mm marine ply. Adhesive of the same color to provide inconspicuous joints. Grooves to be given at every 1mtr to give

expansion & contraction movement to material. The rate is inclusive of all operation, material and required pattern. Cost of base like framework and 12mm thick ply will be paid under respective item. Acrylic solid surface shall have Antibacterial certificate and TUV (Austria) FR grade certified.

## **18. HEAT REFLECTIVE COOL PAINT**

Finishing Terrace with a premium specially formulated roof and exterior coating which reflects the damaging UV rays and reduces the internal temp of the buildings. Reflects damaging ultra violet rays from the structures.

- Reduces internal energy demand.
- Dirt pick-up resistant technology.
- Excellent elongation and adhesion.
- Carbonation resistant.
- Breathable and waterproof.

### **18.1 SURFACE PREPARATION**

Thoroughly abrade the surface to remove loose particles, dust and laticence incrustations and existing paint using coarse wire brushes and water jetting.

Fill up all the cracks and crevices with Putty. No. of Coats: - 1 Primer + 2 top coats

## **19. ROLLER BLINDS**

19.1 The item shall include supplying & fixing roller blinds of following specifications:

The drive unit shall be made of moulded plastic with steel spring support & inserted into the tube and it shall be driven by a ball chain pulley with ball chain and can be positioned at right side or left side of the shade. The shade when lowering or raising, shall be automatically locked in position upon release of the ball chain by means of a built-in friction lock. The end plug shall be moulded of plastic with a steel location pin. The plug shall be inserted into the tube end.(opposite to the drive unit).

The support brackets shall be of coated steel & provided with covers & used in right hand positions differentiated by the acceptance of the rectangular drive unit support or the round idler plug pin. The roller tube shall be of extruded aluminum with 38mm internal diameter & skin thickness of 1mm & shall incorporate a keyway integral with the tube to accommodate the spline. The outside diameter of the roller tube shall be 40mm. The bottom rail shall be a stiffening inserted into bottom rod pocket.

The bottom rail shall be a stiffening inserted into bottom rod pocket. The material may be timber, PVC covered steel tube or VB bottom rail. The ball chain shall be 2mm diameter cord with 4.5mm diameter acetal balls moulded co-axially to it on 6mm pitch to form an endless ball chain which is used for raising or lowering action of the shades.

Fabric shall be attached to the tube with an adhesive strip. A minimum of one turn of fabric must be placed on the roller before the working section of fabric starts.

The fabric shall be as per selection from specified Manufacturer's range & shall be sized according to site requirements, manufactured by Approved make as described below:

Blackout roller blinds with 100% polyester blackout fabric with reverse & front side pigment colour coated complete with installation.

Roller blinds with fabric made of 35% fiberglass, 65% vinyl on fiberglass and has to have Gold Green guard Certification.

#### **19.2 Measurements:**

Length and breadth shall be measured correct to cm. fully opened Roller Blind area from Drive unit to Bottom rail shall be measured in square meter nearest to two places of decimal. The rate shall include the cost of materials and labour required for all the operations described above.

### **20. GLASS FILM**

#### **20.1 Frosted Film:**

Crystal Glass film FROSTED effect with approved artwork, cut using digital plotter. Self-adhesive, bubble-free installation to be done on clean glass, by Authorised Installers only. 3M or equivalent Architectural Markets

#### **20.2 Digitally Printed Film**

Digitally reproduced Film could be fixed on Lift lobbies & Corridor partitions of 3M or equivalent Clear Graphics 114 make or approve equivalent. The film shall be Durable inkjet printed graphics on self adhesive vinyl, special CLEAR film to produce coloured imagery on glass. Customized imagery with approved graphics including providing company warranty at all leads & lifts etc.

### **21. TOUGHENED CERAMIC DIGITALLY PRINTED GLASS**

12mm thick toughened ceramic digitally printed glass. 12 mm annealed Glass used for digital printing should be of Saint Gobain/ Asahi/ Pilkington and should be toughened in vertical tempering line. Digitally printed glass must be and only be of ceramic ink and printed on DIPTECH/TECGLAS Plant; ink should be of ceramic and carrier should be terephthalene oil, Which is then tempered post printing so that the ceramic ink embeds inside the glass making it permanent and homogeneous;; highly durable ; water resistance , UV resistance; environmentally friendly (no lead, no arsenic, no copper, no formaldehyde; compressive strength (1000 MPa) & tensile strength (40 MPa), same as float glass as per the detailed drawings and as approved by Architect/Engineer/DFCCIL.

### **22. STAINLESS STEEL RAILING WORKS**

#### **22.1 Dia 50mm Round Baluster System:-**

Supply and installation of Arch make 304 Grade Stainless Steel Knock Down railing system comprising Ø 50mm Handrail fixed on Ø 50mm S.S. Round baluster (Design Code ABT222-1- 163) placed at maximum 1200mm c/c along with 3 Nos. Ø 16 mm mid rails connected at the side of baluster with fixtures. The



balustrade would be fixed onto floor with casted base plate of minimum 6mm thickness. Base plate shall be concealed with suitable S.S. 304 grade cover Cap so that the mounting anchor fasteners are not visible after installation. Wall thickness of Handrail & Baluster Pipes shall be taken as 1.5mm & Mid Rail Shall be 1.2 mm along with all visible components developed in High Grade S.S. and whenever required, joints to be filled with bushings for extra strength. Railing height to be taken @ 1000mm from floor level.

## **22.2 Wall Mounted Railing systems:-**

Supply and installation of Arch make 304 Grade Stainless Steel Knock Down Wall mounted Railing system comprising Ø 50mm Handrail mounted on the wall through Wall Brackets & anchor fasteners which will be placed at maximum 1200mm c/c distance and as per site requirement. Wall thickness of all Pipes shall be taken as 1.5mm along with all visible components developed in High Grade S.S. and whenever required, joints to be filled with bushings for extra strength.

## **22.3 Installation:-**

Installation shall be by done a qualified, authorized representative of the manufacturer. Installation must be in accordance with standard or non-standard, yet applicable details (instructions) included on installation/shop drawings provided by the manufacturer. Install components plumb and in-line, accurately fitted, free from distortion or defects and securely anchored to structure.

## **22.4 Protection after installation:-**

Contractor is to provide protective covering on handrails and guardrails if construction is not yet finished in the area where the railings are installed.

## **22.5 Measurements:-**

Length of the finished Railing shall be measured correct to a cm. The rate shall include the cost of the labour, T&P and materials involved in all the operations described above.

## **23. Acrylic Solid surface LATTICE JALLI**

Lattice Jalli partitions in 12mm thick acrylic solid surface sheet of approved make. The acrylic solid surface should be conforming to TUV (Austria) standards. Installation to be done in basic series with spickles, thickness (12 mm), as approved by Architect/Engineer/DFCCIL. The material should be CNC cut to achieve the desired design as per Architect/Engineer. The 6mm deep CNC cut Acrylic solid surface/ cnc cut lattice jail sheets to be fixed with the help of 25x25 mm Aluminum/25x25mm teak wood/75x75mm class teak wooden frame from all the 4 sides of the lattice jalli. Lattice jaali frame to be supported with the help of Hilti/ or approved fasteners as per requirement. Adhesive of the same color. The rate is inclusive of framework, material and required pattern approved.

Durability performance & Design flexibility / Non-porous & Hygienic(Anti-bacterial)

Acrylic solid surfaces should be tough and repairable. Acrylic solid surfaces should be solid all the way through, minor cuts, scratches or nicks can be quickly sanded out, restoring the surface to its initial appearance. Acrylic solid surfaces should be long lasting.

Acrylic solid surfaces should be easy to clean and maintain. Acrylic solid surfaces should be stain and resistant and shall be non-porous.

Acrylic solid surfaces to be non-porous it should not support the growth of microbial growth. Acrylic solid surfaces should be workable and as per requirement it should carve able, sandblasted, polished and cut-out to create a one-of-a-kind look in a variety of shapes and finishes. Acrylic solid surfaces wherever required should also be thermoform able or shaped using heat. Acrylic solid surfaces should be as per requirement in relevant colour and should be developed as per design. The material / product used should be selected as per requirement and wherever it requires thermoforming, laying, etching, carving and shaping capabilities then thermoformable material /product should be used. The product should be selected according to its use. The final finished product should be seam less, joint less and shall maintain lustre and when etched it should have a smooth finish. Acrylic solid surface shall have Antibacterial certificate and TUV (Austria) FR grade certified.,

#### Product Specifications

Property	FUNCTION SIGN	INDEX	UNIT	TEST METHOD
Density	1.5 - 1.8		kg/dm <sup>3</sup>	DIN 52 102
Mass	16		kg/m <sup>2</sup>	
Barcol Hardness	55-70			DIN 68 861
Tensile Strength	25-60		N/mm <sup>2</sup>	DIN EN ISO 527
Flextural	30-60		N/mm <sup>2</sup>	EN 310
Modulus elasticity	5000 - 9000		N/mm <sup>2</sup>	EN 310
Ball Drop	170 - 280		N/mm <sup>2</sup>	DIN ISO 2039
Impact Strength	1.5 - 6.5		kJ/m <sup>2</sup>	Din EN ISO 179
Long/thermal Expansion	3.5 x 10		m/m'k	DIN 53 752
Water Absorption	<0.04		%(mass)	DIN 53 495/ASTMD 570
Light Fastness	Blue Scale 5-7,			DIN EN ISO 4892
	Grey Scale 4-5			
Fungi & Bacteria	No Infestation			ISO 846 A/C

Calotitic Value	Ca. 10	Mj/kg	DIN 51 900
Fire Behaviour	B2		DIN EN 13501-1
Chemical Resistant	1B		DIN 68 861-1

#### 24. 3D COPPER MURAL:

3D copper mural to be in panels in various sizes varies from 1.2 to 4.5 sqmtr. Hammered copper shall be fixed on 12mm BWP ply. Cot of ply to be included. Concept of copper mural will be specially be designed keeping in mind that the art mural will enhance the ambience and would improve its look aesthetically. Framing Cost includes frame of 25 mm X 50 mm Aluminum Box/ teak wood section installed on the plastered wall with suitable brackets /fasteners.

#### 25. GI TRAP DOORS

GI Trap Doors are to be made to big sizes – upto 8' long. For instance, even 8' x 4'. Big frames & shutter are reinforced with stiffeners to prevent warping

Only a uniform 2.5mm groove all around to be provided with sliding hinges, making it blend seamlessly with the ceiling

Trap Door to consist of an Inner Frame and an Outer Frame. Both the frames are to be completely flexible for any size requirement. Material for the frame is Galvanised Iron and the finish can be anodized or powder coated as per the recommendation of Architect/Engineer/DFCCIL.

#### 26. 3D ENGRAVED ACRYLIC PANEL:

Designer Wall Paneling with 3D engraving in 18mm thick in solid surface sheet of approved make manufactured as per TUV (AUSTRIA). The colour shall be as as approved by Architect/Engineer/DFCCIL basic white color. Design &, fixing arrangement as per direction of Architect/Engineer/DFCCIL. The material should be CNC 3D cut to achieve the desired design. The CNC cut Acrylic solid surface sheet to be fixed in a cove developed as per design and the cost of cove wood or stainless steel shall be paid separately in separate items. The 3D acrylic shall be carved in the design and theme suiting the environment. The material used shall be very translucent and the light shall pass through the acrylic solid surface enhancing the design. The material used shall have translucency to enhance 3D effect.

Durability performance & Design flexibility / Non-porous & Hygienic (Anti-bacterial)

Acrylic solid surfaces should be tough and repairable. Acrylic solid surfaces should be solid all the way through, minor cuts, scratches or nicks can be quickly sanded out, restoring the surface to its initial appearance. Acrylic solid surfaces should be long lasting. Acrylic solid surface shall have Antibacterial certificate and TUV (Austria) FR grade certified.,

Acrylic solid surfaces should be easy to clean and maintain. Acrylic solid surfaces should be stain and resistant and shall be non-porous.

Acrylic solid surfaces to be non-porous it should not support the growth of microbial growth. Acrylic solid surfaces should be workable and as per requirement it should carve able, sandblasted, polished and cut-out to create a one-of-a-kind look in a variety of shapes and finishes. Acrylic solid surfaces wherever required should also be thermoform able or shaped using heat. Acrylic solid surfaces should be as per requirement in relevant colour and should be developed as per design and the material / product used should be selected as per requirement and it may require thermoforming, laying, etching, carving and shaping capabilities. The product should be selected according to its use. The final finished product should be seam less, joint less and shall maintain lustre and when etched it should have a smooth finish. The backlit ceiling shall have the light passing and shall have translucency.

#### Product Specifications

Property	FUNCTION INDEX SIGN	UNIT	TEST METHOD
Density	1.5 - 1.8	kg/dm <sup>3</sup>	DIN 52 102
Mass	16	kg/m <sup>2</sup>	
Barcol Hardness	55-70		DIN 68 861
Tensile Strength	25-60	N/mm <sup>2</sup>	DIN EN ISO 527
Flexural	30-60	N/mm <sup>2</sup>	EN 310
Modulus elasticity	5000 - 9000	N/mm <sup>2</sup>	EN 310
Ball Drop	170 - 280	N/mm <sup>2</sup>	DIN ISO 2039
Impact Strength	1.5 - 6.5	kJ/m <sup>2</sup>	DIN EN ISO 179
Long/thermal Expansion	3.5 x 10	m/m'k	DIN 53 752
Water Absorption	<0.04	%(mass)	DIN 53 495/ASTMD 570
Light Fastness	Blue Scale 5-7, Grey Scale 4-5		DIN EN ISO 4892
Fungi & Bacteria	No Infestation		ISO 846 A/C
Calotitic Value	Ca. 10	Mj/kg	DIN 51 900
Fire Behaviour	B2		DIN EN 13501-1
Chemical Resistant	1B		DIN 68 861-1

#### 27. STAIN GLASS MURAL:

Stain glass mural sandwich panel in 5mm stain toughened glass panel+5 mm thick toughened clear glass facing outside. Concept of stain glass will be specially be designed keeping the company's profile in mind the art mural will enhance the ambience and would improve its look aesthetically.

The material used in making the stain glass will be lead, 5 stain toughened glass panel+5 mm thick clear toughened glass, Imported resins and staining chemicals, imported color dyes overall thickness of glass in 10mm,thw two panes will be sealed with silicon as/approved from all sides.

Cost includes frame of aluminum powder coating which runs around the glass panel fixed to wall/RCC column.

## **28. ARTIFICIAL TURF:**

Artificial Turf 40 mm thickness –Drain cells & application of Solvent below the Drain Cells. Drain cells functions as a highly efficient lightweight drainage system that rapidly captures and transports even high water volumes associated with torrential rain.

Terms that goes under artificial turf other than Drain Cells:

Large Stones. Rocks ranging from three-eighths to three-fourths of an inch are perfect for artificial grass sub-base.

Fine Materials. It is imperative to have a filler material, called fines, to surround the larger crushed rocks for overall turf stability.

Ideal Mixture.

Weed Fabric.

## **29. PLANTERS:**

Planters for display of plants at Reception and diff area of Building indoor/Outdoor, highly resistant to breakage, harsh weathers and ultra violet rays. These Plants include air purifying plants, that would absorb all the toxins from the air released from the computers thus benefitting the long term health of the employees spending 8-10 hrs Indoors.

Areca palm (3'-4' ht., bushy) & planter size -13"X13"X18" with fillers

Spathypyllum wallici (1'-2' ht. bushy) & FRP planter size -7.5"X7" with fillers

Bosten fern (1'-2' ht. bushy) with & FRP planter size -7.5"X7" with fillers

Drasaena marginata (2' ht. multibranch) & FRP planter size - 10"X10"X10" with Fillers

Ficus lyrata (4' ht. branched ) & planter size -13"X18" with Fillers

Snake Plant (2.5' Ht. ) & planter size -10"X 10"X10" with Fillers

Alocasia with 6" pvc (white) pot of 1' ht

Raphis Palm 3-4' ht. multi tiller (4-5 tiller)

Chamadora of 5-6' ht. bushy of 5-6' ht. bushy

Japanese bamboo/ Black bamboo of 4'-5' ht. multi tiller (7-8 tiller)

Ficus elastica of 2' ht. bushy

## **30.Wall art**

Providing & Placing of Carved Wooden Mural in melamine finish panels of sizes 690mm (W) x 30-40mm (D) x 1000mm (H). The fixing details shall be as per approved design and the surface shall be fixed with suitable fasteners drilled etc. to ensure stability of the wooden mural. The carved wooden mural shall enhance the aesthetic beauty of the vertical/ horizontal surface as per site. Transportation to site included. Installation

and fixing the mural is included. Scaffolding and support system to all height included. The design should be approved by the Architect/Engineer.

### **31.Paintings**

Providing & Placing of paintings in various sizes varies from 2 to 4.5 sqmtr. The canvas should be artistic matte cotton canvas 410 GSM. Matte finished, crack-resistant, water-resistant, top-coated and stretched over stretcher bars(wooden frame) at the back. The stretcher bars are not visible from the front and sides. It comes with hooks and ready for hanging on the wall. The paintings should be mounted on wooden frames with melamine finish. The subject and design of the painting should complement the surroundings and add a meaningful presence and should be as per the decision of the Architect/Engineer.

### **32. Steel Glass Covering/ partition**

Stainless Steel Glass Covering/ partition using spider fittings:- Fabrication, Supply & Installation of horizontal and vertical directional Covering/ partition using spider fittings (Conforming to SS304 Grade, Satin Finish) with various size of Covering/ partition using spider fittings. Structure consisting of SS304-219, 168 Tubular Sections with 75 x 75 Sections, fixing Plate (if required as per architectural plans), with 4-Arm Stainless Steel Spider Glass fitting Arrangements with 8+1.52+8mm Thick Laminated Toughened Glass fixed with clear weather Silicon as per drawing and details. direction as per Engineer In Charge.

### **33. ACOUSTIC SLIDING FOLDING PARTITION**

The partitions shall comprise of flat panels, plus 1 expanding panel (telescopic element) for closure. The sound coefficient (Rw) shall be 50dB. The sound insulation tests of the movable walls are carried out under German DIN standard with results measured in Rw. This is a standard test in a laboratory with so called flanking sound transmission. This test is the most realistic because it is a measurement under site conditions including sound transmission through ceiling, doors, walls etc.

The panels shall stack at the end of the track in center stacking formation. The thickness of each panel is 85mm including 16mm thick MDF on both sides.

The partition runs on a specially designed and firmly held track of heavy-duty aluminum in which a specially designed trolley on ball bearing runs smoothly and noiselessly. The closure of the spaces above, below and between the panels is done by a specially designed mechanism, which closes these gaps to prevent passage of sound.

#### **33.1 Installation:**

The track received from the manufacturer is affixed to this structure with suitable suspension arrangement after leveling and straightening.

Also the longevity and ease of operation depends on the precision and level of track achieved before the partition is installed. Therefore the installation process is as important as the quality of the partition.

These panels are thereafter suspended in the track and checked for smooth operation, parallel horizontal movement and sealing all around.

Providing & Fixing Centre Pole Outdoor Café Umbrella with Diameter is 3.5m which should provide great coverage to table. Fabric should be 100% Waterproof and weatherproof. Rod should be made up of MS, and the rotator liver should be made up of PVC. 20L Water Base shall be included with this umbrella, which could be either filled with water or sand for sturdiness.

Technical Specification of furniture Sub-head to be derived from the Nomenclature of the BOQ ITEM

### **34. MODULAR WORKSTATIONS (TILE BASED SYSTEM)**

#### **34.1 Components:-**

Panels Construction - Each panel consists of Vertical extrusions 2Nos and Horizontal extrusions made of 1.2mm thick aluminum with duly powder coated at every division of tile/block. Each panel have Bottom frame fabricated for 50-60mm panel comprises of L-channels made of 2mm thick CRCA steel (IS: 513), formed plates of 3mm thick HR steel (IS: 2062) & ERW steel tube of size 35x15x1.6mm thick in oval cross section (IS: 7138) welded together. The complete bottom frame shall be powder coated with an average of 50-60 microns thickness of epoxy powder coating. The Bottom Frame is bolted with the Upright verticals. Each Panel is provided with 2Nos Legs of height 120mm are fixed at the bottom frame of the panel. Legs are fabricated by CO2 welded MS Tube of section 38mm x 25mm (IS: 7138 ERW Tube, 38mm x 25mm x 16bg) with the base plate of the MS plate of 35x22x5mm (IS: 2062, 5mm HR) over which an M8 Leveler is fitted which allows for adjustment of the height by 50mm. It will be coated with 45-50micron thickness of epoxy powder coating. Each Panel consists of 2Nos Intermediate blocks. In a 50-60mm Thick panel intermediate block shall comprise of 38mm thick paper honeycomb with 3mm MDF/ Hollow MDF on each sides and 0.6mm decorative laminate on both sides. Particle board framing shall be used on outer boundary of these blocks as well as intermediately at certain locations forming conduit for passing cables. These blocks will be located in the middle bands of the panels made out of a composite construction of MDF and paper honeycomb/ hollow MDF. Each Panel consists of TOP TILES/SPLIT TILES. These tiles shall be slide in to the panels from top before fixing the top horizontal. These tiles shall be supported from top & bottom side with clips made from PP co polymer fitted in horizontal extrusion. In case of split tiles it shall be offered in Fabric magnetic tiles, Whiteboard tiles. Each Panel consists a BOTTOM TILE. These bottom tiles shall be press fitted on to the assembly frame of the panel with the help of snap on clips made of nylon-66 and support clips made from Polypropylene (PP). All partitions and side panels have levelling screws for adjustment in case of uneven floor to take care of +/- 40 mm of uneven flooring.

#### **34.2 Tile Finishes :**

34.2.1 FABRIC MAGNETIC TILES: Fabric magnetic tiles shall be fabric upholstered metal tiles in 0.6 mm thick G.I. Grade O as per IS: 277. The fabrics shall be upholstered with adhesives.

34.2.2 FABRIC TACK TILES: Fabric tackable tiles shall be upholstered metal tiles in 0.6mm thick G.I. grade O as per IS: 277, with Polyurethane foam in the tile for tackability. The fabric shall be upholstered with adhesives.

34.2.3 WHITE BOARD TILES : White board tiles shall be made of 8.0 mm thick particle board conforming to IS: 12823 laminated with 0.6mm thick white glossy high pressure laminate on outer side & 0.6mm backing laminate on inner surface and will be having all its edges with minimum 0.5 mm thick PVC edging.

34.3 Aluminum Trims: The top trims and end trims for 50-60 mm shall be made from aluminum extrusion. All kinds of extrusions for 50-60mm shall have average wall thickness of 1.2 mm & having finish of powder coating. Top trim in 50-60mm thick panel shall be press fitted on the horizontal extrusion, it shall be slide fitted with the help of top trim connector made from PP copolymer 3530 grade. End trim for 50-60mm thick panel shall be slide fitted with the help of end trim connector made from 2.0mm thick M.S. CRCA Grade D as per IS: 513.

34.4 Legs - System shall also have 120 mm high powder coated welded metal legs to give the system an elevated look. Single side legs are fabricated by CO2 welded MS Tube of section 38 mm x 25 mm (IS: 7138 ERW Tube, 38 mm x 25 mm x 16bg) with the base plate of the MS plate of 35mm x 22mm x 5mm (IS: 2062, 5 mm HR) over which an M8 Leveler is fitted

34.5 End/Intermediate separator: partitions of 22.8mm thick including powder coated aluminum trims and supported on Legs for better air circulation and helps in keeping floor clean. The 22.8 mm panels are only to be used as Separator/End panels to provide additional privacy. These panels have various finishes and no cable management ability.

34.6 Panel Construction: The 22.8mm End/Separator panels shall be made of horizontal and vertical uprights. These uprights and horizontals shall be made of aluminum extrusion having material AL96063-T6 & have average wall thickness of 1.2mm & powder coated with epoxy-polyester powder. The Blocks for the End/Separator panels shall be of 16mm to 18mm thickness in the selected finish. The top most block in the panel shall be the top block of the panel. It shall be available in fabric, laminate, whiteboard, fabric metal, tackable and clear glass finishes. The 2Nos blocks in the intermediate bands shall be available in fabric or laminate finish and the lowermost block in the panel shall be the bottom block which shall be in fabric, metal or laminate finish.

34.7 Tiles: Tile Finishes in End/Separator Partitions to be provided as per the site and layout approval. Finishes in these panels shall be

34.8 LAMINATE FINISH BLOCKS: Laminate finish blocks shall be made from 18mm thick particle board, clad with 1mm thick laminate of approved shade.

34.9 FABRIC FINISH BLOCKS: These shall be made from 18mm thick Pre-Laminated Particle Board upholstered with 1mm thick approved shade of fabric using adhesives.

34.10 WHITEBOARD BLOCKS: These shall be made of 16mm thick particle board laminated with 0.6mm thick white glossy high pressure laminate on both sides and having all its edges with minimum 0.5 mm thick PVC edging.

34.11 GLASS BLOCKS: These shall be made of 4mm thick toughened plain glass having diamond polish edge finish.

34.12 FABRIC TACKABLE BLOCKS: These shall be made from 18mm thick Pre-Laminated Board battens which hold 3mm MDF in between. 6mm thick Polyurethane foam shall be pasted on 3mm thick MDF and this assembly shall be upholstered with approved shade of fabric on both sides using adhesive.



34.13 METAL FINISH BLOCKS: Metal finish blocks shall be made from two components of 0.8mm thick M.S. CRCA Grade D as per IS: 513 powder coated with epoxy polyester finish.

34.14 Aluminum Trims: The top trims and end trims for 22.8mm partition shall be made from aluminum extrusion having material AL96063-T6. Top trim in 22.8mm thick panel shall be slide fitted with the help of top trim connector made from PP copolymer 3530 grade. End trim for 50-60mm thick panel shall be slide fitted with the help of end trim connector made from 2.0mm thick M.S. CRCA Grade D as per IS: 513. End trim for 22.8 mm thick panel shall slide with the help of end trim connector made from nylon-66.

34.15 Legs: Legs shall be 120 mm high powder coated welded metal legs. Legs shall be fabricated by CO2 welding MS Tube of section 38mm x 20mm (IS: 7138 ERW Tube) with the base plate of the MS plate of 35mm x 22mm x 5mm (IS: 2062, 5 mm HR) over which an M8 Leveler shall be fitted, The height of the panel leg will be 126mm. This shall be coated with minimum 45 micron thickness of epoxy powder coating.

34.16 Workstation Worktop as per the approved shape and site requirement made out of 25mm thick prelam particle board. All the open edges of work surface shall be provided with machine pressed 2 mm thick PVC lipping glued with hot melt EVA glue. The work surface shall be provided with circular cut out of Dia.65mm as per the requirement, for passing of wires. These cut outs shall be provided with ABS covers. Work surfaces are fitted to the panels by work surface brackets. Brackets are made of 2.0mm thick CRCA grade D steel as per IS : 513-19. Brackets are slide in between end trim and vertical extrusions. The product should be complete and as per approved sample and as per the direction of Architect/Engineer/DFCCIL.

Computer Key Board Tray of 480mm (L) X 280mm (D) X 40mm(H) made out of CRCA steel as per IS : 513I made of 0.9mm thick powder coated with sliding channels and other fixtures/fittings. It should also have a sliding system for accommodating mouse. The product should be complete and as per approved sample and as per the direction of Architect/Engineer/DFCCIL.

CPU Trolley of Size - 345mm(W) x 226(D) x 180mm(H) is made of 1.0 mm thick MS CRCA Sheet and Side support is made of 0.8 mm thick MS CRCA Sheet. It consists of 4Nos Non-lockable twin wheel castors are injection moulded in Black Nylon. The product should be complete and as per approved sample and as per the direction of Architect/Engineer/DFCCIL.

Mobile Pedestal having 3 Drawers Unit having flat metal front and top with Central locking. The Drawer Unit consists of 2Box and 1File Drawers. The Overall size of the Drawer Units is 450mm(W) X 435mm(D) X 646mm(H). Construction & Material of Drawer Unit : Welded Assembled of 0.8 thick CRCA for Body Shell, Drawer Front & tray, Front Side Stiffener, Rear Side Stiffener & Bottom, 1.2mm thick CRCA Top Stiffener & Bottom stiffener. Drawer Fronts & Metal Front Straight Edge. All Drawers with Double extension precision ball slide shall be provided. For Drawer pulling, side wise tapered recess provided in shell behind Drawer Fronts. Locking:10 lever Cam Lock & Central RH locking with actuator & lock channel mechanism. Top Panel : 0.8mm thick Metal Straight Edge Top. Castors : Swiveling non-lockable 4Nos Castors mounted below the body shell. The Total drawer unit is finished with Epoxy Polyester Powder coated to the thickness of 50 microns (+/-10). The product should be complete and as per approved sample and as per the direction of Architect/Engineer/DFCCIL.

### **34.17 Electrical Fittings and Wire management:-**

Wires shall be taken into the system through cable ducts from the junction boxes and it is carried upto the panels through concealed conduits inside the blocks. Wires runs through the system from Bottom tile and extended to the top at various locations by the help of 2 nos. vertical Cable Ducts in each panels. Cable duct shall be made from 0.8 mm thick M.S. CRCA Grade D as per IS: 513 - 1994. It is constructed with two parts, one is body & another is cover. It holds the cables & gives aesthetic appearance by covering all cables entry, which are moving upward to the panels. Size of Cable duct is 107mm W X 154 mm H X 21 mm D.

**34.18 Measurement:** Measurement for payment shall be for each unit for single person seating capacity

## **35 TILE BASE FULL HEIGHT MODULAR PARTITION**

### **35.1 Frames: -**

Partition thickness is 50- 80mm for added stability and main structure shall be a combination of different Aluminum Sections made from Aluminum alloy 63400-WP and shall be powder coated with Epoxy Polyester or Anodized, varying in heights and widths to make a full height cabin up to 3000 mm below the false ceiling level. The frame structure shall be made by joining Aluminum Extrusions by means of brackets made of 3 mm thick HR (IS-2062) and screws. Overall thickness of panel assembly shall be 66 mm. In elevations, the width of tiles shall vary from 300mm to 2400mm in pitch of 150mm and heights shall vary from 600 mm to 2400 mm (actual 534 mm to 2136 mm) in pitch of 600 mm. The system shall provide to make junctions straight partition panels as per approved layout. The super structure above false ceiling level shall consist of True ceiling mounting bracket which shall hold wooden batten frame work made from Rubber wood (50x50xlength of partition). The partition panel extrusions shall be grouted to this superstructure. The system shall have provision for leveling adjustment to compensate for floor unevenness (up to 40 mm) as well as false ceiling height difference (up to 15 mm). Provision shall be provided Horizontal adjustment at wall side with adjustment up to 20 mm.

### **35.2 Raceways:-**

Provision of wire management through the panels vertically shall be possible. Wiring intake into the panel from flooring as well as ceiling shall be provided. Provision in panel width up to 1200 mm width for 2 slots of 100 x 25 at a distance of 100 mm from the edge of the panel shall be provided. Beyond 1200 mm to 2400 mm, the slots shall increase from 2 to 4 nos. the intermediate slots shall be equidistance from the end slots. The end slots shall be same as the ones in the 1200 mm w panels. Provision to provide wire management in full glazed panel in separate power post should be possible.

### **35.3 Tiles:-**

#### **Fabric Tile:**

Fabric Non-tack tiles shall be made of 9.0 mm thick PLB / PLT boards(IS: 12823:1990 ) edge banded with 0.5 mm thick PVC lipping, and upholstered with approved fabric on front side. The overall thickness of tile shall be 10mm.

**Glass Tile:**

The glass used is 5 mm thick clear Toughened glass or 5mm thick BPG Toughened glass (IS-2835) PVC Rubber extrusion fixed on to the extrusion profile, supports the glass edges from back side

**Tackable tile:**

Fabric Tackable tiles shall be made of 0.7mm thick GI Sheet (IS-277), with 8mm thick P.E. foam glued to it on front side which are fabric upholstered on front side. The overall thickness of tile shall be 9 mm. Stiffeners made of GI Sheet (IS-277) shall be provided at the back of the tile.

**Whiteboard marker tiles:**

Back painted glass of 5 mm Shall be provided for glass finished writing board in the panel itself.

**Laminate Tile:**

Wooden DL tile of 9 mm thick PLB edge banded with 0.5 mm thick PVC lipping with approved design of laminate shade shall be provided as per approved panel elevations.

**35.4 Wire Management: -**

Provision of wire management through the panels vertically shall be possible. Wiring intake into the panel from flooring as well as ceiling shall be provided. Provision in panel width up to 1200 mm width for 2 slots of 100 x 25 at a distance of 100 mm from the edge of the panel shall be provided. Beyond 1200 mm to 2400 mm, the slots shall increase from 2 to 4 nos. the intermediate slots shall be equidistance from the end slots. The end slots shall be same as the ones in the 1200 mm w panels. Provision to provide wire management in full glazed panel in separate power post should be possible.

**36.0 TILE BASE LOW HEIGHT MODULAR PARTITION**

**36.1 Frame:-**

Each panel consists of Vertical extrusions 2Nos and Horizontal extrusions made of 1.2mm thick aluminium with duly powder coated at every division of tile/block. Each panel have Bottom frame fabricated for 50-60mm panel comprises of L-channels made of 2mm thick CRCA steel (IS: 513), formed plates of 3mm thick HR steel (IS: 2062) & ERW steel tube of size 35x15x1.6mm thick in oval cross section (IS: 7138) welded together. The complete bottom frame shall be powder coated with an average of 50-60 microns thickness of epoxy powder coating. The Bottom Frame is bolted with the Upright verticals. Each Panel is provided with 2Nos Legs of height 120mm are fixed at the bottom frame of the panel. Legs are fabricated by CO2 welded MS Tube of section 38mm x 25mm (IS: 7138 ERW Tube, 38mm x 25mm x 16bg) with the base plate of the MS plate of 35x22x5mm (IS: 2062, 5mm HR) over which an M8 Leveler is fitted which allows for adjustment of the height by 50mm. It will be coated with 45-50micron thickness of epoxy powder coating. Each Panel consists of 2Nos Intermediate blocks. In a 50-60mm Thick panel intermediate block shall comprise of 38mm thick paper honeycomb with 3mm MDF/ Hollow MDF on each sides and 0.6mm decorative laminate on both sides. Particle board framing shall be used on outer boundary of these blocks as well as intermediately at certain locations forming conduit for passing cables. These blocks will be located in the middle bands of the

panels made out of a composite construction of MDF and paper honeycomb / Hollow MDF. Each Panel consist of TOP TILES/SPLIT TILES. These tiles shall be slide in to the panels from top before fixing the top horizontal. These tiles shall be supported from top & bottom side with clips made from PP co polymer fitted in horizontal extrusion. In case of split tiles it shall be offered in Fabric magnetic tiles, Whiteboard tiles. Top Tiles can be offered in Fabric Magnetic, Fabric Tack tiles, White Board tiles as per approval of Architect/Engineer. Each Panel consists a BOTTOM TILE. These bottom tiles shall be press fitted on to the assembly frame of the panel with the help of snap on clips made of nylon-66 and support clips made from Polypropylene(PP). All partitions and side panels have levelling screws for adjustment in case of Uneven floor to take care of +/- 40 mm of uneven flooring.

### **36.2 Wire Management: -**

Wires shall be taken into the system through cable ducts from the junction boxes and it is carried up to the panels through concealed conduits inside the blocks. Wires runs through the system from Bottom tile and extended to the top at various locations by the help of 2 nos. vertical Cable Ducts in each panels. Cable duct shall be made from 0.8 mm thick M.S. CRCA Grade D as per IS: 513 - 1994. It is constructed with two parts, one is body & another is cover. It holds the cables & gives aesthetic appearance by covering all cables entry, which are moving upward to the panels.

Size of Cable duct is 107mm W X 154 mm H X 21 mm D. Legs - System shall also have 120 mm high powder coated welded metal legs to give the system an elevated look. Single side legs are fabricated by CO2 welded MS Tube of section 38 mm x 25 mm (IS: 7138 ERW Tube, 38 mm x 25 mm x 16bg) with the base plate of the MS plate of 35mm x 22mm x 5mm (IS: 2062, 5 mm HR) over which an M8 Leveler is fitted.

### **36.3 Tiles:-**

Tile Finishes in End/Separator Partitions to be provided as per the site and layout approval. Finishes in these panels shall be

- **LAMINATE FINISH BLOCKS:** Laminate finish blocks shall be made from 18mm thick particle board, clad with 1mm thick laminate of approved shade.
- **FABRIC FINISH BLOCKS:** These shall be made from 18mm thick Pre-Laminated Particle Board upholstered with 1mm thick approved shade of fabric using adhesives.
- **WHITEBOARD BLOCKS:** These shall be made of 16mm thick particle board laminated with 0.6mm thick white glossy high pressure laminate on both sides and having all its edges with minimum 0.5 mm thick PVC edging.
- **GLASS BLOCKS:** These shall be made of 4mm thick toughened plain glass having diamond polish edge finish.
- **FABRIC TACKABLE BLOCKS:** These shall be made from 18mm thick Pre-Laminated Board battens which hold 3mm MDF in between. 6mm thick Polyurethane foam shall be pasted on 3mm thick MDF and this assembly shall be upholstered with approved shade of fabric on both sides using adhesive.
- **METAL FINISH BLOCKS:** Metal finish blocks shall be made from two components of 0.8mm thick M.S. CRCA Grade D as per IS: 513 powder coated with epoxy polyester finish.

**TECHNICAL SPECIFICATIONS FOR PLUMBING WORKS**

## **SECTION-I: BASIS OF DESIGN**

### **1. BASIS OF DESIGN**

The internal Plumbing, Sanitary, Drainage System for the project is designed keeping in view the following:

- 1.1 Requirement of adequate and equal pressure availability of hot and cold water lines in public/common toilets and kitchen (sinks) will be already installed.
- 1.2 Adequate storage of water in underground raw and treated domestic water tanks, already exist at the site.

The works execution and materials used shall be as per the latest relevant I.S. specifications

Wherever reference has been made to International Standards or any other specifications, the same shall mean to refer to the latest specification irrespective of any particular edition of such specification being mentioned in the specifications below or in Schedule of Quantities.

### **2. CONCEPT OF THE SYSTEM**

The following services are envisaged for the tender:

- 2.1 Soil/waste & water supply lines are already exist at the fixture level.
- 2.2 All sanitary items to be supplied & installed considering drawings & site conditions.
- 2.3 The Contractor shall visit the site and shall satisfy himself as to the conditions under which the work is to be performed. He shall also check and ascertain the location of any existing structure or equipment, or any other situation which may affect the work. No extra claim as a consequence of ignorance or on ground of insufficient description will be allowed at a later date.

### **3. PLUMBING/SANITARY WORKS:**

#### **3.1 GENERAL:**

- 3.1.1 The work shall be carried out in the accordance with the drawings and design as would be issued to the Contractor by the Design Consultant and duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications etc. not bearing Design Consultant's signature and stamp. Similarly the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Client's Representative in writing.
- 3.1.2 The work shall be executed and measured as per metric dimensions given in the Bills of Quantities, drawings etc.
- 3.1.3 The Contractor shall acquaint himself fully with the partial provisions for supports that may or may not be available in the structure and if they are available then he utilize them to the extent possible. In any case the Contractor shall provide all the supports regardless of provisions that they have been

already made. Nothing extra shall be payable for situations where insert plates (for supports) are not available or are not useful.

- 3.1.4 Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.
- 3.1.5 The Contractor shall protect/handle the material carefully and if any damage occurs while handling by the Contractor then the sole responsibility shall be of the Contractor. Such damages shall be rectified/ recovered by the Contractor at no extra cost whatsoever.
- 3.1.6 The Contractor shall, within twenty one (21) days of receipt of the Notice of Award for the Project, where applicable, complete the submission of shop drawings to the Client's Representative for approval by the Design Consultants in order to conform to the contract schedule.
- 3.1.7 **Measurements:**  
All measurements shall be taken in accordance with relevant NFPA codes, unless otherwise specified.

#### **4. SANITARY FIXTURES & PIPE FITTINGS**

##### **4.1 SCOPE:**

Work under this section shall consist of transportation, furnishing, installation, testing and commissioning and all labour as necessary as required to completely install all sanitary fixtures, brass and chromium plated fittings, and accessories as required by the drawings and specified hereinafter or given in the Bills of Quantities.

##### **4.2 General Requirements**

All fixtures and fittings shall be fixed with all such accessories as are required to complete the item in good working condition, whether specifically mentioned or not in the Bills of Quantities, specifications, and drawings.

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per architectural design requirements. Wherever necessary the fittings shall be centered to dimensions and patterns desired.

Fixing screws shall be half round head chromium plated brass with C.P. washers wherever required as per directions of Client's Representative.

All fittings and fixtures shall be fixed in a neat workmanlike manner true to levels and heights shown on the drawings and in accordance with the manufacturers' recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, wall or ceiling surfaces, shall be made good at Contractor's cost.

All fixtures of the similar materials shall be by the same manufacturers.

All fittings shall be of chromium plated materials.

Without restricting generally to the foregoing, 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 approved fixing devices, nuts, bolts, screws, hangers, etc. as required. These supports shall have the necessary adjustments to allow for irregularities at the construction site.

For the installation of the CP fittings, Teflon tape shall be used.

#### **4.3 EUROPEAN W.C:**

European W.C. of glazed vitreous china shall be wash down, single or double siphonic type, floor or wall mounted set, flushed by means of flush valve as specified in the Bills of Quantities. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adopter. Wall hung W.C. shall be supported by C.I. floor mounted chair.

Each W.C. seat cover shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C. Seat cover shall be of white solid plastic, elongated open front with heavy duty hinges. Exposed fixture trims shall be Chrome plated, and trims of similar function shall be by the same manufacturer.

Flush valves shall be of the best approved quality procurable with C.P. control valve and C.P. flush pipe.

The flush pipe/bend shall be connected to the W.C. by means of a suitable rubber adopter.

#### **4.4 FLUSHING CISTERN:**

Alternatively flushing cistern to be used shall conform to the requirements. High level cisterns shall be of cast iron unless otherwise specified. Low level cistern shall be of the same material as the water closet or as instructed by the Architect/Engineer. The cisterns shall be mosquito proof & shall fulfill the requirements of the local Authority.

The levels of the W.C. should be checked by placing spirit level on the W.C. W.C. should be tested on completion of fixing by putting small paper balls and flushing out. If all the paper balls are not flushed out. The fixing will have to be rectified / re-aligned.

#### **4.5 URINALS:**

Half stall wall hung urinals of glazed vitreous china shall be provided with 15mm dia. C.P. brass spreader, 32mm dia. C.P. domical waste, and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by one C.I. bracket and two C.I. clips as recommended by manufacturers and as directed by the Client's Representative.

Urinals shall be flushed by means of "NO-TOUCH" infrared operated flush valves.

Waste pipes for urinals shall be any one of the two below given materials and as directed by the Client's Representative:

- G.I. Pipes
- Rigid PVC/High density polyethylene.



Waste pipes may be exposed on wall or concealed in chase as directed by the Client's Representative.

**4.6 URINAL PARTITIONS:**

Urinal partitions shall be white glazed vitreous china, marble, granite or any other material selected by the Project Manager.

Urinal 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 Project Manager..

**4.7 WASH BASINS:**

Wash basins shall be of white vitreous china of best quality manufactured by an approved firm and sizes, and as specified in the Bills of Quantities.

Wash basin shall be of table top / under counter drop in type shall be supported on a pair of rolled steel brackets of approved design and shall be mounted on a countertop so that rim and basin bowl are exposed from top.

Wash basin shall be provided with single lever mixer with chain and rubber plug, chromium plated brass bottle trap of approved quality, design and make, where hot water required. Single tap where hot water is not required.

Wash basin shall be fixed at proper location and height and truly horizontal as shown on drawing or as directed by Client's Representative.

**4.8 BOTTLE TRAPS**

Bottle trap (for wash basins, sinks, urinals etc.,) shall be deep seal (minimum 60mm water seal) cast brass

Bottle, heavy chromium plated. All bottle traps shall be provided with suitable cleaning eye, extension

Piece, flare nuts, all chromium plated. Bottle traps shall be of approved make and design. Traps for washbasins, urinal and sinks shall be 32mm

**4.9 PILLAR COCK / BASIN MIXTURE**

As per OEM (Original Equipment Manufacturer) / Manufacturer's standards.

Wash basin shall be provided with single lever mixer where hot water required. Pillar cock where hot water is not required.

**4.10 SINKS:**

Sinks shall be of stainless steel material as specified in the Bills of Quantities/Drawings.

Each sink shall be provided with R. S. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Each sink shall be provided with 40 mm dia. Chromium Plated waste with chain and plug or P.V.C. waste with Escutcheon plates. Fixing shall be done as directed by Client's Representative.

Supply fittings for sinks shall be mixing fittings or C.P. taps, angle cocks etc. all as specified in the

Bills of Quantities/Drawings.

**4.11 SINK BIB COCK / SINK MIXTURE**

These shall be chromium plated brass heavy quality and shall be easy type with capstan head. The size shall be as specified in the Bills of Quantities.

Supply fittings for sinks shall be mixing fittings where hot water required or long body bib cock where hot water is not required, all as specified in the Bills of Quantities/Drawings.

**4.12 HEALTH FAUCET/SPRAY (OPTIONAL)**

A chromium plated spray with integral hand control valve and connected to a flexible pipe and angle valve with wall flange and hook are fixed as shown on the drawings or as directed by the Project Manager. The angle valve and flange shall be paid under relevant item.

**4.13 ANGLE VALVE**

As per OEM (Original Equipment Manufacturer) / Manufacturer's standards.

**4.14 HOSE CONNECTION**

As per OEM (Original Equipment Manufacturer) / Manufacturer's standards.

**4.15 2 WAY BIB TAP**

These shall be chromium plated brass heavy quality of "EGO" type or equivalent, and shall be easy type with capstan head. The size shall be as specified in the Bills of Quantities.

**5.0 ELECTRICAL WATER HEATER:**

The Electric Water Heater shall be a complete package unit ready for plumbing and electrical service conditions. It shall be insulated with heavy duty 50 mm thick fiberglass blanket insulation and high gloss enamel finish outer shell. Electric Heating Coil rating and storage capacity shall be as shown on drawings.

Vertical pressure type electric water heaters shall be suitable for a minimum working head of 10 bars.

Construction: Inner containers shall be coated with glass, fused to steel at 870°C. This glass should provide corrosion resistance for steel.

Elements brazed to detachable brass heater plate, the whole being easily replaceable when required.

Heating elements constructed of a nickel chromium resistance wire, sheathed in a mineral filling, the whole being encased in a copper tube and subjected to a high voltage test of 1750 volts. Heater shall be supplied with adjustable setting thermostat including high temperature safety cut-out and over-pressure relief valve, drain point, electrical point, temperature indication, pilot indication, and necessary ancillaries.

## SECTION-II: SOIL, WASTE VENT & FITTING

### 1 Noise Insulated Piping System (POLOPLAST – POLO-KAL NG)

#### 1.1 SOCKET PIPES

Three Layer sound insulated Polypropylene piping (PP) system as per ON EN 1451-Part 1-6 & EN 12056 Part 1-5 with 3 layer pipe made of PP-C + PP-MV + PP-C in Blue Ral 5014 (halogen and calcium free) colour, push-fit type, food safe, having high impact and stiffness, offering sound levels of not more than 21 dBA with POLO clip HS/ 22 dBA with Bismat 2000 clamp /equivalent and 16 dBA with Bismat 1000 clamp/equivalent as per DIN 4109 at a flow rate of 4 l/s and having pipe ring stiffness as per ISO/DIS 9969 and tightness as per EN 1277/B and C and DIN 19560, density = 1.25gms/cm<sup>3</sup>, elongation = 0.05mm/m0K and tensile strength > 24 N/mm<sup>2</sup>, with all necessary fittings in blue colour, fitted with factory fitted lip ring, having 3 layers, pipes to be painted with ordinary cement paint for external installation:

➤ **INTERNAL LAYER:**

Of PP-C, hot water resistant to 97 degree C, tested in accordance to ON EN 1451-1 and DIN 19560, good heat and corrosion ageing stability as well as high chemical resistance and a smooth pipe inner-surface.

Color: Blue (halogen and calcium free)

➤ **INTERMEDIATE LAYER:**

Of PP-MV compound reinforced with mineral aggregate, which guarantees greater stiffness and stability.

Color: Grey.

➤ **EXTERNAL LAYER:**

Of PP-C. With high impact resistance and good weathering resistance.

Color: Blue (halogen and calcium free)

#### 1.2 PIPE RING STIFFNESS:

Pipe ring stiffness would be in accordance with ISO/DIS 9969 and TIGHTNESS as per EN 1277/B and C and DIN 19560.

#### 1.3 MARKINGS:

All pipes shall carry the following markings: Batch number; year and week of manufacture; company name; dimension application class; stiffness class, test mark and material details.

#### 1.4 FITTINGS:

Single- Layered fitting reinforced with mineral aggregate, made of a Halogen free PP-C-KV synthetic material, a reinforced wall and factory fitted lip ring, hot water resistant upto 95 degree c in accordance to ON EN 1451-PART 1-6 EN 12056 PART 1-5. Color: Blue (halogen and calcium free)

- 1.5 **INSTALLATION:** The piping system must be clamped properly as required, pipes passing through walls, beams, slabs, columns should pass through sleeves which are padded with insulation material internally (between pipe and sleeve) covering the pipe to avoid transfer of body and structural borne sounds (refer manufacturer's installation guide lines). The piping must not touch any wall, structure, paneling, false ceiling etc.

Minimum supporting:

Nominal outer diameter DN/OD mm	Bracket distance	
	Horizontal pipe routing*) D max. m (max. 15 x dia)	Vertical pipe routing*) D max. m
32	0,5	1,50
40	0,6	1,50
50	0,75	1,50
75	1,10	2,00
90	1,35	2,00
110	1,65	2,00
125	1,85	2,00
160	2,40	2,00
200	3,00	2,00
250	3,00	2,00

## 2.0 Traps

### 2.1 Floor Traps

Floor traps where specified shall be siphon type full bore PP (WHITE), McAlpine, UK having a minimum 50 mm deep seal. All traps are under slung from the slab and shall be adequately supported.

### 2.2 Urinal Traps

Urinal traps shall be siphon type full bore PP (WHITE), McAlpine, UK having a minimum 50 mm deep seal. All traps are under slung from the slab and shall be adequately supported.

### 2.3 Cleanout Plugs

Floor Clean Out and line clean out plugs

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, "Y" and on straight runs at such intervals as required as per site conditions. Clean out plugs shall terminate flush with the floor levels. Line clean outs shall be supported with manufacturer provided bracket. They shall be of push fit type of PKNG mane (Poloplast)

## 3.0 Drainage under floor/above floor (service floors, basement ceiling etc.) (POLOPLAST – POL-KAL NG (upto 250mm dia / ECO-PLUS Premium above 250mm dia)

- 3.1 All drainage lines passing under building, in exposed position above ground e.g. service floors, basement ceiling etc. shall be Multilayered as per details given in sub-clause 3.10 above or shall be as per details given below. Position of such pipes shall generally be shown on the drawings.

### 3.2 SOCKET PIPES

3 layer technology Polo-Eco Plus Premium 10 pipes and fittings for underground/ misc. drainage applications having external layer of PP-Blend + mineral reinforcement, supporting layer of PP + magnesium silicate and internal in PP with chemical resistance between 2-13pH and ring rigidity of  $\geq 10\text{kN/m}^2$  having OFI certification for longitudinal stability & impermeability of pie connection in line with EN 14741.

### 3.3 FITTINGS

3-layered reinforced polypropylene (PP) sewage pipes, halogen and lead free, with integral push-fit socket and factory-fitted lip ring, tested and monitored according to the Product Standard EN 1852 – 1. Fittings upto dimension DN/OD 200 are manufactured by injection molding (1-layer), above DN/OD 200 (250 and above) the fittings are butt or extrusion welded by the manufacturer. Fabrication of fittings at site shall not be permitted.

### 3.4 Pipe Joints

Field-proven push-fit connection with improved and modified lip ring of high ageing-resistant shall be provided with the pipes and fittings for easy push-fit installation, installation procedure as given in clause 3.10 above shall be followed.

### 4.0 Air Admittance Valves (AAV) (McAlpine, UK / STUDOR, UK)

Air admittance valves shall be made in ABS/PVC capable of operating at temperatures between 0 degree c and 60 degree c. The AAV shall be of suitable flow rate and installed in main discharge stacks and / or branches. Design based on air flow capacity required in proportion to the discharge unit capacities. The vendor is to supply data sheet showing relevant calculations and drawings indicating location and type of AAV as required.

AAV's to have following performance parameter:

- Temperature range: -20 degree Celsius to 60 degree Celsius.
- Open pressure: -70 pa (-0.010 psi)
- Max. Pressure rating tightness: 10,000 pa (1 m/40" h2o) at 0 pa or higher

### 5.0 SS GRATING

Floor gratings shall be hinged type cast/ sheet stainless steel with matching recessed rim. Each grating will be provided with a cockroach trap. Each floor drain shall be provided with a specially fabricated sheet metal stainless steel double anti-cockroach internal grating to prevent ingress of cockroaches inside the building.

## SECTION-III: RAIN WATER PIPES & FITTINGS

### RAIN WATER PIPES

All open terraces shall be drained by rain water down takes.

Rainwater down takes are separate and independent of the soil and waste system and will discharge into the open ground Storm water Drainage system of the Complex.

Rain water in open courtyards shall be collected in catch basins and connected to the storm water drainage line.

#### **PVC Pipes & Fittings**

Pipes and fittings shall be uPVC. All pipes shall be straight and smooth as specified in Schedule of Quantities.

Pipes and fittings for main vertical stacks and branches 110 mm. & 160 mm. dia., shall be RainwaterSystem known in the short form as drainage system with injection moulded fittings and approved type of socket & 'O' rubber ring joints.

Joints shall be done as per the manufacturer's recommendations. The pipes and fittings must have matching dimensions for perfect joints in the system. 'O' ring fittings must have sufficient gap (approx. 10 mm.) for thermal expansion of pipes.

PVC pipes shall be clamped to the wall with approved type uPVC saddle clamps/U clamps and G.I. rod fixed to the angle iron support system within the shaft.

Use proper uPVC pipe adapters for connections between traps & uPVC pipes where necessary. Such joints shall be made of an approved type of 'Putty'.

#### **MEASUREMENT:**

Sanitary fixtures shall be measured by numbers.

Rates for all items mentioned above shall be inclusive of cutting holes and chases and making good the same, stainless steel screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning.

Project Manager's decision with respect to the correct interpretation regarding mode of measurement shall be final and binding on the contractor.

### **SECTION- IV: WATER SUPPLY SYSTEM**

#### **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 by the drawings, specified here-in -after and given in the Schedule of Quantities.

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

Distribution system from main supply headers to all fixtures and appliances for cold & hot water.  
Cold water supply lines from city water connections to Under Ground Water Tank.  
Garden irrigation system

Excavation and refilling of pipes trenches.  
Pipe protection and painting.  
Control valves, masonry chambers and other appurtenances.  
Connections to all plumbing fixtures, tanks, appliances and municipal mains  
Inserts for R.C.C. tanks

#### General requirements

All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.

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

Pipes shall be fixed in such 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.

Clamps, hangers and supports on RCC walls, columns & slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.

All pipe clamps, supports, nuts, bolts, washers shall be galvanised MS steel throughout the building. Painted MS clamps & MS nuts, bolts & washers shall not be accepted.

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 the water supply systems including one for domestic water supply.

Source Water supply will be acquired from Municipal Corporation water mains (as available) to a service connection and collected in water storage tanks located underground.

The system has been connected to a gravity feed system from overhead tanks to all parts of the building

It is proposed to provide flushing cistern for all WCs. Infrared NO-TOUCH flush valves shall be provided for Urinals. These will be fed from overhead tank by gravity.

Domestic water supply shall be provided with cold water system only. Hot water provisions to kitchen and all toilets connected to a local electric hot water storage geyser other than add on solar system at terrace for inlet of geyser in kitchen etc.

### **(CPVC) G.I. pipes & fittings**

All pipes inside the buildings for domestic hot and cold water supply shall be CPVC conforming to CTs SDR-13.5 at a working pressure of 320 PSI at 23 deg.C. and 80 PSI at 82 deg. C.

Solvent welded CPVC fittings etc. tees, elbows, couplers, unions, reducers, brushing etc. including transition fittings (connection between CPVC and metal pipes/G.I. ie. Brass adapters conforming to ASTM D-2846) shall be provided.

All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall run above false ceiling with vertical drop in wall chases for all fixtures. No pipes to run inside sunken floor as far as possible. Pipes may run under the ceiling or floors and other areas as shown on drawings.

### **Joining Pipes & Fittings**

#### **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. All burrs should be removed for proper contact between pipe and fittings during jointing.

#### **Solvent Cement Application**

Only CPVC solvent cement conforming to ASTM-F-493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket.

#### **Assembly**

After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe  $\frac{1}{4}$  to  $\frac{1}{2}$  turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set up.

#### **Testing**

The system should be hydrostatically pressure tested at 150 psi (10 Bar) for one hour. During pressure testing, the system should be fitted with water and if a leak is found, the joint should be cut out the replaced with new one.

#### **Transition of Flow guard CPVC in metals**

When making a transition connection to metal threads, special brass/plastic transition fitting (Male and female adapters) should be used. Plastic threaded connections should not be over torque.

#### **Threaded sealants**

Teflon tape shall be used to make threaded connections leak proof.

#### **Solvent Cement**



Only CPVC solvent cement conforming to ASTM F 493 should be used for joining pipe with fittings and valves.

#### Hangers and supports

For horizontal runs, support should be given at 90 cm. intervals for diameters of 25mm. and below and at 1.2 m. intervals for larger sizes.

Supports should be as per the below mentioned table: (Change sizes into mm.)

Size of pipe	20°C	49°C	71°C	82°C
Inch (mm)	Ft. (mm)	Ft. (mm)	Ft. (mm)	Ft. (mm)
½" (15mm)	5.5 (420mm)	4.5 (340)	3.0 (230)	2.5 (190mm)
¾" (20mm)	5.5	5.0 (380)	3.0	2.5
1" (25mm)	6.0 (460mm)	5.5	3.5 (270)	3.0
1¼" (32mm)	6.5 (500mm)	6.0	3.5	3.5
1½" (40mm)	7.0 (530mm)	6.0	3.5	3.5
2" (50mm)	7.0	6.5	4.0 (305mm)	3.5

Please confirm above physical (mm) dimensions in practice

#### Anchor Fasteners

All pipe supports, hangers and clamps to be fixed on RCC walls, beams, columns, slabs and masonry walls 230mm. thick and above by means of galvanised expandable anchor fasteners in drilled holes of correct size and model to carry the weight of pipes. Drilling shall be made only by approved type of power drill as recommend and approved by manufacturer of the anchor fasteners. Failure of any fastening devices shall be the entire responsibility and contractor shall redo or provide additional supports at his own cost. He shall also compensate the DPL for any damage that may be caused by such failures.

#### Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and on straight runs as necessary at appropriate locations as required and/or directed by Project Manager.

#### Flanges

Flanged connections shall be provided on pipes as required or where shown on the drawings, all equipment connections as necessary and required or as directed by the Project Manager. Connections shall be made by correct number and size of GI nuts, bolts & washers with 3mm thick gasket. Where hot water connections are made insertion gasket shall be of suitable high temperature grade and quality approved by the Project Manager. Bolt hole dia. for flanges shall conform to match the specification for C.I. sluice valve and C.I. butterfly valve.

### Trenches

All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches shall be as follows:-

Dia. of pipe -----	Width of trench -----	Depth of trench -----
15 mm to 50 mm	30 cm	75 cm
65 mm to 150 mm	45 cm	100 cm

### Sand filling

G.I. pipes in trenches shall be protected with fine sand 15 cms all round before filling in the trenches. Painting (Painting for CPVC pipes not required)

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 given in this document or specified by Project Manager.

### Pipe protection (Protection for CPVC pipes not required)

All G.I. pipes in wall chase /below floors or laid under-ground shall be protected against corrosion by the application of two coats of bitumen paint covered with polythene tape and a final coat of bitumen paint.

G.I. waste pipes buried in ground or sunken slab shall be protected with multilayer bitumen membrane tape 3mm thick with a final coat of hot or cold applied bitumen. Pypkote or equivalent.

### Ball Valves

Valves upto 40 mm dia. shall be screwed type Ball Valves with stainless steel balls, spindle, teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm<sup>2</sup>, and accompanying couplings and steel handles.(to BS 5351)

### Butterfly Valves

Valves 50 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle.

### Motorised Water Valve:

The Motorized Water Valve shall consist of gunmetal valve body with stainless steel trim and equal percentage flow characteristics, modulating motor and linkage.

### Testing

All pipes, fittings and valves after fixing at site, shall be tested by hydrostatic pressure of 1.5 times the working pressure or 10 kg/cm<sup>2</sup> whichever is more.

Pressure shall be maintained for a period of at least thirty minutes without any drop.

A test register shall be maintained and all entries shall be signed and dated by Contractor (s) and Project Manager.

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 by the Contractor during the defects liability period without any cost.

After commissioning of the water supply system, 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.

### **Measurement**

CPVC or G.I. pipes above ground shall be measured per linear meter (to the nearest cm) and shall be inclusive of

all fittings e.g. coupling, tees, bends, elbows, unions, flanges and U clamps with nuts, bolts & washers fixed to wall or other standard supports.

Jointing with teflon tape, white lead and insertion gasket of appropriate temperature grade.

Cutting holes, and chases in walls, floors, any pipe support required for pipes below ground & making good the same.

Excavation, back filling, disposal of surplus earth and restoring the ground & floor in original condition.

### **Pipe Supports.**

Fabricated and galvanised supports shall be measured by weight. Weight for each type of clamp shall be calculated on basis of the quantity of structural and MS used from the theoretical weight calculated on basis of the components theoretical weight of the sections.

Rate quoted for supports & hangers shall be inclusive of:-

Expandable anchor fastens.

Galvanising of all supports & hangers.

Cutting holes in walls, ceilings on floors and making good where permitted.

Nuts, bolts and washers for fixing and assembling.

Wooden/PVC pipe saddles for vertical or horizontal runs.

### **ML5 ULTRA-V PIPES**

ULTRA VIOLET PROTECTED PP-r PE 80 glass fibre compound 5 layer piping system in BLACK color with proprietary Ecosan GREEN fittings, with operating conditions as per EN ISO 21003, jointing to be by hot socket fusion method, having life span of 50 years (extrapolated) and having linear expansion of 0.038 mm/mK. The used irradiation rate is equivalent to more than 10 years in the city of Cairo, Egypt.

**5 LAYER TECHNOLOGY, having:**

- 1st layer of specially stabilized PP-r of UV protection.
- 2nd and 4th layer of HPCE glass fibre compound for greater stability and a 75% lower linear expansion as compared to single layer pipes.
- 3rd and 5th layer of PP-RCT provides high temperature stability and improved long term resistance.

AVAILABLE IN SIZES: 20MM TO 63MM.

**TECHNICAL SPECIFICATIONS FOR FURNITURE WORKS**  
**(SECTION – II)**

**Note: Technical Specifications for Furniture Works shall be as per the specifications mentioned in the relevant BOQ Items.**

**TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS**  
**(SECTION – III)**

## **1.0 INTERNAL WIRING**

### **1.1 GENERAL**

This section covers specification for Internal wiring of the office area and building.

### **1.2 STANDARDS AND CODES**

The wiring work shall be carried out as per standards and specifications of the CPWD. In addition the relevant clauses of the Indian Electricity Act 2003 and Indian Electricity Rules 1956 as amended upto date shall also apply.

IS:732 - 1989	Code of practice for electrical wiring installations
IS: 8828 - 1978	Miniature air break circuit breakers for voltages not exceeding 1000 volt
IS:13032 - 1991	Miniature circuit breaker boards for voltages upto and including 1000 volts AC
IS:12640 - 1988	Residua current operated circuit breakers
IS:694 - 1990	PVC Insulated cables for working voltages upto and including 1100 V
IS:694 - 1990	PVC Insulated cables for working voltages upto and including 1100 V
IS:9537(Part-1)-1980	Conduits for electrical installations :General requirements
IS:3480 - 1966	Flexible steel conduits for electrical wiring
IS:2667 - 1988	Fittings for rigid steel conduits for electrical wiring
IS: 371 - 1979	Ceiling roses
IS: 3854 - 1988	Switches for domestic and similar purposes
IS: 4615 - 1968	Switch socket outlets (non-interlockingtype)

### **1.3 Introduction**

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

Cabling and switchgear to receive power.

- a. The building shall be divided into convenient number of parts, each part served by a rising main system to distribute power vertically/horizontally.
- b. Power flows from rising main through tap-off box to floor main board to final DBs and then to wiring.



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

#### 1.4 System of Distribution and Wiring

- a. The wiring shall be done from a distribution system through main and/or branch distribution boards.
- b. Each main distribution board and branch distribution board shall be controlled by an incoming circuit breaker. Each outgoing circuit shall be controlled by a circuit breaker.
- c. Only MCCB/MCB DBs shall be used.
- d. 'Power' wiring shall be kept separate and distinct from light wiring, from the level of circuits, i.e., beyond the branch distribution boards. Conduits for light/power wiring shall be separate.
- e. Essential/non-essential/UPS distribution each will have a completely independent and separate distribution system starting from the main, switchboard upto final wiring for each system. No mixing of wiring is allowed.
- f. Each MDB/DB/Switch Board will have reasonable spare outgoing ways for future expansion.
- g. Balancing of 3-phase circuit shall be done.

#### 1.5 Wiring

##### Submain & Circuit Wiring

##### (a) Submain Wiring

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

##### (b) Circuit Wiring

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

#### 1.6 Point Wiring

##### Definition

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

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

##### Scope

Following shall be deemed to be included in point wiring:

- a. Wiring cables between the switch box and the point outlet, loop protective earthing of each fan/ light fixture.
- b. All fixing accessories such as clips, screws, Phil plug, rawl plug etc. as required.
- c. Control switch or MCB, as specified.
- d. 3 pin or 6 pin socket, ceiling rose or connector as required. (2 pin and 5 pin socket outlet shall not be permitted.)
- e. Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc. Bushed conduit or porcelain tubing where wiring cables pass through wall etc.
- f. Interconnecting wiring between switches within the switch box on the same circuit.

#### **Point Wiring for Socket Outlet Points**

- a. The light plug (6 A) point and power (16 A) point wiring shall be measured on linear basis, from the respective tapping point of live cable, namely, switch box, another socket outlet point, or the sub-distribution board as the case may be, up to the socket outlet.
- b. The metal/PVC box with cover, switch/MCB, socket outlet and other accessories shall be measured and paid as a separate item.
- c. The power point outlet may be 16 A/6 A six pin socket outlet, where so specified in the tender documents.

#### **Group Control Point Wiring**

- a. In the case of points with more than one point controlled by the same switch, such points shall be measured in parts i.e. (a) from the switch to the first point outlet as one point and classified accordingly and (b) for the subsequent points, the distance from that outlet to the next one and so on, shall be treated as separate point(s) and classified accordingly.
- b. No recovery shall be made for non-provision of more than one switch in such cases.

#### **Twin Control Light Point Wiring**

- a. A light point controlled by two numbers of two way switches shall be measured as two points from the fitting to the switches on either side and classified according to 3.4.4.
- b. No recovery shall be made for non-provision of more than one ceiling rose or connector in such cases.

### **1.7 Wiring System**

- a. Wiring shall be done only by the looping system. Phase/live conductors shall be looped at the switch box. For point wiring, neutral wire/earth wire looping for the 1st point shall be done in the switch box; and neutral/earth looping of subsequent points will be made from point outlets.
- b. In wiring, no joints in wiring will be permitted any where, except in switch box or point

outlets, where jointing of wires will be allowed with use of suitable connector.

- c. The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switchgear.
- d. Light, fans and call bells shall be wired in the 'lighting' circuits. 15A/16A socket outlets and other power outlets shall be wired in the 'power' circuits. 5A/6A socket outlets shall also be wired in the 'power' circuit both in residential as well as non-residential buildings.
- e. Colour Coding

Following colour coding shall be followed in wiring:

Phase	:	Red/Yellow/Blue.(Three phase
wiring) Live	:	Red (Single phase wiring)
Neutral	:	Black
Earth	:	Yellow/Green.

- f. Termination of Circuit into Switchboard

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

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

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

## 1.8 Passing through Walls or Floors

- a. When wiring cables are to pass through a wall, these shall be taken through a protection (steel/ PVC) pipe or porcelain tube of suitable size such that they pass through in a straight line without twist or cross in them on either porcelain, PVC or other approved material.
- b. All floor openings for carrying any wiring shall be suitably sealed after installation.

## 1.9 Joints in Wiring

- a. No bare conductor in phase and/or neutral or twisted joints in phase, neutral, and/ or protective conductors in wiring shall be permitted.
- b. There shall be no joints in the through-runs of cables. If the length of final circuit or submain is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes.
- c. Termination of multistrand
- d. ded conductors shall be done using suitable crimping type thimbles.

### 1.10 Capacity of Circuits

- a. Lighting circuit shall feed light/fan/ call bell points. Each circuit shall not have more than 800 Watt connected load or more than 10 points whichever is less. However, in case of LED points where load per point may be less, number of points may be suitably increased.
- b. Power circuit in non-residential building will have only one outlet per circuit.
- c. Load more than 1 KW shall be controlled by suitably rated MCB and cable size shall be decided as per calculations.
- d. Power Wiring with Bus Trunking

### 1.11 Socket Outlets

- a. Socket outlets modular type shall be 6A 3 pin, 16 Amp 3 pin or 16/6 Amp 6 pin. 5 pin socket outlets will not be permitted.  
  
The third pin shall be connected to earth through protective (loop earthing) conductor. 2 pin or 5 pin sockets shall not be permitted to be used.
- b. Conductors connecting electrical appliances with socket outlets shall be of flexible type with an earthing conductor for connection to the earth terminal of plug and the metallic body of the electrical appliance.
- c. Sockets for the power outlets of rating above 1KW shall be of industrial type with associated plug top and controlling MCB.
- d. Shutter type (interlocking type) of sockets shall be used.
- e. Every socket outlet shall be controlled by a switch or MCB, as specified. The control switch/MCB shall be connected on the 'live' side of the line.
- f. Unless and otherwise specified, the control switches for the 6A and 16A socket outlets shall be kept along with the socket outlets.

### 1.12 Cables

- a. Copper conductor cable only will be used for submain/ circuit/ point wiring.
- b. Minimum size of wiring:
  - Light Wiring : 1.5 sq.mm.
  - Power Wiring : 4.0 sq.mm.
  - Power circuit rated : More than 1 KW, Size as per calculation.
- c. Insulation : Copper conductor cable shall be FRLS,PVC insulated Conforming to BIS Specification.
- d. Multi stranded : Cables are permitted to be used.

### 1.13 Wiring Accessories

- a. Switch Box

- (i) Switch box shall be hot dip galvanized, factory fabricated, suitable in size for surface/ recess mounting and suitable in size for accommodating the required number of switches and accessories (where required to be used for applications other than modular switches/ sockets).
  - (ii) Switch box also can be of non-metallic material. The Engineer will approve specified makes of reputed quality and specifications.
- b. Ceiling Rose
  - (i) A ceiling rose shall not be used on a circuit, the voltage of which normally exceeds 250V.
  - (ii) Only one flexible cord shall be connected to a ceiling rose. Specially designed ceiling roses shall be used for multiple pendants.
- c. Fittings

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

#### 1.14 Attachment of Fittings and Accessories

- a. Conduit Wiring System
  - (i) All accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in flush pattern inside the switch/regulator boxes. Accessories like ceiling roses, brackets, batten holders etc. shall be fixed on outlet boxes. The fan regulators may also be fixed on outlet boxes, if so directed by the Engineer-in-charge.
  - (ii) Aluminium alloy or cadmium plated iron screws shall be used to fix the accessories to their bases.
  - (iii) The switch box/regulator box shall normally be mounted with their bottom 1.25 m from floor level, unless otherwise directed by the Engineer-in-charge.
- b. Fixing to Walls and Ceiling
  - (i) Wooden plugs for fixing to wall/ceiling will not be allowed. Fixing will be done with the help of PVC sleeves/Rowel plugs/ dash fasteners as required.
  - (ii) Drilling of holes shall be done by drilling machines only. No manual drilling of hole will be allowed.

#### 1.15 Fans, Regulators and Clamps

- a. Ceiling Fans
  - (i) Ceiling fans including their suspension shall conform to relevant Indian Standards.
  - (ii) The capacity of a ceiling fan to meet the requirement of a room with the longer dimension D meters should be about  $55 D \text{ m}^3/\text{min}$ .
  - (iii) The height of fan blades above the floor should be  $(3H + W)/4$ , where H is the height of the room, and W is the height of the work plane.
  - (iv) The minimum distance between fan blades and the ceiling should be about 0.3

meters.

- (v) When actual ventilated zone does not cover the entire room area, then optimum size of ceiling fan should be chosen based on the actual usable area of the room, rather than the total floor area of the room.
  - (vi) Energy Efficient fans with BEE 3-5 star rating or complying with IS 374: 1979, shall be used. The minimum service value of fans shall be  $3.5 \text{ m}^3/\text{min}/\text{W}$  and air delivery  $200 \text{ m}^3/\text{min}$ .
  - (vii) Standard power with air delivery of Fans shall be as per IS 374.
  - (viii) Step Type Electronic regulators shall be used instead of resistance type regulators for controlling speed of fans.
  - (ix) All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.
  - (x) The leading in wire shall be of nominal cross sectional area not less than 1.5 sq. mm. and shall be protected from abrasion.
  - (xi) Unless otherwise specified, all ceiling fans shall be hung 2.75 m above the floor.
  - (xii) In the case of measurement of extra down rod for ceiling fan including wiring, the same shall be measured in units of 10 cm. Any length less than 5 cm shall be ignored.
- b. Exhaust Fans
- (i) Exhaust fans shall conform to relevant Indian Standards.
  - (ii) Exhaust fans shall be erected at the places indicated drawings. For fixing an exhaust fan, a circular opening shall be provided in the wall to suit the size of the frame, which shall be fixed by means of rag bolts embedded in the wall. The hole shall be neatly plastered to the original finish of the wall. The exhaust fan shall be connected to the exhaust fan point, which shall be wired as near to the opening as possible, by means of a flexible cord, care being taken to see that the blades rotate in the proper direction.
  - (iii) Exhaust fans for installation in corrosive atmosphere, shall be painted with special PVC paint or chlorinated rubber paint.
  - (iv) Installa
  - (v) tion of exhaust fans in kitchens, dark rooms and such other special locations need careful consideration; any special provisions needed shall be specified.

#### 1.16 Marking of Switch Boards

a. Schematic Diagram

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

b. Marking of each Main Board

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

c. Marking of Distribution Board

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

d. Marking of Power/Light DBs

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

e. Marking for Non-essential/Essential/UPS/Switch Boards

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

f. Marking of Main Earthing Terminal

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

## 2.0 LT Distribution Switchgear

Only following type switchboards will be used:

- (a) Main/Submain switchboard of cubicle type.
- (b) DBs – Conventional DBs of reputed makes can also be used with the approval of Engineer-in-Charge in addition to prewired DB.
- (c) Specially designed switchboards.

Also specially designed switchboards can be used with detailed specification and fabrication drawings approved by the Engineer-in-Charge.

## 2.1 Location of Switchboards

- a. Switchboards are to be located in common areas like corridors, lobby etc. and not to be located in locked room.
- b. Switchboard shall be located only in dry situation and in well-ventilated space. They shall not be placed in the vicinity of storage battery or exposed to chemical fume.
- c. Switchboards shall not be erected above gas stove, or sinks or within 2.5 meter of any washing unit in washing rooms of launderings or in the bath rooms, toilets, or kitchen.
- d. As far as possible main boards shall not be located in basement. Such main boards can be located in ground floor.
- e. It is preferable to locate floor main boards in rising main shafts of adequate size, with steel

doors (having ventilation) or in suitable room.

- f. Similarly DBs can be in suitable niches in corridor walls having doors.
- g. Locating main boards under staircase or standing open in corridor is not a desirable practice, besides being highly unaesthetic.
- h. The main switchboard, which receives power to the building, should be invariably located in a switch room, having round the clock access, for emergency attendance to the switchboard.

### **3.0 MEDIUM VOLTAGE DISTRIBUTION BOARDS**

#### **3.1 GENERAL**

This section covers specification of DBs.

#### **3.2 STANDARDS AND CODES**

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

BIS certified equipment shall be used as a part of the Contract in line with Government regulations. Necessary test certificates in support of the certification shall be submitted prior to supply of the equipment.

It is to be noted that updated and current Standards shall be applicable irrespective of those listed below.

Miniature Air Circuit Breakers for AC circuits	IS 8828 : 1978
Degrees of Protection provided by enclosures for low voltage switchgear	IS 2147 : 1962
Code of Practice for installation and maintenance of switchgear not exceeding 1000 volts	IS 10118 : 1982
General requirements for switchgear and controlgear for voltages not exceeding 1000 volts	IS 4237 : 1982

#### **3.3 MINIATURE CIRCUIT BREAKERS**

- The MCB's shall be of the completely moulded design suitable for operation at 240/415 Volts 50 Hz system.
- The MCB's shall have a rupturing capacity of 10 KA at 0.5 p.f.



- The MCB's shall have inverse time delayed thermal overload and instantaneous magnetic short circuit protection. The MCB time current characteristic shall coordinate with H.R.C. fuse/PVC cable characteristic.
- Type test certificates from independent authorities shall be submitted with the tender.

### **3.4 FINAL DISTRIBUTION BOARDS**

- Final distribution boards shall be flush mounting, totally enclosed, dust and vermin proof and shall comprise of miniature circuit breakers, earth leakage circuit breakers, neutral link etc as detailed in the schedule of quantities.
- The distribution equipment forming a part of the Distribution Boards shall comply to the relevant Standards and Codes of the Bureau of Indian Standards and as per detailed specifications included in this tender document.
- The board shall be fabricated from 14 gauge CRCA sheet steel and shall have a hinged lockable spring loaded cover. All cutouts and covers shall be provided with synthetic rubber gaskets. The entire construction shall give a IP 42 degree of protection.
- The bus-bar shall be of electrical grade copper having a maximum current density of 1.6 ampere per square mm and PVC insulated throughout the length.
- All the internal connections shall be with either solid copper PVC insulated or copper conductor PVC insulated wires of adequate rating.
- All the internal connections shall be concealed by providing a hinged protective panel to avoid accidental contact with live points.
- All outgoing equipment shall be connected direct to the bus bar on the live side. The equipment shall be mounted on a frame work for easy removal and maintenance.
- The sheet steel work shall undergo a rigorous rust proofing process, two coats of filler oxide primer and final powder coated paint finish.
- All the circuits shall have an independent neutral insulated wire, one per circuit, and shall be numbered and marked as required by the Architect/Engineer/DFCCIL.
- A sample of the completed board is to be got approved by the architects/Engineer before commencement of supply and erection.

### **3.5 SHEET STEEL TREATMENT AND PAINTING**

- Sheet Steel materials used in the construction of these units should have undergone a rigorous rust proofing process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process. The steel work shall then receive two coats of oxide filler primer before final painting. Castings shall be scrupulously cleaned and fettled before receiving a similar oxide primer coat.
- All sheet steel shall after metal treatment be given powder coated finish painted with two coats of shade 692 to IS 5 on the outside and white on the inside. Each coat of paint shall be properly stoved and the paint thickness shall not be less than 50 microns.

### 3.6 NAME PLATES AND LABELS

- Suitable engraved white on black name plates and identification labels of metal for all Switch Boards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

## 4. LIGHTING SYSTEM

### 4.1 SCOPE

- The Contractor shall design, supply, install, test and commission a high efficiency lighting system for all areas of the buildings. Light fittings for all areas shall be complete with lamps, supports and accessories. The light fittings and all associated accessories shall be subject to the acceptance of the Engineer.
- The Lighting System shall also incorporate Lighting Management System (LMS) to manage and control lights from single location. LMS shall use wireless technology (Zigbee/Bluetooth/Wi-fi) to control the lights with minimal wiring.
- The LMS shall be able to communicate to Building Management System (BMS) seamlessly over BACnet or other open protocol. LMS shall provide all available data to BMS.
- Lux level study shall be conducted to assess the lux levels in various areas as per NBC and then luminaire type and quantity drawing to be submitted accordingly for approval of the Engineer-in-Charge.
- The quantity of the luminaires is only indicative as per attached drawings which may change according to the lux level report submitted.
- Lighting levels shall be uniformly distributed throughout the area, and shall be designed such that glare, dark recesses and areas of poor lighting levels are avoided.
- The type of luminaries and normal average maintained illumination levels for various areas and services shall be as per prevalent specification of NBCC or other applicable codes.
- Various types of luminaires are being employed as per BOQ. The details of application of such variety of lights shall be made available at the time of finalisation of lighting drawing.

### 4.2 ACCEPTABLE CODES AND STANDARDS

The luminaries and associated equipment shall comply with the following codes and standard:

IS: 1913	General Safety Requirements for Luminaires
IS: 1777	Industrial Luminaires with Metal Reflectors
IS: 3553	Specification for Watertight Electric Lighting Fitting
IS: 3528-1966	Water Proof Electric Light Fitting
IS: 1646: 1997	Code of Practice for Fire Safety of Building
IEC 60598-2-1	Fixed General Purpose Luminaires
IEC 60598-1	General Requirements and Tests
IS: 3646 (All 3 Parts)	Code of Practice for Interior Illumination
NFPA	National Fire Protection Association
IEC 62031	LED modules for general lighting-Safety requirements
EN 61547	Equipment for general lighting purposes EMC immunity requirement.
IEC 60598-2-1	Fixed general purpose luminaires
IEC 60598-1	Luminaires- General requirement and tests

IEC 61000-3-2	Electro Magnetic compatibility (EMC) -Limits for Harmonic current emission
IEC 61347-2-13	Lamp control gear : particular requirements for DC or AC supplied electronic control gear for LED modules
IS 10322	Specification for the luminaires
IEC 62384	DC or AC supplied electronic control gear for LED modules performance requirements
EN 13032-1	Measurement and presentation of photometric data of lamps and luminaires: Measurement and file format
EN 13032-2	Measurement and presentation of photometric data of lamps and luminaires: Presentation of data for indoor and outdoor work places
LM 79	Internationally recognized method for the electrical and photometric measurement of solid state lighting products
LM 80	Internationally recognized method for measuring lumen maintenance of LED light sources
IEC 60529	Classification of degree of protections provided by enclosures
IS 16108.2012	Photo biological safety of Lamps & Lamp Systems

### 4.3 SYSTEM DESCRIPTION

The lighting system shall comprise of the following:

#### I. Normal Lighting

The normal lighting shall be fed from normal supply Distribution Boards.

#### II. Emergency Lighting

10% of lighting fixtures in all areas and minimum one light in each chamber shall be emergency light fixtures powered by UPS.

#### III. General

- Motion/Occupancy sensors (PIR) for occupancy sensing and lighting sensors for day light harvesting shall be used.
- All luminaires with drivers shall have power factor of 0.90 or above.

### 4.4 LUMINAIRE

#### 4.4.1 Lighting Features

Following features are required in the lighting fixtures:

- Energy efficient
- Long Life
- Rugged and durable
- Smaller lighting fixture
- Environmental friendly – no Mercury
- Dimmable for automation

- g. Available in different colours
- h. Better heat management
- i. Use of good quality diffuser

#### 4.4.2 Design Parameters

Following parameters shall be met in the Luminaire:

- a. CRI of the source, must be  $>80$
- b. Usable lumen per watt of fitting, must be  $>100 \text{ lm/W}$
- c. Glaring Index of fixture,  $\text{UGR} < 19$
- d. Life of lamp, must be  $50\text{k}+$

NOTE: The Luminaires supplied shall be compatible with LMS.

#### 4.4.3 Construction

The luminaire shall be made of extruded or die cast aluminium, otherwise as specified in the BOQ.

#### 4.4.4 LED Chip

Suitable number of LED lamps shall be used in the luminaires. LED lamps of NICHIA/CREE/OSRAM/ SEOUL/BRIDGELUX/ make shall be used for the purpose.

High power and high lumen efficient LEDs shall be used: The efficiency of the LED lamps at  $85^\circ\text{C}$  junction temperature shall be more than 100%.

The working life of the lamp at junction temperature of  $85^\circ\text{C}$  at rated current shall be more than 50,000 working hours @ L70 of accumulative operation.

These features shall be supported with data-sheet. Colour temperature of the proposed white colour LED shall be as mention in BOQ and the color variation should be within MacAdam Step specified in the fixture description in BOQ. The output of LED shall be more than 100 lumen per watt at minimal operating current and shall ensure guaranteed Lumen maintenance report as per guidelines shall be produced for the power LEDs used. Power factor of complete fitting shall be more than 0.9 at full load

All manufacturers must confirm that all supplied LEDs fall within a 3-step MacAdam

#### 4.4.5 Secondary Optic:

Suitable diffuser (made of PC/PMMA) or lenses shall be provided to increase the illumination uniformity and distribution.

#### 4.4.6 Parameters

Each luminaire shall meet the following parameters, or as specified in the BOQ:

- Fixture should have minimum efficacy at System level (Not Chip Level)  $\geq 110$  lumens/watt, unless otherwise specified in BOQ
- $\text{CRI} > 80$ ,
- $\text{THD} < 10\%$ ,
- $\text{PF} > 0.90$ ,
- $\text{R9} > 20$ ,
- IP20,
- $\text{UGR} < 19$ ,
- $\text{IK} \geq 04$ ,

- CCT of 5700/6500K (SDCM<3)
- Operating working temp range -  $0^{\circ}\text{C} < T_a < 45^{\circ}\text{C}$
- Operating Voltage Range of 140 - 270V.
- Internal Surge Protection 2.5KV
- Flicker free operations ripple <5%,
- The internal wiring to be done with LSZH wires.
- The fixture should comply with the parameters as per IS10322.
- The LED driver should comply to IEC61000-3-2 ed.3.2, 2009 for Harmonics, IEC61347-2 -13, 2006 in Conjunction with IEC61347-1 ed.2.0, 2007 for Electrical Safety, IEC62384 ed.1.1, 2011 for performance and IEC61547 ed.2.0, 2009, CISPR-15 for EMI.
- Manufacturer shall have inhouse lab approved by NABL or Ministry of Science, Govt of India or reports to be verified at NABL approved labs for parameters by firm.
- LM79 and LM80 reports need to be submitted from a NABL/UL accredited lab to verify above parameters.
- Both the fixture and Driver should have BIS approval.

## 4.5 LIGHTING MANAGEMENT SYSTEM

LMS shall need to be connected wirelessly to the luminaires installed in whole area of the building in order to meet the requirement of control and management of lighting fixtures. It must be able to sense the data and transmit to the central system.

NOTE: The Luminaires supplied shall be compatible with LMS.

### 4.5.1 SYSTEM REQUIREMENTS

#### ➤ **Grouping**

The system shall be able to group together number of lights and a lighting behaviour template shall be assigned to each group. The lighting behaviour and grouping of lighting fixtures shall be able to be changed remotely.

#### ➤ **Switching**

The system shall be able to switch off/on the lights with predefined schedule and manually as well from remote location. Switching shall be for a group of lights or individual, as well.

#### ➤ **Daylight Harvesting**

The system shall be capable to communicate the lighting sensors of individual/group of lights to measure the light level and shall reduce the light output of the fixture (reduced energy consumption) when enough light is already available, for example through sun light

#### ➤ **Dimming**

The system shall be able to adopt the preconfigured office light behaviour templates that enable targeted dimming.

#### ➤ **Human Centric Lighting**

The system shall be able to adopt the human centric lighting behaviour of the light fixtures depending on the period of the time during a day. The CCT of lighting shall adopt different CCT from beginning of day to evening to provide the comfort.

➤ **Connectivity and Network Topology:**

Each light/sensor shall communicate wirelessly using the ZigBee/Bluetooth protocol with a Wireless Gateway. Every light fixture shall be connected in the network and can ensure that the control data is transmitted reliably to network node/device.

#### **4.5.2 SYSTEM DESCRIPTION**

**a. User Dashboard:**

The standalone/cloud software shall allow the lighting system to be controlled, monitored and managed. The dashboard shall have functionality that includes energy reports, occupancy reports and heatmaps, ability to set up and run schedules, and to manage generated alerts. The software shall allow for users to control the light levels for areas across the building at area or floor level. The lighting control software shall incorporate of user login access security. The system shall be capable of displaying alternate applications in accordance with the user rights profile defined for each user. The system shall automatically log out users after a defined period has elapsed since the last application activity.

**b. System Health Monitoring:**

It shall be possible to monitor and control the entire system in near real-time. The system shall be capable of monitoring and displaying a comprehensive range of diagnostic and fault information in a graphical dashboard.

**c. Energy Monitoring:**

The management software shall display historical measured energy consumption data in a dashboard format. Notional calculations will not be accepted. The purpose of this facility shall be to provide clear visibility of lighting system energy performance to occupants, to encourage utilization behaviour that reduces energy demand

**d. Occupancy Graphs & Heatmaps:**

The management software shall display historical occupancy metrics based on the PIR sensors. The system shall support occupancy metrics without the inclusion of the hold time of the sensor.

The dashboard shall be able to display occupancy reports with a percentage of occupancy. The purpose of this feature is to provide clear visibility of occupancy usage of the spaces to encourage decisions or strategies to improve the facility overall usage and reduce real state costs. The dashboard shall also include heatmaps visualization for an easy display of information.

The system shall support the visualization of range heatmap, where the user can select the hours of the day, days of the week, months and years to get an average for every single sensor. It shall be displayed in both a graph and a heatmap picture.

### 4.5.3 System Components

The Lighting Control System, in general must comprise of the following components:

#### a. Wireless Dimmable Controller

Wireless Dimmable Controller with PIR and Ambient Light Sensing shall be used. Temperature & Humidity capability in these sensors may be additional feature, but optional only. Sensors shall be factory fitted along with the driver. Drivers and sensors shall be CE, UL and BIS compliant.

The sensor shall be field configured through LMS or IR and operator can override operation of the sensor. The sensor shall hold up to five configurations to operate the light based on the time of the day. The sensor shall cover an area of 200 - 300 sq. feet depending on the height of ceiling. Operator shall have the ability to override the sensor mode to Auto or manual based on the time of the day for special occasions.

#### b. Wireless Controller for Tunable Lights

Wireless Controller with one PIR Sensor capable of controlling tunable colour fixtures with inbuilt Ambient Light Sensor for dimming shall be used. It shall have capability to add additional sensors to extend the overall coverage area. The controller shall be configurable from LMS to override PIR / ALS / Colour. The controller shall have field configurable various modes of operation. Drivers and sensors shall be CE, UL and BIS compliant.

The sensor shall be field configured through LMS or IR and operator can override operation of the sensor. The sensor shall hold up to five configurations to operate the light based on the time of the day. The sensor shall cover an area of 300 - 500 sq. feet depending on the height of ceiling. Operator shall have the ability to override the sensor mode to Auto or manual based on the time of the day for special occasions.

The additional sensor shall have the same specification as primary sensor.

#### c. Wireless Relay Controller for ON/Off controls

Wireless Relay Controller with one PIR only sensor shall be used for Controlling non-dimmable fixtures. It shall be CE, UL and BIS compliant.

#### d. Wireless Switch for area control

Wireless Switches shall be used for Room and Scene Control. It shall have LCD display to display light status, Temperature & humidity status. It shall allow control of lights of ON/Off, Dim or CCT. It shall allow to set pre-determined scenes.

#### e. Battery Operated Wireless Switch for area or Zone Control

Wireless Battery-Operated Wall mounting switch/remote capable of controlling ON/Off and Dim up/down shall be used. Battery operated remote operation with a life of at least 5 year of battery life

**f. Wireless Receiver/Transmitter**

Wireless Receiver will be a tunnelling device for all control, status and configuration messages from LMS to individual controllers and vice-versa. The device shall have a range of at least 25 meters indoor and shall have the capability to handle at least 100 controllers.

**g. Main Gateway Processor**

Processor panel containing one processor. The processor shall allow third party BMS application to discover all lighting points and Group points over BACnet IP and allow control of lights for ON/Off/DIM and change colour. The product shall be CE and FCC certified.

**4.6 TESTS**

The electronics covered for this equipment shall pass all the tests called for in the specification. The tenderer shall indicate the deviation or compliance otherwise the offer may be rejected.

Tests are classified as:

- Type test,
- Routine and

**Type Test:**

Type tests shall be carried out to prove confirmation with the requirement of specification and general quality/design features of the unit. In case of any change in design of unit, complete type test shall be repeated.

**Routine Tests:**

These tests shall be performed by the manufacturer on sample(s) taken from a lot as per sampling plan specified by BIS at NABL accredited labs in the presence of Client Representative. The charges for the above tests to be borne by the manufacturer/supplier. The test results shall be submitted to the Engineer. The firm shall maintain the records with traceability.

**4.6.1 Test Scheme:**

**Routine Test**

1. Visual and Dimensional check
2. Checking of documents of purchase of LED
3. Resistance to humidity
4. Insulation resistance test
5. HV test
6. Over voltage protection
7. Surge protection
8. Reverse polarities
9. Temperature rise Test
10. Ra % (Color Rendering Index) as per BOQ specifications
11. Lux measurements
12. Tests for IP as per BOQ specifications

**4.7 WARRANTY**

All Luminaires and its gears along with LMS software & hardware shall carry replacement warranty for a period of 05 (Five) years from the date of commissioning.



## 5.0 LT CABLES

### 5.1 GENERAL

Technical specifications in this section covers supplying and laying of :

- LT cables.

### 5.2 STANDARDS AND CODES

All equipments, components, materials and entire work shall be carried out in conformity with applicable and relevant Bureau of Indian Standards and Codes of Practice, as amended upto date and as below. In addition, relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and /or IEC Standards shall be applicable.

Equipments certified by Bureau of Indian Standards shall be used in this contract in line with government regulations. Test certificates in support of this certification shall be submitted, as required.

It is to be noted that updated and current standards shall be applicable irrespective of dates mentioned along with ISS's in the tender documents.

PVC insulated heavy duty cables	IS 1554 - 1988
Cross link polyethylene insulated PVC (sheathed XLPE cables)	IS 7098 - 1985
Code of practice for installation and maintenance of power cables	IS 1255 - 1983
Conductors for insulated electrical cables	IS 8130 - 1984
Drums for electrical cable	IS 10418 - 1982
Methods of test for cables	IS 10810 - 1988
Recommended current rating	IS 3961 - 1987
Recommended short circuit rating of high voltage	IS 5891 - 1970

Medium voltage cables shall be aluminium conductor XLPE insulated, PVC sheathed armoured conforming to IS 7098. Cables shall be rated for a 1100 Volts. The conductor of cables from 16 Sq. mm. to 50 Sq. mm. shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 sq. mm and above. Conductors shall be made of electrical purity aluminium 3/4 H or H temper. Conductors shall be insulated with high quality PVC base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanised compound. Armouring shall be applied over outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer's name and trade mark at every metre length. Cores shall be provided with following colour scheme of PVC insulation.

1 Core	:	Red/Black/Yellow/Blue
2 Core	:	Red and Black
3 Core	:	Red, Yellow and Blue

3 1/2 /4 Core : Red, Yellow, Blue and Black

Current ratings shall be based on the following conditions.

- |                                  |         |
|----------------------------------|---------|
| a) Maximum conductor temperature | 70° C   |
| b) Ambient air temperature       | 45° C   |
| c) Ground temperature            | 30° C   |
| d) Depth of laying               | 1000 mm |

Short circuit rating of cables shall be as specified in IS 7098.

Cables have been selected considering conditions of maximum connected loads, ambient temperature, grouping of cables and allowable voltage drop. However, the contractor shall recheck the sizes before cables are fixed and connected to service.

### **5.3 Delivery, Storage and Handling**

Cable drum shall be stored on a well drained, hard surface, preferably of concrete, so that the drums do not sink in ground causing rot and damage to the cable drum. The cable drum shall conform to IS 10418. During storage, periodical rolling of drums, in the direction of arrow marked on the drum, shall be done once in 3 month through 90°C Both ends of cables shall be properly sealed to prevent moisture ingress Drums shall be stored in well ventilated area protected from sun and rain. Drums shall always be rested on the flanges and not on flat sides. Damaged battens of drums etc. shall be replaced. Movement of drums shall always be in direction of the arrow marked on the drum. For transportation over long distance, the drums shall either be mounted on drum wheels and pulled by ropes or they shall be mounted on trailers etc. drums shall be unloaded preferably by crane otherwise they shall be rolled down carefully on suitable ramps. While transferring cable from 1 drum to another, the barrel of the new drum shall have diameter not less than the original drum. Cables with kinks or similar visible defects like defective armouring etc shall be rejected. Cables shall be supplied at site in cut pieces as per actual requirements.

### **5.4 LAYING OF CABLES**

Cables shall be so laid that the maximum bending radius is 12 times the overall diameter of the cable for medium voltage cables. Cables shall be laid in masonry trenches, directly on walls/cable trays, directly buried in ground or in pipes/ducts as elaborated below. Cables of different voltages and also power and control cables shall be laid in different trenches with adequate separation. Wherever available space is restricted such that this requirement cannot be met, medium voltage cables shall be laid above HT cables.

#### **5.4.1 In Masonry Trenches**

Wherever so specified, cables shall be laid in indoor/outdoor masonry/RCC trenches to be provided by Owners. Cables shall be laid on MS supports fabricated from minimum 38mm x 38mm x 6mm painted / galvanized angle iron supports grouted in trench walls at intervals not

exceeding 600 mm. If required, cables shall be arranged in tier formation inside the trench. Suitable clamps, hooks and saddles shall be used for securing the cables in position and dressing properly so that the clear spacing between the cables shall not be less than the diameter of the cable. Trenches shall be provided with chequered plate/RCC covers. Wherever so specified, trenches shall be filled with fine sand.

#### 5.4.2 On Trays/Walls

Wherever so specified, cables shall be laid along walls/ceiling or on cable trays. Cable shall be secured in position and dressed properly by means of suitable clamps, hooks, saddles etc. such that the minimum clear spacing between cables is diameter of the cable. Clamping of cables shall be at minimum intervals as below.

Type of cables	Size	Clamping by	Fixing intervals
MV	Upto and including 25 sq mm	Saddles 1 mm thick	45 cm
MV & HV	35 sq mm to 120 sq mm	Clamps 3 mm thick 25 mm wide	60 cm
MV & HV	150 sq mm and above	Clamps 3 mm thick 40 mm wide	60 cm

Note :The fixing intervals specified apply to straight runs. In the case of bends, additional clamping shall be provided at 30 cm from the centre of the bend on both sides.

Cable trays, of sizes as per schedule of quantities and drawings shall be of perforated doubled bend channel/ladder design unless otherwise stated. Cable trays shall be fabricated from minimum 2 mm thick sheet steel and shall be complete with tees, elbows, risers, and all necessary hardware. Cable trays shall comply with the following:

Trays shall have suitable strength and rigidity to provide proper support for all contained cables. Trays shall not have sharp edges, burrs or projections injurious to cable insulation. Trays shall include fittings for changes in direction and elevation. Cable trays and accessories shall be painted with one shop coated of red oxide zinc chromate primer and two side coats of aluminium alkyl paint or approved equivalent. Cable trays shall not have sharp edges, burrs or projection that may damage the insulation jackets of the wiring. Cable trays shall have side rails or equivalent structural members.

Unless otherwise specifically noted on the relevant layout drawing, all cable tray mounting works to be carried out ensuring the following :

Cable tray mounting arrangement type to be as marked on layout drawing. Assembly of tray mounting structure shall be supplied fabricated, erected & painted by the electrical contractor. Tray mounting structures shall be welded to plate inserts or to structural beams as approved by the Architect/Engineer/DFCCIL. Wherever embedded plates & structural beams are not available

for welding the tray mounting structure electrical contractor to supply the MS plates & fix them to floor slab by four anchor fasteners of minimum 16 mm dia having minimum holding power of 5000 Kg at no extra cost. Maximum loading on a horizontal support arm to be 120 Kg. metre of cable run. Width of the horizontal arms of the tray supporting structures to be same as the tray widths specified in tray layout drawings, plus length required, for welding to the vertical supports. The length of vertical supporting members for horizontal tray runs shall be to suit the number of tray tiers shown in tray layout drawings. Spacing between horizontal supports arms of vertical tray runs to be 300 mm. Cable trays will be welded to their mounting supports. Minimum clearance between the top most tray tier and structural member to be 300 mm. Cables in vertical race ways to be clamped by saddle type clamps to the horizontal slotted angels. Clamps to be fabricated from 3 mm thick aluminium strip at site by the electrical contractor to suit cable groups. The structural steel (standard quality) shall be according to latest revision of IS : 226 & 808. Welding shall be as per latest revisions of IS : 816. All structural steel to be painted with one shop coat of red oxide and oil primer followed by a finishing coat of aluminium alkyd paint where any cuts or holes are made on finished steel work these shall be sealed against oxidation by red oxide followed by the same finishing paint. Steel sheet covers wherever indicated to be similarly painted. Trays shall be erected properly to present a neat and clean appearance. Trays shall be installed as a complete system. Trays shall be supported adequately by means of painted MS structural members secured to the structure by dash fasteners or by grouting. The entire cable tray system shall be rigid. Each run of cable tray shall be completed before laying of cables. Cable trays shall be erected so as to be exposed and accessible.

### **5.4.3 Buried Directly In Ground**

#### **5.4.3.1 General**

Cables shall be so laid that they will not interfere with under ground structures. All water pipes, sewage lines or other structures which become exposed by excavation shall be properly supported and protected from injury until the filling has been rammed solidly in places under and around them. Any telephone or other cables coming in the way are to be properly shielded as directed by Architects/Engineer. Surface of the ground shall be made good so as to conform in all respects to the surrounding ground to the satisfaction of Architect/Engineer/DFCCIL.

#### **5.4.3.2 Routing of cables**

Before cable laying work is undertaken, the route of the cables shall be decided with the Architects/Engineer. While shortest practicable route shall be preferred, cable runs shall follow fixed development such as roads, footpaths etc with proper off-sets so that future maintenance and identification are rendered easy. Whenever cables are laid along well demarcated or established roads, the LV/MV cables shall be laid further from the kerb line than HV cables. Cables of different voltages and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted, LV/MV cables shall be laid above HV cables. Where cables cross one another, the cables of higher voltage shall be laid at a lower level than the cables of lower voltage. Power and communication cables shall as far as possible

cross at right angles. Where power cables are laid in proximity to communications cables the horizontal and vertical clearances shall not normally be less than 60 cm.

#### **5.4.3.3 Width of Trench**

The width of trench shall be determined on the following basis. The minimum width of trench for laying single cables shall be 350 mm. Where more than one cable is to be laid in the same trench in horizontal formation, the width of trench shall be increased such that the inter-axial spacing between the cables except where otherwise specified shall be at least 200 mm. There shall be a clearance of at least 150 mm between axis of the end cables and the sides of the trench.

#### **5.4.3.4 Depth of Trench**

The depth of trench shall be determined on the following basis:

- Where cables are laid in single tier formation, the total depth of the trench shall not be less than 750 mm for cables upto 1.1 kV and 1250 mm for cables above 1.1 kV.
- When more than one tier of cables is unavoidable and vertical formation of laying is adopted, the depth of trench shall be increased by 300 mm for each additional tier to be formed.

### **5.5 Excavation Of Trenches**

The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature of 12 times the overall diameter of the largest cable shall be provided. Where gradients and changes in depths are unavoidable these shall be gradual. Excavation should be done by any suitable manual or mechanical means. Excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. Adequate precautions shall be taken not to damage any existing cables, pipes or other such installations during excavation. Wherever bricks, tiles or protected covers or bare cables are encountered, further excavation shall not be carried out without the approval of the Architect/Engineer/DFCCIL. Existing property exposed during trenching shall be temporarily supported or propped adequately as directed by the Architect/Engineer/DFCCIL. The trenching in such cases shall be done in short lengths, necessary pipes laid for passing cables therein and the trench refilled as required. If there is any danger of a trench collapsing or endangering adjacent structures the sides shall be well shored up with timbering and/or sheathing as the excavation proceeds. Where necessary these may even be left in place when back filling the trench. Excavation through lawns shall be done in consultation with the Architect/Engineer/DFCCIL. Bottom of the trench shall be level and free from stone, brick, etc. The trench shall then be provided with a layer of clean dry sand cushion of not less than 80 mm in depth.

### **5.6 Laying Of Cable In Trench**

The cable drum shall be properly mounted on jacks or on a cable wheel at a suitable location. It should be ensured that the spindle, jack etc are strong enough to carry the weight of the drum without failure and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating. The cable shall be pulled over rollers in the trench steadily and

uniformly without jerks or strains. The entire cable length shall, as far as possible, be laid in one stretch. However when this is not possible the remainder of the cable shall be removed by flaking i.e. making one long loop in the reverse direction. After the cable is uncoiled and laid over the rollers, the cable shall be lifted slightly over the rollers beginning from one end by helpers standing about 10 metres apart and drawn straight. The cable should then be taken off the rollers by additional helpers lifting the cables and then laid in the trench in a reasonably straight line. For short runs and cable sizes upto 50 sq mm 1.1 kV grade the alternative method of direct handling can be adopted with the prior approval of the Architect/Engineer/DFCCIL. If two or more cables are laid in the same trench care should be taken to preserve relative position. All the cables following the same routes shall be laid in the same trench. Cables shall not cross each other as far as possible. When the cable has been properly straightened the cores shall be tested for continuity and insulation resistance. The cable shall be measured thereafter. Suitable moisture sealing compound/tape shall be used for sealing of the ends. Cable laid in trenches in a single tier formation shall have a covering of clean dry sand of not less than 170 mm above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. If additional tiers are formed each of the subsequent tiers also shall have a sand cushion of 300 mm. The top most cable shall have a final sand covering not less than 170 mm before the protective cover is laid. A final protection to cables shall be laid to provide warning to future excavators of the presence of the cable and also to protect the cables against accidental mechanical damage. Such protection shall be with second class bricks of not less than 200 mm x 100 mm x 100 mm (normal size) laid breadth wise for the full length of the cable to the satisfaction of the Architect/Engineer/DFCCIL. Where more than one cable is to be laid in the same trench this protective covering shall cover all the cables and project at least 50 mm over the sides of the end cables. In addition bricks on edge shall be placed along the entire run on either side of the cable run. The trenches shall then be back filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered in successive layers not exceeding 300 mm. Unless otherwise specified a crown of earth not less than 50 mm in the centre and tapering towards the side of the trench shall be left to allow for subsidence. The crown of earth should however not exceed 100 mm so as not to be a hazard to vehicular traffic. Where road berms or lawns have been cut or kerb stones displaced the same shall be repaired and made good to the satisfaction of the Architect/Engineer/DFCCIL and all surplus earth and rocks removed to places as specified.

#### **5.6.1 Laying In Pipes/Closed Ducts**

In locations such as road crossings, entry to buildings/poles in paved areas etc., cables shall be laid in pipes or closed ducts. Spun reinforced concrete pipes shall be used for such purposes and the pipe shall not be less than 100 mm in diameter for a single cable and not less than 150 mm for more than one cable. These pipes shall be laid directly in ground without any special bed. Sand cushioning and/or brick tiles need not be used in such installations. Unless otherwise specified the top surface of pipes shall be at a minimum depth of 1000 mm from the ground level when laid under roads, pavements etc. The pipes for road crossings shall preferably be on the skew to reduce the angle of bend as the cable enters and leaves the crossing. Pipes shall be

continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing. No deduction shall be made for sand and bricks not used for cables passing through RCC Hume pipes or for parts of vertical cables at the lighting poles.

### **5.6.2 Laying Of Cables In Floors**

Laying of cables directly in floors shall be avoided and GI pipes of adequate size shall be used wherever necessary. However if the cables have to be laid direct in the floor specific written approval of Architect/Engineer/DFCCIL shall be obtained and the Contractor shall cut chases, lay the cables and make good the chases to original finish.

### **5.6.3 Cable Entry Into Buildings**

Cable entry into buildings shall be made through RCC pipes recessed in the floor. RCC Hume pipes shall be provided well in advance for service cable entries. The pipe shall be filled with sand and sealed at both ends with bitumen mastic to avoid entry of water. Suitable size manholes shall be provided wherever required to facilitate drawing of cables as per requirements.

## **5.7 TERMINATION/JOINTING OF CABLES**

Soldered jointing/termination shall be totally avoided. Solderless terminations by using Dowel crimping tools and suitable legs shall be adopted for all cable terminations. Any terminations may without use of proper crimping tool is shall be liable to be rejected. In the case of aluminium conductors, it is to be ensured that the conductor oxidation is cleaned by means of emery paper and then a thin coat of tin is applied before pinching into any equipment. Heat shrinkable Raychem type or approved equivalent terminations shall be provided for High Voltage cables and Siemens make or approved equivalent make brass double compression glands shall be provided for Medium Voltage cable terminations. Straight through jointing of Medium Voltage or High Voltage cable shall normally be totally avoided. If absolutely unavoidable, such jointing shall be carried out as per procedure to be got specifically approved from Architect/Engineer/DFCCIL.

## **5.8 MEASUREMENT OF CABLE RUNS**

The cable runs shall be measured upto the outer end of the boxes without any allowances for overlap in joints. The actual run of the cables shall be measured and the rate shall include all the above mentioned material, labour etc for laying as required.

## **5.9 CABLE LOOPS**

At the time of the installation approximately 3 metres of surplus cable shall be left

- at each end of the cable
- on each side of underground straight through/tee/termination joints.
- at entries to buildings

- and such other places as may be decided by the architects/Engineer.

This cable shall be left in the form of a loop.

Wherever long runs of cable length are installed cable loops shall be left at suitable intervals as specified by the Architect/Engineer/DFCCIL.

#### **5.10 BONDING OF CABLES.**

Where a cable enters any piece of apparatus it shall be connected to the casting by means of an approved type of armoured clamp or gland. The clamps must grip the armouring firmly to the gland or casting, so that in the event of ground movement no undue stress is placed on to the cable conductors.

#### **5.11 TESTING**

##### **5.11.1 Tests At Manufacturer's Work**

The cables shall be subjected to shop test in accordance with relevant standards to prove the design and general qualities to the cables as below (as per IS 10810) :

- Routine test on each drum of cables.
- Acceptance tests on drums chosen at random for acceptance of the lot.
- Type test on each type of cables, inclusive of measurement of armour DC resistance of power cables.

##### **5.11.2 Site Testing**

- All cables before laying shall be tested with a 500 V megger for 1.1 kV grade or with a 2500/5000 V megger for cables of higher voltages. The cables cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armour and insulation resistance between conductors.
- All cables shall be subject to above mentioned test during laying, before covering the cables by protective covers and back filling and also before the jointing operations.
- After laying and jointing, the cable shall be subjected to a 1.5 minutes AC/DC pressure test.
- In the absence of facilities for pressure testing in accordance with clause\_\_ above it is sufficient to test for one minute with 1000 V megger for cables of 1.1 kV grade and with 2500/5000 V megger for cables of higher voltages.

##### **5.11.3 Test Witness**

Tests shall be performed in presence of representative of Architect/Engineer/DFCCIL. The Contractor shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.



## 6.0 LT PANELS AND DB

### 6.1 GENERAL

This section covers specification of Medium Voltage Switchboards incorporating items of switchgear like Circuit Breakers, SFUs, metering and protection.

### 6.2 STANDARDS AND CODES

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

BIS certified equipment shall be used as a part of the Contract in line with Government regulations. Necessary test certificates in support of the certification shall be submitted prior to supply of the equipment.

It is to be noted that updated and current Standards shall be applicable irrespective of those listed below.

Low Voltage switchgear & controlgear	IS 13947 : 1993
Part I : General rules	
Part II : Circuit Breakers	
Part III : Switches, disconnectors, switch disconnectors and fuse combination units	
Part IV : Contactors and Motor starters	
Part V : Control circuit devices and switching elements	
Marking of Switchgear busbars	IS 11353 : 1985
Degree of Protection of Enclosures for low voltage switchgear.	IS 2147 : 1962
Electrical relays for power system protection	IS 3231 : 1986
Code of Practice for selection, installation and Maintenance of switchgear & controlgear	IS 10118 : 1982
Low voltage switchgear & controlgear assemblies	IS 8623 : 1993

### 6.3 SWITCHGEAR

#### 6.3.1 Moulded Case Circuit Breakers

Moulded case circuit breakers (MCCB) incorporated in switchboards wherever required, shall conform to IS 13947 : 1993 in all respects. MCCBs shall be suitable either for single phase 240 Volts or 3 Phase 415 Volts AC 50 Hz supply.

MCCB cover and case shall be made of high strength heat resisting and flame retardant thermosetting insulating material. Operating handle shall be quick make/break, trip - free type.

Operating handle shall have suitable ON, OFF and TRIPPED indicators. Three phase MCCBs shall have a common handle for simultaneous operation and tripping of all the three phases. Suitable arc extinguishing device shall be provided for each contact. Tripping unit shall be of thermal/magnetic type provided on each pole and connected by a common tripe bar such that tripping of any one pole causes three poles to open simultaneously. Thermal/magnetic tripping device shall have IDMT characteristics for sustained over loads and short circuits.

Contact trips shall be made of suitable arc resistant sintered alloy. Terminals shall be of liberal design with adequate clearances.

MCCBs shall be provided with following accessories, if specified in drawings/ schedule of quantities :

- Under voltage trip
- Shunt trip
- Alarm switch
- Auxiliary switch

MCCBs shall be provided with following interlocking devices for interlocking the door a switch board.

- Handle interlock to prevent unnecessary manipulations of the breaker.
- Door interlock to prevent door being opened when the breaker is in ON position
- Deinterlocking device to open the door even if the breaker is in ON position.

MCCBs shall have rupturing capacity as specified in drawings/schedule of quantities.

All MCCB shall be provided with adapter terminal for facilitates higher sizes of cable/ links

### **6.3.2 Metering, Instrumentation And Protection.**

Ratings, type and quantity of meters, instruments and protective devices shall be as per drawings and schedule of quantities.

### **6.3.3 Current Transformers**

C/Ts shall confirm to IS 2705 (part -I, II and III) in all respects. All C/Ts used for medium voltage application shall be rated for 1 kV. C/Ts shall have rated primary current, rated burden and class of accuracy as specified in schedule of quantities/drawings. Rated secondary current shall be 5A unless otherwise stated. Minimum acceptable class for measurement shall be class 0.5 to 1 and for protection class 10. C/Ts shall be capable of withstanding magnetic and thermal stresses due to short circuit faults of 31 MVA on medium voltage. Terminals of C/Ts shall be paired permanently for easy identification of poles. C/Ts shall be provided with earthing terminals for earthing chassis, frame work and fixed part of metal casing (if any). Each C/T shall be provided with rating plate indicating :

- Name and make

- Serial number
- Transformation ratio
- Rated burden
- Rated voltage
- Accuracy class

CTs shall be mounded such that they are easily accessible for inspection, maintenance and replacement. Wiring for CT shall be with copper conductor PVC insulated wires with proper termination works and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

#### **6.3.4 Potential Transformer**

PTs shall conform to IS 3156 (Part-I,II and III) in all respects.

#### **6.3.5 Measuring Instruments**

Direct reading electrical instruments shall conform to IS 1248 or in all respects. Accuracy of direct reading shall be 1.0 of voltmeter and 1.5 for ammeters. Other instruments shall have accuracy of 1.5. Meters shall be suitable for continuous operation between  $-10^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . Meters shall be flush mounting and shall be enclosed in dust tight housing. The housing shall be of steel or phenolic mould. Design and manufacture of meters shall ensure prevention of fogging of instrument glass. Pointer shall be black in colour and shall have Zero position adjustment device operable from out side. Direction of deflection shall be from left to right. Selector switches shall be provided for ammeters and volt meters used in three phase system.

#### **6.3.6 Multi Function meters**

MFM shall be employed on the Panels and DBs as specified in the BOQ. MFM shall have seamless integration with BMS and shall supply all data with suitable means. All parameters shall be made available to BMS. Meters shall be suitable for operation with current and potential transformers available in the panel.

#### **6.3.7 Relays**

Protection relays shall be provided with flag type indicators to indicate cause of tripping. Flag indicators shall remain in position till they are reset by hand reset. Relays shall be designed to make or break the normal circuit current with which they are associated. Relay contacts shall be of silver or platinum alloy and shall be designed to withstand repeated operation without damage. Relays shall be of draw out type to facilitate testing and maintenance. Draw out case shall be dust tight. Relays shall be capable of disconnecting faulty section of network without causing interruption to remaining sections. Analysis of setting shall be made considering relay errors, pickup and overshoot errors and shall be submitted to Architect/Engineer/DFCCIL for approval.

**6.3.8 Over current relays**

Over current relays shall be induction type with inverse definite minimum time lag characteristics. Relays shall be provided with adjustable current and time settings. Setting for current shall be 50 to 200 % in steps of 25%. The IDMT relay shall have time lag (delay) of 0 to 3 seconds. The time setting multiplier shall be adjustable from 0.1 to unity. Over current relays shall be fitted with suitable tripping device with trip coil being suitable for operation on 5 Amps.

**6.3.9 Earth fault relay**

Same as over current relay excepting the current setting shall be 10% to 40% in steps of 10%.

**6.3.10 Under voltage relay**

Under voltage relays shall be of induction type and shall have inverse limit operation characteristics with pickup voltage range of 50 to 90% of the rated voltage.

**7.0 CONDUIT, CABLE TRAY AND RACEWAY****7.1 General**

The Contractor shall supply and install the conduits, cable trays and raceways as indicated in BOQ and specified herein.

**7.2 Applicable Codes and Standards**

The conduits, cable trays and raceways shall comply with the following codes and standards:

IS: 9537 P-I:1980	: Conduits for Electrical Wiring Part I General Requirements
IS: 9537 P-II: 1981	: Conduits for electrical wiring Part II Rigid Steel Conduits
IS: 3837	: Accessories for Rigid Steel Conduits for Electrical Wiring
IS: 3480	: Flexible Steel Conduits for Electrical Wiring
IS: 732	: Code of Practice for Electrical Wiring Installations
IS: 2667	: Fittings for Rigid Steel Conduits for Electrical Wiring
IS 9537 : Part 1	: 1980/IEC 60614-1 (1978) : Conduits for electrical installations: Part 1 General requirements
IS 9537 : Part 2	: 1981(superseding IS:1653) : Conduits for electrical installations: Part 2 Rigid steel conduits
IS: 3837:1976	: Accessories for rigid steel conduits for electrical wiring
IS: 3480:1966	: Flexible steel conduits for electrical wiring
IS: 732: 1989	: Code of practice for electrical wiring installations

IS: 2667-1988 : Fittings for rigid steel conduits for electrical wiring

IS: 2412-1975 : Link clips for electrical wiring

IS:371-1999 : Ceiling roses

In addition to above, Indian Electricity Act 2003 and IE Rules 1956 as amended from time to time, General Specifications for electrical works Part-1 internal-2005 issued by CPWD shall be followed.

### 7.3 Material Description

The conduit, cable tray and raceway shall be designed and manufactured in accordance to the Indian Standards or International Standards and accepted by the authority and shall be installed to comply with relevant provision in Indian Standards Specifications, Indian Electricity Rules and IE wiring regulation.

### 7.4 Components

#### (1) GI Conduits and Accessories

- a. The steel conduits shall be made of hot-dip galvanized, produced in electrical resistance welding process with the weld bead on both inside and outside removed in accordance with Indian standard IS:9537 part 3 or equivalent.
- b. Flexible conduit and fittings for life safety equipment shall be galvanized, watertight pattern, flame retardant, Low smoke and fume, over-sheathed and separate earth wire enclosed within the conduit (if applicable).
- c. The standard manufactured elbows shall be used for all sizes of conduits diameter larger than 1 inch (25mm), and the field bends to be handled with great care not to damage the conduits, shall be permitted to be used for conduit of 1 inch and smaller.
- d. The conduits shall be defined in SI units.

#### (2) Cable Tray

- a. Cable trays used in indoors shall be made of hot dip galvanized perforated steel after fabrication to provide good corrosion resistance during storage, installation and service. The ventilated type cable tray, punching with cover shall be provided with the dimensions as indicated on the drawings.
- b. The number of cables laid in the cable tray shall be provided in compliance in compliance with the requirements of the Indian Standard Specifications, Indian Electricity Rules and IE wiring regulations. 40% spare capacity shall be provided for cable laying inside the cable tray.
- c. Cable tray shall not be installed across building or structural expansion joints. On horizontal runs, the tray shall be installed with a 20 mm gap at the expansion joint. Support shall be installed within 150 mm on either side of the joint.

- d. Wherever cables are laid in cable trays these shall be concealed above false ceiling. Trays shall conform to NEMA with minimum 2.0 mm thickness, perforated and galvanized steel.

### (3) Raceway

- a. Raceways shall be made of hot dip galvanized perforated steel after fabrication to afford good corrosion resistance during storage, installation and service life and shall be provided to form the continuous steel sheet troughs with removable covers attached to the race way by screws for housing the cables. The minimum thickness required for raceway shall be as per the following table:

Size of the Raceway (WXH) (mm)	Thickness (mm)
50X50 up to 100X50	1.6
100X100 up to 150X100	1.6
200X100 up to 300X100	1.6
150X150 up to 300X150	1.6
Larger than above	2.0

- b. Raceways shall be installed so that all networking/telecom cables are separate from power cables.
- c. Each section of the raceway shall be electrically bonded with a minimum 6 mm<sup>2</sup> cross section area earth bonding strap or wire, to the next section to form an electrically continuous system and bonding to main grounding system shall be with copper green/yellow, LSZH material sheathed single core cable.
- d. The number of cables laid in the cable tray shall be provided in compliance with the requirements of the Indian Standard Specifications, Indian Electricity Rules and IE wiring regulations. 40% spare capacity shall be provided for cable laying inside the raceway.

### (4) Boxes and Accessories

- a. All boxes provided in the conduit work shall be made of metal. A box provided for cable connections and concealed in ceiling shall be a standard galvanized steel square or circular box or a metal box, made of steel sheet with not less than 1.6 mm thickness, with one primer anti-rust coated and two coating finishes.
- b. All wall/ceiling boxes on exposed work shall be of die cast aluminium or cadmium-plated cast-iron.
- c. Conduit outlet boxes, for socket outlets, lighting switches, etc., shall be of hot dip galvanized steel complete with adjustable lug, ample knockouts, and brass earth terminals fitted in the base.

## 7.5 Testing and Commissioning

Field inspection and testing for conduit, cable tray and raceways installed shall be carried out prior to energization of any equipment / system.

**8.0 TECHNICAL SPECIFICATIONS FOR MACHINE-ROOM LESS LIFTS****8.1 General**

This specification covers the requirements of Design, Fabrication, Supply, Installation, Commissioning, packing, forwarding, transportation to site, unloading, furnishing of final drawings and manuals, handling at site, performance demonstration and performance acceptance etc. of various capacity passenger and goods lifts as per BOQ. To make the system complete in all respects and required Civil/Electrical work as per technical Specification & as per the tender document. The lift shall be capable for seamless integration with BMS.

**8.2 SITE CONDITIONS**

Temperature	:	Maximum 45 Deg. C Minimum 4 Deg. C
Humidity	:	Not more than 90% at maximum temperature.
Rainfall	:	1000 - 1500mm Per Annum

+

**8.3 ELECTRICAL SUPPLY SPECIFICATION**

System Voltage	415V
Voltage variation limits	+/- 10%
No. of phases	3
Frequency	50 c/s
Frequency variation limits	+3% or -5%
Fault level	Not exceeding 50 KA at 415 V
Neutral earthing on LV side	Solidly earthed

**8.4 STANDARDS**

The following Indian Standard Specifications and Codes of Practice, currently applicable and updated as of date irrespective of dates given below, shall apply to the equipments and the work covered by this contract. In addition the relevant clauses of the Indian Electricity Act 2003 and Indian Electricity Rules 1956 with latest amendments up to date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable

1. Code of Practice for installation, operation and maintenance of electric passenger & goods lifts.IS-14665 (Part 2) Sec-1 :2000
2. Code of practice for installation, operation and maintenance of electric service lift.IS-14665 (Part 2) Sec-2 : 2000
3. Safety Rules Section-1 Passenger and Good lifts IS-14665 (Part 3) Sec-1 : 2000

4. Safety Rules Section-2 – Service Lifts IS-14665 (Part 3) Sec-2 : 2000
5. Outline dimension for electric lifts. IS-14665 (Part-1) : 2000
6. Inspection Manual for Electric Lifts IS-14665 (Part 5) : 1999
7. Electric Traction Lifts – Components
8. Installation And Maintenance of Lifts For Handicapped Persons (Code of Practice) IS-14665 (Part 4) Sec-1 to 9 :2001IS 15330 :2003
9. Specification for lifts cables. IS-4289 (Par-1) : 1984 Reaffirmed 1991
10. Specification for hot rolled and slit steel tee bars IS-1173-1978 Reaffirmed 1987
11. Method of loading rating of worm gear. IS-7443-1974 Reaffirmed 1991
12. Code of practice for selection of standard worn and helical gear box.IS-7403-1974 Reaffirmed 1991
13. Isometrics screw threads. IS-4218-(Part-II)1976 Reaffirmed 1996
14. Degree of protection provided by enclosure for low voltage switchgear and control gear. IS-2147-1962
15. Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service. IS-1271- 1985 Reaffirmed 1990
16. Code of practice for earthing. IS-3043-1987
17. Electrical installation Fire Safety of Building. IS-1646-1997
18. PVC insulated electric cable for working voltage up to and including 1100 volts.IS-694-1990
19. Code of practice for electrical wiring and installation IS-732-1989
20. PVC insulated (Heavy Duty) electric cables for working voltage up to and including 1100 volts. IS-1554-1988 (Part-1)
21. Flexible steel conduits IS-3480-1966
22. Accessories for rigid steel conduit for electrical wiring IS-3837-1976
23. Boxes for the enclosure of electrical accessories IS-5133-1969 (Part 1)
24. Guide for safety procedures and practices in electrical work. IS-5216- 1982 (Part-1)
25. Conductors for insulated electric cables and flexible cordes IS-8130- 1984
26. Miniature Circuit Breakers IS-8828-1996
27. Rigid steel conduits for electrical wiring (Second revisions) IS-9537-1981
28. Methods of test for cables IS-10810-1998
29. Earth Leakage Circuit Breakers. IS-12640-1988
30. Moulded Case Circuit Breakers IS-13947-1993
31. General requirement for switchgear and control gear for voltage not exceeding 1000 volts.IS-13947-1993
32. 1100 volt grade XLPE insulated armoured cables IS 7098
33. Specifications for hoistway door-locks IS 7754-1975
34. Rules for design, installation, testing and operation of lifts, escalators and moving parts.IS 1735-1975

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



- 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.

## **8.5 ELECTRIC TRACTION DRIVE SYSTEM**

### **8.5.1 TRACTION MACHINE**

The construction of all Elevator machines shall conform with IS-14665

### **8.5.2 BRAKE**

- a. The Electro-magnetic brake with non-asbestos lining shall be spring applied and electrically released type having noiseless operation.
- b. The brake shall be capable of stopping and holding the Elevator car in its downward travel to rest with 125% of its rated load from the maximum governor tripping speed. In this condition the retardation of the Car shall not exceed that resulting from the operation of the Safety gear or stopping on the buffer.
- c. Springs used to apply the brake shoes (two nos.) shall be in compression and adequately supported.
- d. Brake linings shall be of renewable incombustible materials and shall be secured to the brake shoes such that normal wear shall not weaken their fixings. Band brakes shall not be used.
- e. No earth fault, short circuit or residual magnetism shall prevent the brake from being applied in the event of loss of power supply to the Elevator motor and control circuit.
- f. A means of adjusting the brake plunger stroke and releasing the brake in emergency shall be provided.
- g. The Elevator machine shall be fitted with a manual emergency device capable of having the brake released by hand and requiring a constant effort to keep the brake open.
- h. The fail safe break shall incorporate an approved design of brake switch i.e. pick up, hold, discharge. Brake coil shall be wired in series & their respective switches in parallel. The operation of brake shall be thyristor controlled from solid state drive in order to effect minimum pick up time and synchronized start.

### **8.5.3 Driving Mechanism**

#### **Lift Machine**

The lift machine shall be suitable for 415 volt 3 phase 50 Hz AC supply with a voltage variation of  $\pm 10\%$ . The lift machine shall have high efficiency and low power consumption and shall be designed to withstand peak currents in lift duties.

#### **8.5.4 Driving Sheaves**

- a. The sheaves shall be manufactured in steel or SG iron and fitted with sealed for life lubricated bearings.
- b. The sheaves shall have machined rope grooves that can be reworked for future wear.
- c. Adequate provision shall be made to prevent any suspension ropes leaving groove due to rope slack or introduction of foreign objects.

#### **8.5.5 Alignment**

- a. The brake plunger, collar, sleeve, motor, sheaves and all bearings shall be mounted and assembled so that proper alignment of these parts is maintained.
- b. The assembly shall be reviewed and rectified when excessive noise is emitted during operation.

#### **8.5.6 Gearless Machines**

The gearless machine shall consist of a motor traction sheave and brake drum or brake disc completely aligned on a single shaft. Gearless machine shall be AC gearless with VVVF drive.

#### **8.5.7 Anti-Vibration Supports**

The whole traction machine shall be mounted on appropriate anti-vibration supports to minimize noise and vibration.

### **8.6 CONTROL SYSTEMS**

#### **DESCRIPTION**

The Lifts shall have state of art microprocessor based AC variable voltage variable frequency (ACVVVF) drive. Some of the technical parameters required are innumerate below.

- a. Starting current 1.2 - 1.5 times full load running current
- b. Power saving 50 - 55%
- c. Leveling accuracy  $\pm 3$  mm
- d. Acceptable voltage fluctuation +10%

The controller shall be suitable mounted totally enclosed cubicle type with hinged doors on the front provide easy access to all components in the controller. Cubicle shall be well ventilated such that the temperature inside never exceeds the safe limits of the components at ambient room conditions. The controller shall operate within the supply voltage variation of plus 10% to minus 10% of the nominal voltage.

The Controller shall include protection against the following abnormalities and shall cut off the power supply, apply the brake and bring the car to a rest in the event of any of the abnormalities occurring.

- a. Over current
- b. Under voltage
- c. Overvoltage

- d. Single phasing
- e. Phase reversal
- f. Earth leakage

### **Features**

Control system features are detailed as below.

- **Attendant Operation**

Lift shall be provided with attendant control facilities. A key switch for change of operation mode shall be provided in a lockable recess panel on the car operation panel. After gaining control on the lift, the attendant can direct the car to stop at any storey. The attendant can also by pass the landing calls (but not cancel them) or reverse the direction of travelling.

- **Automatic By-pass**

Load weighing devices located either on car top or under the car cage shall be provided for all lifts. Whenever the load exceed 60-70% of the capacity load of the lifts, the lifts shall ignore all landing calls and only respond to car calls.

- **Over load device**

A load weighing devices shall operate when the load in the car exceeds the rated capacity. The operation of the device shall activate buzzer sound and flashing 'overload' signals. At the same time the car doors shall be prevented from closing. When the excess load has been removed from the car, the buzzer alarm shall be muted automatically and the car shall function normally. The sensitivity shall be 30 kg for Passenger lift.

- **Automatic self-levelling**

All lifts shall be provided with automatic self-levelling feature that shall bring the lift car level to within  $\pm 3$  mm for passenger elevators of the landing floor regardless of load or direction of travel. The automatic self levelling feature shall correct for over travel and rope stretch.

## **8.7 LIFT CAR, DOORS AND SAFETY DEVICES**

### **8.7.1 CAR ENCLOSURES**

- **Frame**

Every lift car body shall be in a steel car frame assembly which shall have sufficient mechanical strength to resist the forces applied by the safety gear or impact of the car on the buffers. The deflection of the steel members carrying the platform shall not exceed 1/1000 of their span under static conditions when the rated load is evenly distributed on the platform.

At least four renewable guide shoes or shoes with renewable linings or sets of guides rollers shall be provided two at the top and two at the top and two at the bottom of the car frame assembly.

- **Enclosure finishes**

The car enclosure, doors etc. shall be as per detailed in BOQ. The following are to be provided.

- Alarm System: An emergency alarm buzzer, including wiring shall be provided and connected to a plainly marked push button in the car operating panel. The alarm bell shall be located in central security room. The alarm unit shall be solid state siren type, to give a waxing and waning siren when the alarm button in the car is pressed momentarily
- Sealed Maintenance Free Nickel Cadmium Batteries capable of maintaining the following in each lift for 2 hrs after mains failure.
  - Emergency light of adequate illumination in car
  - Car Ventilation
  - ARD
  - Intercommunication System
  - Alarm bell
- One no. 16 amp switch socket outlet to IP 54 and a permanent weatherproof type luminaries to IP54 (with lighting switch ) adequately protected shall be provided on the top of the lift car for maintenance
- One no. 16 amp switch socket outlet to IP 54 at bottom of lift car for maintenance

## **8.7.2 OPERATION PANEL**

A full length car operating panel incorporating following control/indications shall be provided on the return panel

- CD Illuminated touch push buttons of micro pressure type corresponding to the floors served at Ground floor and Inside Car. For Other floors LED Illuminated touch push buttons of micro pressure type to be provided.
- Door open and door close button
- Emergency stop button with Alarm
- Two position key operated switch for 'with attendant' and 'without attendant' operation.
- Ventilation fan ON/OFF switch with auto OFF when there is no call after 120 seconds (Two Speed & concealed vents).
- Built in intercom of the hands free type as well as space for providing EPABX telephone instrument and 5 pair telephone trailing cable to communicate from car to Two Locations i.e. Operator's Room (at remote location) & Security Guard Room and vice-versa.
- Dynamic car direction display
- Car position indicator (digital)
- Audio/Visual overload warning indicator
- Digital voice synthesizer (Optional) for announcing special messages with

background music.

### **8.7.3 LANDING FIXTURE**

The landing fixtures shall be recess mounted on a base junction box in the wall by the side or on top of landing doors as required. Each landing fixtures shall consist of micro touch type landing call buttons with illuminated call acknowledge signal and illuminated digital type car position indicators on separate stainless steel face panels with hairline finish.

### **8.7.4 CAR AND LANDING DOORS**

All car doors shall extend to the full height and width of landing opening unless otherwise specified and shall be operated with variable frequency door operator. A similar imperforate door shall be provided for every landing opening in the lift hoistway enclosure. The top track of the landing and car doors shall not obstruct the entrance to the lift cars. All car and landing doors shall have a fire resistance of not less than 1 hours. In addition, all the car and landing doors shall meet the following general requirements.

- **Car door locking devices**

Every car door shall be provided with an electrical switch to prevent the lift car from being started or kept in motion unless the car door is closed. A mechanical locking device shall also be provided to prevent door opening from inside the car whilst the car is in motion.

- **Landing door locking devices**

Every landing door shall be provided with a mechanical locking device to prevent opening of the door from the landing side in normal cases unless the lift car is in that particular landing zone.

- **Projections and recesses**

Sliding car and landing doors shall be guided on door tracks and sills for the full travel of the doors.

- **Door locking devices**

All doors locking devices, door switches and associated actuating rods, levers or contracts, shall be inaccessible from the landing or the car.

- **Protective devices**

Protective devices shall be fitted to the leading edges of both car door panels. It shall automatically initiate reopening of the door in the event of a passenger being struck (or about to be struck) by the door in crossing the entrance during the closing movement. The obstruction of either leading edge when closing shall actuate the protective device to function.

- **“Door open” alarm**

“Door open” alarm shall be provided in the car to initiate alarm and a continuous buzzer if a car or landing door has been mechanically kept open for a present period. The period shall be adjustable from 0-10 minute.

- **Emergency landing door unlocking devices and key**

- Every landing door shall be provided with an emergency landing door unlocking device. When operated by an authorized person with the aid of a key to fit the unlocking triangle, the landing door shall be unlocked irrespective of the position of the lift car for rescue purpose. When there is no “unlocking” action, the key shall only be able to stay in the locked position.
- In the case of coupled car and landing doors, the landing doors shall be automatically closed by means of weight or springs when the car is outside the unlocking zone.

#### **8.7.5 Door Hangers and Tracks**

The car and the landing doors shall be provided with two point suspension sheave type hangers complete with tracks. Sheaves and rollers shall be steel with moulded nylon collar and shall include shielded ball bearings. Tracks shall be of suitable steel section with smooth surface. The landing doors shall be complete with headers, sills, frames etc. as required.

#### **8.7.6 Lift Door Protection**

Multiple-Infra red door protection and mechanical shoes shall be provided for lift to control door movement which shall cover the entire door opening effectively.

#### **8.7.7 Protective Hand Rail in the Car shall be provided in the lift cabin.**

#### **8.7.8 CABIN FAN**

A noiseless pressure fan shall be provided in the lift cabin.

### **8.8 HOIST ROPES**

Hoist way material shall be non-flammable (02 hrs fire rated) except travelling cables which shall be flame resistant.

#### **Lift Ropes – IS 14665 (Part 4 / Sec 8)-2001**

Round strand steel wires ropes made from steel wire ropes having a tensile strength not less than 12.5 tonnes/cm<sup>2</sup> and of good flexibility shall be used for lift. Lubrications between the strands shall be achieved by providing impregnated hemp core. The lift ropes shall conform to IS 14665- (Part-4-Sec. 8):2001 and the required factor of safety shall be adhered to. The minimum diameter of rope for cars and counter weight of passenger and goods lift shall be 8mm.

#### **Rope fastenings**

The ends of lift ropes shall be properly secured to the car and counter weight hitch plates as the case may be with adjustable rope shackles having individual tapers babbitt sockets, or any other

suitable arrangement. Each lift rope shackle shall be fitted with a suitable shackle spring, seat washer, shackle nut & lock & shackle nut split pin.

#### **Guards for Lift Ropes**

Where lift ropes run round a sheave or sheaves on the car and/ or counterweight of geared/ gearless machine suitable guards shall be provided to prevent injury to maintenance personnel.

#### **Number & Size of Ropes**

The contractor must indicate the number and size of lift ropes and governor ropes proposed to be used, their origin, type, ultimate strength and factor of safety. The contractor should furnish certificate or ropes from the rope manufacturers issued by competent authority.

### **8.9 COUNTER WEIGHT**

The counter weight for lift cars shall be in accordance with clause 6 of IS 14665 (Part 4-Sec-3) : 2001 and shall be designed to balance the weight of empty lift car plus approximately 50 percent of the rated load. It shall consist of cast sections firmly secured in relative movement by at least two numbers steel tie rods having lock nuts/split pins at each end and passing through each section and Housed in a rigid steel frame work. Cracked and broken sub weights shall not be accepted. Counter weight for passenger lifts should be able to accommodate suitable weight Interior finishes. In case interior finishes material exceeds this provision, then the elevator contractor shall adjust the Counter Weight accordingly, however this will be decided and intimated much before the delivery of the elevators.

- **Counter Weight Guards**

Guards of wire metal / mesh shall be provided in the lift pit to a suitable height above the pit floor to eliminate the possibility of injuries to the maintenance personnel.

### **8.10 GUIDES / Guide Rails**

Car and counterweight guide shall be machined T section as per relevant Indian Standards IS-14665 of 2000 revised up to date. The guides shall be capable of withstanding forces resulting from the application of the car or counter weight safety devices The guide rails shall be minimum 16mm Tongued & Grooved type.

### **8.11 TRAILING CABLES**

A single trailing cable for lighting control and signal circuit is permitted, if all the conductors of this trailing cables are insulated for maximum voltage running through any one conductor of this cable. The lengths of the cables shall be adequate to prevent any strain due to movement of the car. All cables shall be properly tagged by metallic / plastic tags for identification. Cable jacket should be suitable for immersion in water, salt water & oil etc.

### **8.12 SAFETY DEVICES**

Safety devices shall be capable of operating only in the downward direction and stopping fully loaded car, at the tripping speed of the over speed governor, even if the suspension devices

break, by gripping the guides, and holding the car there. Governor sheave in elevator pit shall be enclosed in a wire cage to a height of 2.40 mtr. All safety devices statutorily required by Lift Inspector, including but not restricted to the following shall be provided.

- **Terminal slow down switches**

These shall be provided and installed to slow down the lift car when approaching the top and bottom landings. The slow down switches shall act independently from the normal car operating device.

- **Over travel limit switches**

These shall be provided and installed to stop the car within the top and bottom clearance, independent of the normal car operating device. The bottom over travel limit switch shall become operative when the bottom of the car touches the buffer.

When the over travel limit switches are operative, it shall be impossible to operate the car until the car has been hand would to a position within the normal travel limits.

- **Pit Switch**

An emergency stop switch shall be located in the pit which when operated shall stop the car regardless of the position of hoist way.

- **Terminal Buffers**

Suitable spring buffers mounted on RCC foundation blocks shall be provided in the pit in compliance with ANSI/ASME/CENEN-81 /JIS codes for stopping the car in case of mal-operation. Dowels for the purpose shall be left while casting the pit floor alternatively floor reinforcement could be exposed by chipping for welding additional reinforcement for Dowels. However clearance from underside of the car resting on a fully compressed buffer shall not be less than 1.20 mtr. Buffers shall be designed for a design speed + 15%. Oil buffers shall be provided for the passenger elevators for speed of more than 1.75 mps and spring buffers for lower speed.

- **Interlocking**

Adequate interlocking is to be provided so that the car shall not move if the landing doors are even partially open and also the lift is overloaded.

- **Over speed governor**

Over speed governor shall be of centrifugal type and shall operate the safety gear at a speed at least equal to 115% of the rate speed and less than the over speed governors shall be driven by flexible wire ropes with the following requirements:

- The breaking load of ropes shall be related to the force required to operate the safety gear by the safety factor of at least 8
- The nominal rope diameter shall be at least 7 mm



- The ratio between the pitch diameter of the over speed governor pulley and the nominal rope diameter shall be at least 30. The over speed governors shall be sealed after setting the tripping speed. The breaking or slackening of the governor rope shall cause the motor to stop by an electric safety device.

- **Alarm bells**

A Concealed 200 mm diameter alarm bell shall be installed in the main security area. The alarm bell shall sound when the alarm bell button in the car operating panel is pressed. The bell shall mute when the pressure on the alarm bell button is released.

- **Emergency Stop Switches**

An emergency stop for use by maintenance personnel shall be provided in each lift car.

## **FIREMAN SWITCH**

Lift shall have a Fireman switch with glass front for access by the Firemen. The operation of this switch shall cancel all calls to this lift and shall stop at the next nearest landing if traveling upwards. The doors shall not open at this landing and the lift shall return to the ground floor. In case the lift is traveling downwards when the fireman's switch is operated it shall go straight to the ground floor bypassing all calls enroute. The emergency stop button inside the car shall be rendered in-operative. The fireman's switch shall be located adjacent to the lift opening at the terminal floor and shall be at a height of approximately 2 m above the floor level. For easy identification of fireman's lift which conform to the local authorities requirements, a red and white diagonal striped backing shall be provided behind the glass of the fireman's switch.

A permanent notice of prominent size indicating the floors served shall be provided and displayed adjacent to the fireman's lift at the terminal floor. The notice shall be made of laminated plastic sheet or other approved materials with red letters on white background. Details of the notice shall be submitted to the Architect/Engineer/DFCCIL for approval prior to fabrication.

## **8.13 CONTROL OF NOISE AND VIBRATION**

### **8.13.1 General**

The whole of the lift assembly, including the opening and closing of the car and landing doors shall be quiet in operation and shall be free of rattling or squeaking noises. Lift doors operation shall be smooth to avoid the transmission of impact noise to the surrounding structure. Noise level resulting from the operation of the lifts, including direct sound transmission, breakout noise and re-radiation of structure borne noise, shall not exceed the specified noise criteria of the adjacent spaces. Vibration resulting from operation of lifts or escalators shall not be perceptible in any occupied areas.

### **8.13.2 Car construction**

All elements of the lift car construction shall be sufficiently rigid to avoid generation of noise by panel excitation as a result of movement. The total noise level in a moving lift car shall not exceed 45 dBA with the ventilation system operating.

### 8.13.3 Machinery

The gearless traction machine and compact PM motor are installed within the hoist way and the slim control panel is located on the shaft side wall. Provision shall be made for the control vibration isolation measures employed to ensure that structure borne noise resulting from the operation of the lift machinery is not audible in any occupied area. Lift machinery noise levels under normal operating conditions shall not exceed 70 dBA at 1 m from the equipment in free field.

### 8.13.4 Arrival chimes

Noise from arrival chimes shall not exceed 60 dBA.

The above levels shall be measured at 3 m from the arrival chimes using a noise meter set to 'fast' response. Chimes with adjustable loudness shall be provided.

## 8.14 FIRE SAFETY REQUIREMENTS

General requirements of lifts shall be as follows:

- Landing doors in lift enclosures shall have a fire resistance of not less than one hour.
- Lift car door shall have a fire resistance rating of one hour.
- Grounding switch (es), at ground floor level, shall be provided on all the lifts to enable the fire services to ground the lifts.

## 8.15. ASSOCIATED WORKS

### 8.15.1 Scope

Based on power requirements of lifts furnished by the lift contractor, power supply for the lifts machines, terminating in a Switchboard located at a desired location, shall be provided by IIA. The earth bar provided on this Switchboards shall be connected to the building earthing system. All cabling /wiring/loop earthing beyond this Switchboard for interconnection with the lift controllers / motors/ indicators / push buttons / safety devices etc. shall be provided by the lift contractor and its cost shall be deemed to be included in the quoted rates.

### 8.15.2 Cabling

Cabling between switchboard and the controller /lift motor shall be with XLPE insulated FR PVC sheathed 1100 volt grade aluminium conductor armoured cables conforming to IS 7098 or PVC insulated, PVC sheathed, 1100 volt grade al conductor armoured cables conforming to IS 1554. Cables shall be terminated in glands fitted with armour clamps the gland body shall be provide with an internal conical sating to receive the armour clamping cone and clamping nuts which shall secure the armour wires. A PVC shroud shall be fitted to cover the gland body and exposed armour wires Trailing cables for the lifts shall be EPR insulated stranded copper conductor flexible cables conforming to IS 9968 Control cabling shall be with multi core stranded copper conductor PVC insulated and sheathed 1100 volt grade cables conforming to IS 8130. Minimum size of the cable shall be 2.5 sq mm. Where cables pass through walls or floor slabs, pieces of GI sleeves shall be provided for cast into the wall / floor and cable shall be drawn therein.

### 8.15.3 Wiring

All wiring shall be carried out with FRLS PVC insulated 1100 volt grade stranded copper conductor wires conforming to IS 694 drawn in MS rigid / flexible conduiting system and / or MS raceways. Minimum 2.5 sq mm size wires shall be used. Wires shall be cut only at terminations. Intermediate jointing shall not be permitted. Drawing, cutting and terminating of the wires shall comply with the relevant Indian standard specifications and shall be carried out in the most workman like manner as per standard practice. All normal care like cutting the insulation with a pencil edge, taking care not to cut the strands and proper tightening of terminal connector screws to avoid loose connection or breaking of conductors etc. shall be taken. Heavy gauge black enameled screw type ISI embossed MS conduits with superior quality accessories approved by Architect/Engineer/DFCCIL shall be used in the work. Conduits could either be recessed in floors / walls or fixed on surface with saddles and clamps. Final connections to vibrating the equipment shall be made with metal flexible conduits. Entire work shall be carried out in work man like manner as per standard practice.

### 8.15.4 Earthing

Metal enclosures of all electrical equipment and devices including frames of motors, controllers, switchgear, conduits and raceways etc. shall be properly earthed so as to form an equi-potential zone. Loop earthing of vibrating equipment shall be done with flexible copper earthing braid or flexible cables. The lift motor frame shall be connected to the building earthing system termination at the switchboard by duplicate loop earthing conductors of appropriate size.

## 8.16 ASSOCIATED CIVIL & STRUCTURAL ITEMS

All civil and structural items of work associated with erection and operation of lifts shall be provided by the Contractor at his cost including (but not restricted to) the following.

Hook for lifting lift equipments in the top of shaft.

Temporary scaffoldings and safety barricades during lift installation in and around lift Lift wells

- Sill angels
- Bearing plates
- Buffer supports
- Checquered plates
- Fascia plates
- Ladders in pits (MS)
- Safety railing on car top
- Separator /stretcher beams if required .
- Dowels for terminal buffers in pit floor during casting.

The Contractor shall ensure erection and fixing of steel work in such a manner that no RCC wall or any other structural member is damaged.

## 8.17 INSTALLATION

a) The LIFT shall be installed as per IS : 1860.

Wiring and earthing shall be extended from the electrical shaft & lift shaft as per requirement. Power cable & earthing point will be made available at power panel at one location for each lift by other agencies.

b) All openings at the various landings shall be temporarily guarded during installation.

c) All safety procedures associated with lifting of heavy equipment, operation of electrical tools & earthing should be strictly complied with.

d) All electrical wiring shall have flame resisting moisture proof insulation and will be run in heavy gauge metal conduit/ casing.

The trailing cable between the car and lift well will be multicore type designed for lift services and will have flame resisting moisture proof covering.

Cables should conform to relevant IS amended up to date.

The supply and erection of lift shall conform to the latest lift act in force and modern lift practice in all respects.

All wiring and earthing etc. shall conform to IE rules and regulations

## **8.18 TESTING**

All equipment included in contractor's scope of supply shall be tested at Manufacturer's Works, before delivery and necessary Test Certificates shall be submitted for approval of Consultants.

The Contractor shall carry out all performance tests after installation, in the presence of the Architect/Engineer/DFCCIL, as per specification.

The Contractor shall bear all expenses for such tests.

The Contractor shall be responsible for executing the contract as per Indian Electricity Rules, Rules and Regulations of supply authorities and the Rules of the local Electrical Inspectorate.

Any changes/modifications pointed out by the authorities shall be carried out at no extra cost

### **8.18.1 OTHER TESTS**

Each elevator shall be tested at site as per IS 4666 & EN 115. Among others, the tests shall include:

- (a) Operational tests with functional check on safety devices
- (b) Speed of operation at rated load
- (c) Overspeed tests .
- (d) Leveling accuracy
- (e) HV test
- (f) Earth resistance .

## 8.19 TAKING OVER OF INSTALLATION

The equipment & installation shall be deemed to have been taken over by the Client, when the following are completed:

- (a) The Consultants have certified that all contractual obligations have been fulfilled by the Contractor.
- (b) All performance tests shall be carried out in the presence of client / consultant and Test Certificates are furnished in requisite copies.
- (c) The installation is approved by the lift inspectorate.
- (d) The 'As Built' Drawings are submitted. (Hard and soft Copies)

## COMPONENTS & ACCESSORIES

The following components & accessories forming a part of the elevator installation shall be supplied and installed.

All the items shall conform to the requirements of the BIS listed above and the specification.

- (a) Guide rails of steel with working surfaces machined for the car and counter weight.
- (b) Spring buffers locate in the lift pit.
- (c) Steel car frame with replaceable guide shoes .
- (d) Lift cars fitted with all interiors, false ceiling, flooring, ventilation fan, lights, operator's panel, floor indicator, Lift mirror, Handrails, emergency stop facility etc.
- (e) Motor operated sliding, center opening car doors wherever applicable.
- (f) Motor operated sliding, center opening landing doors wherever applicable.
- (g) Counter weight with guide shoes .
- (h) Safety gears .
- (i) Speed governors.
- (j) Suspension ropes
- (k) Sheaves & pulleys
- (l) Lift machines
- (m) Controllers & wiring materials
- (n) Terminal stopping and final limit switches.
- (o) Leveling devices
- (p) Lifting beam for machines.
- (q) Any other accessories as required.

## 8.20 Lift Announcement :

The lift shall be provided with special announcements as follows:-

- (a) When supply is out and lift is working in ARD (Automatic rescue device) announcement shall be "supply is out you may alight from the lift as soon as the door opens"
- (b) When supply is out, ARD is not working, and the lift stops in between floors announcement shall be "ARD" is not working please ask help through intercom"

## 8.21 DETAILS OF LIFT WELL

8.21.1 The lift well shall be as per clause 5 of IS: 14665.

8.21.2 There shall be no other opening in the lift well except for the landing openings.

All landing openings in lift well enclosures shall be protected by doors/ collapsible doors, which shall extend to the full height and width of the landing opening

8.21.3 Light points shall be provided in the lift well at a spacing not exceeding 10m.

All the light points shall have control from the machine room.

Socket outlet may also be provided at a suitable place for use by maintenance staff above the ground floor landing.

## 8.22 LIFT PIT:

The lift pit shall be provided proper water proofing treatment so that the same remains dry.

If the lift pit depth is more than 1.6m, a ladder to the height of 0.75m above the lift pit floor shall be provided to reach the lift pit.

The lift pit shall have provision for a separate access.

In case of two lifts in the well, one access to the lift pit shall be adequate dividing beam and rigid metal screen to separate each lift from an adjacent lift or its counter weight

### a) GUIDERAILS

The guide rails shall be as per **IS: 14665**.

Rigid steel guides shall be used for guiding lift car and counterweight throughout its travel.

The strength of the guides, its attachments and the joints shall be sufficient to withstand the forces imposed due to the operation of the safety gear and deflection due to uneven loading of the lift car.

Only machined guide rails shall be provided for passengers and hospital lifts.

The guide tracks shall be supported at suitable intervals and shall be embedded into the walls.

Wood or fiber blocks or plugs shall not be used for securing guide brackets.

### b) GUIDE SHOES

Two numbers of guide shoes at the top and two numbers at the bottom shall be provided on the lift car and counter weight.

Guide shoes shall be provided with adjustable mountings and shall be rigidly secured in accurate alignment at the top and bottom on each side of the car sling and counterweight frame construction.

When oil buffers attached to the bottom of the counterweight are used then additional guide shoes shall be provided on each side of the buffer frame.

For passenger lifts and bed-cum-passenger lifts, sliding guide shoes shall be provided for speeds up to 1.5 mps (meter per second.)

Sliding guide shoes for cars shall be flexible.

Solid guide shoes can be used for counter weights for speeds up to 1.0 mps.

When speed exceeds 1.5 mps, roller guide shoes shall be provided for car and the counterweight

**c) BUFFERS:**

Buffers shall be provided at the bottom limit of travel for cars and counterweights.

Energy dissipation type buffers shall be used wherever the rated speed of the lift exceeds 1 mps but energy accumulation type buffers shall be preferred if the rated speed of the lift does not exceed 1 mps.

**d) COUNTER WEIGHT:**

The counterweights shall be of metal and it shall be in the form of multiple sections.

It shall be contained and secured within a steel frame and shall be equal to the weight of the complete car plus approx 50% of the rated load.

At least, four guide shoes, capable of being easily renewed or having renewable linings shall be provided on the counterweight.

**e) SUSPENSION ROPES**

Cars and counterweights shall be suspended from round strand steel wire ropes of best quality having a tensile strength not less than 12.5 tonnes/cm<sup>2</sup>.

The size and number shall be in accordance with standard Code of practice/BIS specifications.

Lubrications between the strands shall be achieved by providing impregnated hemp core. The nominal diameter of the ropes shall be at least 8mm.

**f) COMPENSATION ROPES**

For travels over 40 m and/or rated speed of the lift exceeds 2.5 mps, the provision of compensation ropes with tensioning pulleys shall be considered.

For speeds of 2.5 mps or below, quiet operating chains or similar devices shall be used as the means of compensation.

For speeds above 3.5 mps, an anti-rebound arrangement of idler tension pulley shall be provided to prevent the counterweight jumping with the application of the car safety gear.

## **8.23 CAR CONSTRUCTION**

The lift car construction shall be in conformity with Code of Practices, BIS specifications and IE Rules.

**CAR FRAME:**

The lift car body shall be carried in a steel car frame sufficiently rigid to withstand the operation of the safety-gear without permanent deformation of the car frame.

The deflection of the members carrying the platform shall not exceed  $1/1000$  of their span under static conditions with the rated load evenly distributed over the platform.

**CAR ENCLOSURES:**

The whole of the internal face of the car shall be of 1.5 mm thick stainless steel sheet lined.

A suitable backing shall be used to reinforce the car wall panels.

A stainless steel handrail shall be provided on three sides of the lift car, extended to within 150 mm of all corners and a stainless steel skirting panel approximately 100 mm deep shall be provided.

Stainless steel false ceiling with concealed fluorescent light fitting and ventilating fan complete with metal ceiling diffuser shall be provided.

The car ventilation fan shall be switched off within a period which shall be adjustable from 5 to 15 minutes after the last registered call is answered.

The lift car excluding linings, shall be constructed of non-combustible materials. The lift car shall have adequate illumination. The illumination level shall not be less than 150 lux on the lift floor level.

**EMERGENCY LIGHTING:**

The lift car shall also be provided with emergency lighting operated by a rechargeable battery supply.

The lighting shall be automatically switched on in the event of failure of normal power supply to the lift.

**CAR PLATFORM:**

The lift car platform shall be designed on the basis of rated load evenly distributed. The dimensions shall conform to IS: 14665 unless otherwise specified. The flooring shall be smooth and non-skid type.

The PVC/rubber flooring of minimum 3mm thickness shall be preferred for passenger and bed-cum-passenger lifts.

The flooring for goods lift shall be strong enough to take the rated load without any deformation or damage.

**CAR ROOF:**

The car roof shall be solid type and capable of supporting a weight of at least two persons (approx 140 kg) without causing permanent deformation.

Ceiling lights shall be of recessed type and be protected by stainless steel metal bars.

A recessed ceiling fan complete with heavy duty metal diffuser and capable of providing 20 air changes per hour in the car shall be provided.

**CAR DOORS:**

The doors for passenger lifts shall be of metal and the internal face of the car door shall be suitably lined as the same in the lift car.



The doors shall be in two panels and centre opening with automatic power opening and closing unless otherwise specified.

The car shall be equipped with an electronic door sensor which can detect an obstruction at the car entrances and control the closing of the doors.

The car door shall be provided with an electrical switch which will prevent the lift car from being started or kept in motion unless all car doors are closed.

#### **DOOR RE-OPENING DEVICE:**

Door re-opening device shall be fitted to the leading edge of both car door panels, which shall automatically initiate re-opening of the door in the event of a passenger being struck (or about to be struck) by the door in crossing the entrance during the closing movement.

It shall be so designed and installed that for centre opening doors the obstruction of either leading edge when dosing will cause it to function.

#### **"DOOR-OPEN" ALARM FOR MANUALLY OPERATED DOORS:**

For manually operated doors and were assisted doors, a 'door open' alarm shall be provided in the car to draw attention to a car or landing door which has been left open for an adjustable period up to 10 minutes.

#### **LANDING DOORS**

The car entrance shall be provided with a car door, which shall extend to the full height and width of the car opening.

The opening for the landing doors shall not be wider than that of the lift car. The top track of the door shall not obstruct the car entrance.

All landing openings in lift well enclosures shall be protected by doors / collapsible doors which shall extend to the full height and width of the landing opening.

#### **LANDING DOOR LOCKING DEVICE**

Every landing door shall be provided with an effective locking device so that it shall not normally be possible to open the door from the landing side unless the lift car door is in that particular landing zone.

It shall not be possible under normal operation to start the lift car or keep it in motion unless all landing doors are in the closed position and locked.

#### **TERMINAL STOPPING AND LIMIT SWITCHES**

The lift shall be provided with normal terminal stopping switches and limit switches. They shall be positively operated by the movement of the car.

These switches shall either be mounted on the car frame or in the lift well.

The limit switches shall either open directly by mechanical separation of the circuits feeding the motor and brake, and provisions shall be made so that the motor cannot feed the brake solenoid, or open, by an electrical safety device, the circuit directly supplying the coils of the two contactors, the contacts of which are in series in the circuits supplying the motor and brake.

### **SAFETY GEAR**

The lift (except service lift) shall be provided with safety gears capable of operating only in the downward direction and capable of stopping a fully laden car, at the tripping speed of the over-speed governor, even if the suspension devices break, by gripping the guides and holding the car there.

### **OVER-SPEED GOVERNOR**

The car safety shall be operated by speed governor located overhead and driven by governor rope suitably connected to the car and mounted on its own pulley.

Over-speed governor shall operate the safety gear at a speed at least equal to 115% of the rated speed.

For rated speeds upto 1 mps maximum governor tripping speed shall be either 140% of the rated speed or 0.88mps, whichever is higher.

For rated speed exceeding 1 mps, maximum governor speed shall be 115% of the rated speed plus 0.25mps.

The means for adjusting the over-speed governor shall be sealed after setting the tripping speed.

### **GOVERNOR ROPES**

The governor ropes shall not be less than 6 mm in diameter and shall be of flexible wire rope.

The rope shall be tensioned by a tensioning pulley and the pulley (or its tension in weight) shall be guided.

The breakage or slackening of the governor rope shall cause the motor to stop by means of an electrical safety device.

The device shall be of bi-stable type requiring manual reset.

### **OVERLOAD DEVICE AND FULL LOAD DEVICE**

The lift shall be provided with an overload device which shall operate when the load in the car is 10% or more in excess of the rated load of the lift.

The overload device, when in operation, shall:-

- prevent any movement of the car,
- prevent the closing of any power operated door whether fitted to the car or To the landing at which the car is resting, and
- give audible and visible signals inside the car.

The lift shall resume normal operation automatically on removal of the excessive load. The overload device shall be inoperative while the Lift car is in motion.

#### **FULL LOAD DEVICE**

The lift (other than a service lift) shall be provided with a full load device having an adjustable setting range from 80% to 100% of the rated load and when operated, it shall by-pass all landing calls.

When the load in the car is reduced, the car shall stop for landing calls as normal.

#### **EMERGENCY ALARM DEVICE**

An emergency alarm push button together with a buzzer (or an alarm bell) shall be provided in the lift car and connected to the machine room and the main entrance lift lobby and backed up by an emergency supply. The pattern of lift alarms shall be distinguishable from that of fire alarms.

An intercom system connecting the lift car and the machine room /guard room (if manned) shall be provided.

#### **EMERGENCY EXIT**

The lift car shall be provided with an emergency exit in the roof of minimum size 500 mm x 350 mm x 400 mm in diameter.

Panels for emergency exits shall: -

- be clear of any apparatus mounted above the roof of the lift car
- be capable of being opened, re-closed and re-locked without a key
- be provided with an electric safety device which will prevent operation of the lift

When the panel is not locked, operate the buzzers (or alarm bells) and also switch off the car ventilation fan.

### **8.24 CONTROL AND INDICATION IN CAR**

The lift car shall have a control faceplate made of stainless steel with thickness of not less than 25mm and comprising :-

- Call buttons with acceptance signals to correspond with the landing served
- An alarm push button with protection from being operated accidentally
- "Door open" and "Door close" push buttons
- Audible and visible signals in connection with the over load device
- light switch, alarm reset switch, fan switch and cleaner's " Stop-switch" keeping the car door open in the form of key switches or housed in a recessed metal box with hinged or sliding lid which will be key-locked,
- Two- way intercom speaker (optional),
- The control faceplate shall be fixed onto the car panel by stainless steel screws.

For lifts equipped with attendant control, the control faceplate shall also incorporate a non-stop button for the purpose of bypassing landing calls, but the calls shall remain registered until answered. This button shall be inoperative unless the lift is operated by an attendant.

The car direction and position indicator shall be of digital type display with LED's actuated by solid state circuitry unless otherwise specified. The position indicator shall have a minimum height of 50 mm and easy to read even from distance and properly illuminated.

## **8.1 LIFT MACHINERY FOR ELECTRIC LIFT**

### **8.25.1 LIFT MOTOR**

The induction motor shall be designed to operate for an unlimited period according to the expected duty of the lift.

The motor may be supplied and controlled by static elements when A.C. variable speed system is specified.

### **8.25.2 MOTOR GENERATOR SET(Not Applicable)**

The motor generator set shall comprise a motor and a generator built as a complete unit directly coupled.

The motor and the generator shall be suitably rated to deal with the load and speed specified.

Controls shall be provided so that the set shall start up on the registration of a landing call or car call and shall continue to run for a period which shall be adjustable from 5 to 15 minutes, after the last registered call is answered.

### **8.25.3 BEARING AND GEAR CASE**

Bearings shall be of the ball bearing type or sleeve ring type with oil ring bearings Gear cases shall be provided with thrust bearings suitable for the application.

### **8.25.4 EMERGENCY OPERATION BY MANUAL DEVICE**

For geared lift machines, the hoisting machine shall be provided with a smooth wheel which may be fitted to the shaft to move the lift car up or down by manual operation.

The direction of movement of the car shall be clearly indicated on the machine.

### **8.25.5 EMERGENCY OPERATION BY ELECTRICAL SWITCH**

For machines where the manual effort to raise the car together with its rated load exceeds 400N, an electrical switch for emergency operation shall be installed in the machine room.

Directional push buttons protected against accidental operation shall be provided in the machine room such that when the emergency electrical switch is operated

The car can be moved up or down by applying constant pressure on the buttons. The car speed under the emergency operation shall not exceed 0.63 m/s. The emergency electrical switch and its push buttons shall be so placed that the machine can readily be observed during operation.

### **8.25.6 ELECTRO-MECHANICAL BRAKE**

Every lift machine shall be provided with a brake which is capable of stopping the machine when the car is traveling at its rated speed and with the rated load plus 25%.

It shall also be fitted with a manual emergency operating device capable of having the brake released by hand while a constant manual pressure is required to keep the brake open.

## **9 GOODS LIFT**

### **9.1 DETAILS OF THE GOODS LIFT CAR**

The side and rear wall panels shall each be provided with three-equally-spaced full length lateral protective wooden battens of 200 mm wide by 25 mm thick.

The surface of the wooden battens shall be covered with 1.0 mm thick metallic sheet as required. The top battens shall be fixed at a height of 1100 mm above finished car floor level.

The car roof shall be able to support the weight of two persons without causing permanent deformation.

Ceiling lights shall be of recessed type and be protected by stainless steel metal bars.

A recessed ceiling fan complete with heavy duty metal diffuser and capable of providing 20 air changes per hour in the car shall be provided.

The car floor shall be constructed of metallic sheet of suitable thickness with 2 mm high multi-grip non-slip pattern.

The floor construction shall be in the form of a metal drain pan (optional).

In case of metallic floor being drain type, the rear and side edges shall be folded up by 100 mm from the floor to form the drain pan.

All joints and the comers of the pan shall be welded to prevent water leakage.

The goods lift cars may also be constructed as mentioned above except the floor drain system.

### **9.2 GOODS LIFT CAR DOOR**

The car doors shall be robust, manually operated, horizontally sliding and made of stainless steel / MS sheet. Power operated, automatic, horizontally sliding doors shall be multi-panel of stainless steel construction, similar to those for passenger lifts, but strong enough for goods lift use.

### **9.3 LIFT CAR AND METHOD OF DRIVE:**

Service lift cars shall be of rigid construction and totally enclosed except for service openings and made of wood or metal and reinforced at the point of suspension.

The car shall not be made of inflammable materials. Two pairs of renewable guide shoes shall be fitted.

Unless otherwise specified, removable shelves shall be fitted inside the car and be so retained that they shall not be displaced by the movement of the car.

The car shall be constructed with openings on opposite sides and shall be provided with some form of protection to prevent the goods from projecting outside the car.

The method of drive for the lift shall be by traction i.e. sheaves and ropes or by positive drive using drum and ropes without counterweights.

#### **9.4 GUIDE :**

The car and counterweight shall each be guided by rigid guides.

Guides and their fixings shall be capable to withstand the application of the safety-gear (if provided) when stopping a fully loaded car or counterweight.

#### **9.5 BUFFER:**

Buffers shall be provided under all cars and counterweights.

A lift with positive drive shall be provided with additional buffers on the car top to function at the upper limit of travel.

The buffers used shall be one of the following types viz spring, rubber or resilient plastic.

#### **9.6 COUNTERWEIGHT:**

Counterweights shall be of metal.

A metal frame shall be provided to prevent their displacement. In the case of drum drive, there shall be no counterweight.

#### **9.7 SUSPENSION**

Cars and counterweights shall be suspended by means of round strand steel wire ropes. The factor of safety of suspension ropes shall not be less than 10,

The minimum number of ropes shall be two and they shall be independent.

The diameter of sheaves or pulleys shall not be less than 30 times the rope diameter.

#### **9.8 SAFETY GEAR**

Safety gear tripped by an over-speed governor shall be provided for the car where the rated capacity is 250 kg, accessible spaces exist beneath the lift well or gross car roof area equals to or greater than 0.37 m<sup>2</sup>.

Where there is an accessible space beneath the well, the counterweight shall be equipped with safety gear.

#### **9.9 LOAD PLATE AND WARNING NOTICE**

A load plate giving the contract load of the lift in kg shall be fixed in a prominent position at each landing entrance.

A warning notice in English, Hindi and local language shall be prominently fixed at each landing entrance.

## **9.10 CAR AND LANDING DOOR**

All landing openings in the lift well shall be protected by doors.

Every car or landing door shall be provided with an electric safety device which shall prevent the lift from being operated when any car or landing door is open.

It shall not be possible during normal operation to open a landing door unless the car is in the unlocking zone.

The landing doors shall be provided with the facility of being unlocked from outside with the aid of a special purpose key provided for use only by a competent lift worker.

## **TERMINAL STOPPING SWITCHES**

Service lifts shall be provided with terminal stopping switches to stop the car automatically at or near the terminal service levels.

## **PAINTING**

All exposed metal parts especially iron parts shall be painted with 2 coats of approved synthetic enamel paint after 2 coats of synchromesh primer after erection and before commissioning the lift.

## **9.11 APPROVAL**

The supplier shall obtain the approval of drawings & installation from the CEIG. Also approval shall be obtained from fire authorities for the features provided.

## **DOCUMENTATION**

The suppliers shall furnish the following documentation in requisite number of copies (one each group of buildings)

- (a) GA drawing of shaft & lift well giving all details to the civil contractors
- (b) Lifting hook size and locations.
- (c) Rail supporting and wall inserts
- (d) Bracket location, shaft ventilation opening size and location.
- (e) Control schematic GA of controllers
- (f) Operation and maintenance manual
- (g) Test certificates.
- (h) As Built drawings.

## **9.12 GUARANTEE**

The equipment supplied and the installation shall be guaranteed for satisfactory performance and workmanship, for a Maintenance period of 12 months from the date of handing over to the entire satisfaction of client in good working condition and liability of supplier under this guarantee include schedule maintenance as suggested by OEM, factored items repair or replacement of all defective parts if any, which may prove faulty during this period including such parts as may be tendered in operative by wear-and tear but exclude such parts as may be rendered inoperative by vandalism.

The contractor shall replace free of cost all equipment or parts supplied by him and found defective within this period.

In case the contractor fails to replace or render services for defective materials & parts, the client reserves the right to do so, at the contractor's risk and expenses without prejudice.

## **10.0 EARTHING**

### **10.1 GENERAL**

All the non-current carrying metal parts of electrical installation shall be earthed properly. All metal conduits, trunking, cable sheaths, switchgear, distribution fuse boards, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing shall be in conformity with Indian Electricity Rules.

The Earthing System shall in totally comprise the following:-

- (a) Earth Electrodes
- (b) Earthing Leads
- (c) Earth Conductors

All three phase equipment shall have two separate and distinct body earths and single phase equipment shall have a single body earth.

### **10.2 STANDARDS**

All equipments, components, materials and entire work shall be carried out in conformity with applicable and relevant Bureau of Indian Standards and Codes of Practice, as amended upto date and as below. In addition, relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and /or IEC Standards shall be applicable.

Equipments certified by Bureau of Indian Standards shall be used in this contract in line with government regulations. Test certificates in support of this certification shall be submitted, as required.

It is to be noted that updated and current standards shall be applicable irrespective of dates mentioned along with ISS's in the tender documents.

### **10.3 EARTHING MATERIAL**

Materials of which the protective system is composed shall be resistant to corrosion or be adequately protected against corrosion. The material shall be as specified in the schedule of quantities and shall comply to the following requirements:

- Copper - When solid or stranded copper wire is used it shall be of the grade ordinarily required for commercial electrical work generally designated as being of 98% conductivity when annealed, conforming to Indian standard specifications.
- Galvanised Steel - Galvanised steel used shall be thoroughly protected against corrosion by hot dipped Zinc coating. The material coating shall withstand the test specified in IS 2309:1969.
- The strips to be used shall be in maximum lengths available as manufactured normally avoiding unnecessary joints.



## **10.4 EARTH ELECTRODES**

### **10.4.1 Plate Earth Electrode**

The plate electrodes shall be of copper/ GI as called for in the schedule of quantities. The minimum dimensions of the electrodes shall be 600 mm x 600 mm. Thickness of copper electrodes shall not be less than 3 mm and of GI electrodes not less than 6 mm.

The electrode shall be buried in ground with its face vertical and top not less than 4 metre below ground level.

### **10.4.2 Earth Electrode Pit**

#### **Method Of Installing Watering Arrangement**

In the case of plate earth electrode, a watering pipe of 20 mm dia of medium class G.I. Pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided at the top of this pipe for watering the earth. The watering funnel attachment shall be housed in masonry enclosure of not less than 300 x 300 x 300mm. A RCC frame base with removable RCC cover slab M-25-4nos- 10mm dia - M.S. reinforcements bar at top & bottom both way shall be suitably embedded in the masonry enclosure

### **10.4.3 Location Of Earth Electrode**

The following guidelines shall be followed for locating the earth electrodes

An earth electrode shall not be situated less than 2 metres from any building.

The excavations for electrode shall not affect the column footings or foundations of the buildings. In such cases electrode may be further away from the building.

The location of the earth electrode shall be such where the soil has reasonable chance of remaining moist, as far as possible.

Entrances, pavements and road ways shall not be used for locating the earth electrode.

### **10.4.4 Number Of Earth Electrodes**

In all cases the relevant provision of rule 33, 61 & 67 of the Indian Electricity Rules 1956 as amended shall be complied with.

Metallic covers or supports of all medium or H.T. apparatus or conductors shall, in all cases be connected to not less than two separate and distinct earth electrodes.

### **10.4.5 EARTHING LEADS**

The strip earthing leads shall be connected to the Earth Electrode at one end and to the metallic body of the main equipment at the other end. The earthing lead shall connect to the earthing network in the installation.

### **10.4.6 Earthing Lead Sizes**

Strip earthing leads shall be of copper/GI and as per specifications.

#### **10.4.7 Earthing Lead Installation**

The length of buried strip earthing lead shall be not less than 15 metres and shall be buried in trench not less than 0.5 m deep.

If conditions necessitates use of more than one earthing lead they shall be laid as widely distributed as possible preferably in a single straight trench or in a number of trenches radiating from one point.

#### **10.4.8 Method Of Connecting Earthing Lead To Earth Electrode**

In the case of plate earth electrode the earthing lead shall be securely bolted to the plate with two bolts, nuts, checknuts and washers as required by IS 3043 : 1987.

All materials used for connecting the earth lead with electrode shall be GI in case of GI Pipe and GI plate earth electrodes or tinned brass in case of Copper plate electrode.

#### **10.4.9 Protection Of Earthing Lead**

The earthing lead from electrode onwards shall be suitably protected from mechanical injury and corrosion by a 15 mm dia GI pipe in case of wire and 100/40mm dia medium class GI Pipe

The portion of the G.I. pipe within ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing or pavements). The portion within the building shall be recessed in walls and floors to adequate depth.

### **10.5. EARTHING CONDUCTORS**

Earthing conductors shall form the earthing network throughout the installation for earthing of all non-carrying metal parts.

#### **• Connection Of Earthing Conductors**

- ❖ Main earthing conductors shall be taken from the earth connections at the main switch boards to all other switchboards in the network.
- ❖ Sub-mains earthing conductors shall run from the main switch board to the sub distribution boards and to the final distribution boards.
- ❖ Loop earthing conductors shall run from the distribution boards and shall be connected to any point on the main/sub-main earthing conductor, or its distribution board or to an earth leakage circuit breaker.
- ❖ Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to switch boards at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing, Switches, accessories, lighting fitting etc shall be effectively connected to the Loop Earthing Conductors. These though rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered earthed, even though the run of metallic conduit is earthed.

- **Earthing Conductor Installation**

The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size.

Joints shall be revetted and brazed in approved manner.

Sweated lugs of adequate capacity and size shall be used for termination. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned.

- **Sizing Of Earthing Conductors**

All fixtures, outlet boxes and junction boxes shall be earthed with Bare copper wires as specified.

All 3 phase switches and distribution boards upto 60 amps rating shall be earthed with 2 Nos. distinct and independent 4 mm dia copper/6 mm dia GI wires. All 3 phase switches and distribution boards upto 100 amps rating shall be earthed with 2 Nos. distinct and independent 6 mm dia copper/8 mm dia GI wires. All switches, bus bar, ducts and distribution boards of rating 200 amps and above shall be earthed with a minimum of 2 Nos. separate and independent 25 mm x 3 mm copper/25mm x 6 mm GI tape.

## **10.6. PROHIBITED CONNECTIONS**

Neutral conductor, sprinkler pipes, or pipes conveying gas, water, or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lighting protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system.

## **10.7. RESISTANCE TO EARTH**

No earth electrode shall have a greater ohmic resistance than 1 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be upto one ohms. The electrical resistance measured between earth connection at the main switchboard and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate fuses or circuit breakers, and shall not exceed one ohm.

## **10.8. Earthing System – Specification**

Earthing system should comply to the requirements specified below. Earthing system should offer a resistance less than 5 ohms throughout the year. In places where Soil resistivity is more, multiple earth electrodes are to be installed to get the required value. Length of the earthing rod also can be increased to achieve low and stable resistance value.

Solid rods are recommended as earth electrode than a pipe due to the fact that solid rods can be easily driven by hydraulic hammers. Deep driven rods provide more stable and less Earth Resistance. Doubling the length of the rod will reduce earth resistance up to 40 %, where as doubling the diameter will reduce the resistance by only 10 %, but may increase the cost by 4 times. Lower earth resistance can also be achieved by increasing the number of earth rods. E.g. 40 % reduction in earth resistance is possible if the rods are increased from 1 to 2. The minimum spacing between earth pits should be equal to the length of the rod. Increasing the spacing between earth pits also reduces the earth resistance significantly.

### 10.8.1 Need and importance of Earthing:

- Human and Personnel safety.
- Equipment protection.
- Provides low impedance path for fault currents.
- To ensure good quality power.
- Protection against lightning and transient currents, noise reductions, Limitation of EMI.

### 10.8.2 References:

IEC 60364: Low Voltage Electrical Installations-Part 5-54: Selection & Erection of Electrical equipment- Earthing arrangement & protective conductors.

IEC 62561: Lightning Protection system Components.

IEC 62305: Protection Against Lightning –Part 3: Protection of structures & life Hazards

UL 467: Grounding and Bonding Equipments

UL96: Lightning Protection System – Components

IS 2309: Code of practice for protection of buildings & allied structures from lightning

IS 3043: Code of practice for earthing.

### 10.8.3 Components of earthing system:

- Earth electrode
- Couplers and Connectors
- Inspection Chamber (Earth Pit)
- Earth enhancement material
- Connecting cable/tape/strip with accessories.

### 10.8.4 Earth Electrode:

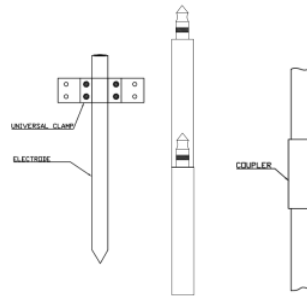
Copper coated Solid steel Rods shall be made of high tensile low carbon steel rod, with molecular bonded with 99.9% electrolytic copper with minimum coating thickness of 250 microns. The minimum length of the earth rod shall be 3 meters which is either a single rod or smaller rods with couplers or similar arrangement. For dry areas, length of the rods can go up to 9 meters. The vendor should quote price of the rod in length of 3 meters. The rod as well as the couplers should satisfy the requirements as per the above-referred standards. For Lightning protection application rods should have a diameter of 14.2 mm or 17.2 mm. In order to carry fault current, earth rods used in Power networks should be of diameter 20 mm or 25 mm. In case of applications more than 3 meters, diameter of the rod should be 20 or 25 mm. These rods also should have facility to drive with an electric/hydraulic hammer.

Interconnecting Strips / Earthing Conductor: Copper coated steel strips / tapes should be used to interconnect different earthing rods as well as horizontal earthing (Ring earthing). These strips should have a coating thickness of minimum 70 microns and have minimum cross sectional area of 90 Sqmm. (Eg 30 X 3 strip)

### 10.8.5 Couplers / Connecting clamps:

Couplers for interconnecting rods should be made of Brass or any other copper alloy, which is resistant to corrosion. For rods with diameters larger than 20 mm self locking arrangements are preferable instead of couplers. Connectors for connecting Electrode with Earthing conductor/strip should be of Brass/copper alloy or copper coated steel. Fasteners should be made of Stainless steel. Size should be selected according

to the electrode and earthing conductor dimensions. Different arrangements should be as per the below fig.



### 10.8.6 Inspection Chamber :

Should have an inner dimension of 250 mm X 250 mm X 250 mm made of FRP material. Flush Mounted, removable and lockable cover of the earth pit should be able to withstand 15KN. The area inside the inspection chamber should be such that, the UNIVERSAL CLAMP/EBB/Bus bar is not too deep inside the inspection chamber or projecting out of inspection chamber. The chamber should have facility for marking earth resistance and latest testing date by paint at the cover and previous recorded values inside the cover.

### 10.8.7 Earth Enhancement material:

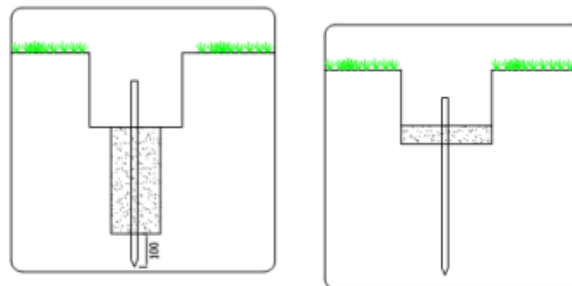
This is a conductive compound producing low resistance of an earth termination system. Earth enhancing compound shall be so designed and constructed that in normal use their performance is reliable and without danger to persons and the surroundings. The material shall be chemically inert to sub soil and shall not pollute the environment. It shall provide a stable environment in terms of physical and chemical properties and exhibit low resistivity. It shall not be corrosive to the earth electrode itself. The material should have a resistivity less than 50 Ohm meter

#### 10.8.7.1 Installation:

Normal soil in Marsh land: Electrodes can be hand driven or hammered into earth for the required length.

Semi Hard Soil: Electrodes can be hammered electrically or hydraulically for the required length.

Hard Soil: Bore a hole with a minimum diameter of 100 MM with at a depth of up to 3 meters. Place the electrode at the centre of the hole in such a way that bottom 100 mm of the electrode is in bond with the mother soil. For deep driven rods with depth more than 3 meters, remaining length of the rod should be driven into the mother soil. (ref fig) Fill the hole with earth enhancement compound.



#### **10.8.7.2 Inspection & maintenance:**

Maintenance of the earthing system has to be done at least once in 6 months, preferably before the monsoon period and a record should be maintained to verify earthing system conductors and components, electrical continuity, earth resistance value, re-fastening of components viz-nuts, bolts etc.

#### **10.8.8 Drawing:**

Layout of the complete earthing system with dimensions shall be submitted.

Warranty: Earthing system should provide stable resistance for a period of 18 months after installation as well as for full season. During this period monthly readings are to be recorded by the end user.

#### **10.8.9 Earth Enhancement Compound**

Earth enhancement material is a superior conductive material that improves earthing effectiveness, especially in areas of poor conductivity (rocky ground, areas of moisture variation, sandy soils etc.). It improves conductivity of the earth electrode and the ground contact area. It shall be tested and conform to the requirements of IEC 62561-7 having the following characteristics:-

- Shall be carbon based with min 95% of fixed carbon content premixed with corrosion resistant cement to have set properties. Cement shall not mix separately & shall not have Bentonite.
- Shall have high conductivity, improves earth's absorbing power and humidity retention capability.
- Shall be non-corrosive in nature having low water solubility but highly hygroscopic.
- Shall have resistivity of less than 0.12 ohms -meter.
- Shall be suitable for installation in dry form or in a slurry form.
- Shall not depend on the continuous presence of water to maintain its conductivity.
- Shall be permanent & maintenance free and in its "set form", maintains constant earth resistance with time.
- Shall be thermally stable between -100 C to +600 C ambient temperatures.
- Shall not dissolve, decompose or leach out with time.
- Shall not require periodic charging treatment nor replacement and maintenance.
- Shall be suitable for soils of different resistivity.
- Shall not pollute the soil or local water table and meets environmental friendly requirements for landfill, shall not be explosive & shall not cause burns, irritation to eye, skin etc. In this regard "Safety Data Sheets" shall be submitted by the manufacturers.

#### **Earth Pit Cover**

- An Earth Inspection pit cover is an inspection chamber used to give safety to an earthing arrangement and also provide an easy access to earth resistance testing.
- Earth Pit cover shall be made of Poly Plastic material.
- Earth pit cover shall be tested at 5 ton load.

### **11.0 ROUTINE AND COMPLETION TESTS**

#### **11.1 INSTALLATION COMPLETION TESTS**

At the completion of the work, the entire installation shall be subject to the following tests:

- (a) Wiring continuity test

- (b) Insulation resistance test
- (c) Earth continuity test
- (d) Earth resistivity test

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the contractor at his own cost.

## **11.2 WIRING CONTINUITY TEST**

All wiring systems shall be tested for continuity of circuits, short circuits, and earthing after wiring is completed and before installation is energised.

## **11.3 INSULATION RESISTANCE TEST**

The insulation resistance shall be measured between earth and the whole system conductors, or any section thereof with all fuses in place and all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 1100 volts for medium voltage circuits. Where the supply is derived from AC three phase system, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 megohms divided by the number of points provided on the circuit the whole installation shall not have an insulation resistance lower than one megohm.

The insulation resistance shall also be measured between all conductors connected to one phase conductor of the supply and shall be carried out after removing all metallic connections between the two poles of the installation and in those circumstances the insulation shall not be less than that specified above.

The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant Standard specification or where there is no such specification, shall not be less than half a megohm or when PVC insulated cables are used for wiring 11.5 megohms divided by the number of outlets. Where a whole installation is being tested a lower value than that given by the above formula subject to a minimum of 1 Megohms is acceptable.

## **11.4 TESTING OF EARTH CONTINUITY PATH**

The earth continuity conductor including metal conduits and metallic envelopes of cable in all cases shall be tested for electric continuity and the electrical resistance of the same alongwith the earthing lead but excluding any added resistance of earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

## **11.5 TESTING OF POLARITY OF NON-LINKED SINGLE POLE SWITCHES**

In a two wire installation a test shall be made to verify that all non-linked single pole switches have been connected to the same conductor throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three of four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to

one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Architect/Engineer/DFCCIL as well as the local authorities.

#### **11.6 EARTH RESISTIVITY TEST**

Earth resistivity test shall be carried out in accordance with IS Code of Practice for earthing IS 3043.

#### **11.7 PERFORMANCE**

Should the above tests not comply with the limits and requirements as above the contractor shall rectify the faults until the required results are obtained. The contractor shall be responsible for providing the necessary instruments and subsidiary earths for carrying out the tests. The above tests are to be carried out by the contractor without any extra charge.

#### **11.8 TESTS AND TEST REPORTS**

The Contractor shall furnish test reports and preliminary drawings for the equipment to the Architect/Engineer for approval before commencing supply of the equipment. The Contractor should intimate with the tender the equipment intended to be supplied with its technical particulars. Any test certificates etc., required by the local Inspectors or any other Authorities would be supplied by the Contractor without any extra charge.

### **12. SPECIAL INSTRUCTIONS TO TENDERERS**

#### **12.1 GENERAL**

- Only the preferred makes of material as stipulated shall be accepted.
- For any fixtures and fittings required to be fixed to the RCC slab, the Contractor shall drill the required holes with the use of an appropriate drilling machine with drill bits and no extra charges shall be payable on this account.
- The rates quoted shall be for work to be carried out at all heights and levels as at site and no extra payment shall be made for the same.
- The rates quoted for wiring shall be applicable for concealed or surface conduiting as required

#### **12.2 CONDUITING**

The rates to be quoted by tenderers shall include any or all of the following. No additional costs shall be paid for tools etc. as required to complete the work.

- All cutting of chasis in brick walls shall be electric with chase cutting machine/ tools.
- Whenever required chases shall be cut in stone walls with a chase cutting machine and with specific tools as required prior to plastering.
- In case of exposed stone walls the conduits shall be laid alongwith the construction of the wall and coordinated with civil activity.

#### **12.3 POINT WIRING**

- The Point Wiring shall commence from the Distribution Board and shall include the circuit wiring of length as required via the switch to the fitting/socket outlet as called for unless otherwise specified.
- The rates for all point wiring shall include the supplying and fixing of:



- (a) ISI approved & marked conduits.
- (b) Conduit accessories conforming to IS
- (c) MS draw, inspection and junction boxes.
- (d) Zinc chromate passivated switch boxes, outlet boxes etc.
- (e) All fixing accessories such as clips, brass screws etc.
- (f) Embedding conduits and accessories in walls and floors etc during construction and/or cutting chases and making good as necessary in the case of concealed conduit work and/or providing and fixing saddles, hangers, stirrups etc. and grouting of the same as required for surface conduiting.
- (g) Switches, wiring accessories and moulded cover plate as required.
- (h) Painting all conduits, outlet boxes and junction boxes.
- (i) Providing and fixing PVC connector at outlet box/junction box provided for light points.
- (j) Providing PVC cover at outlet box/ junction box provided for light points.

## **12.4 SWITCHES, OUTLETS AND ACCESSORIES**

All switches, socket outlets and other accessories shall be approved by the Owners prior to installation. The Contractor shall furnish samples of all materials within 7 days of the award of the work.

## **12.5 MAINS AND SUB-MAINS**

The rate for all items shall include:

- (a) ISI approved & marked conduits.
- (b) Conduit accessories conforming to IS
- (c) MS draw, inspection and junction boxes.
- (d) Providing and fixing approved saddles, hangers, trays, etc., and grouting the same as required for exposed conduits.
- (e) Embedding conduits and accessories in walls and floors etc during construction and/or cutting chases and making good as necessary in the case of concealed conduit work and/or providing and fixing saddles, hangers, stirrups etc. and grouting of the same as required for surface conduiting.
- (f) Providing and fixing junction boxes with 3-mm thick Perspex sheet covers including painting covers on inner side to match the colour of the surrounding walls.
- (g) Effecting adequate and proper connections at termination.
- (h) Providing all fixing accessories such as clamping devices, nuts, bolts and screws.
- (i) Providing sealing compound thimbles, crimping etc., at joints and terminations as called for.

## **12.6 EARTHING**

The rates for earthing items include:

- (a) All fixing accessories such as brass saddles, brass screws rawl plugs, etc.
- (b) Jointing by riveting/ soldering/ welding.
- (c) Cutting chases, holes and making good the same wherever required.
- (d) Effecting adequate and proper interconnections.
- (e) Excavation of earth, refilling, watering and ramming and making good as approved.

## **12.7 FIXING OF LIGHTING FIXTURES**

The rates shall include the following:

1. All components that may be required to make the installation complete in all respects such as:
  - a) Suitable length of down rod, hanger and connecting wires where called for. The Down rod shall be paid for separately on a running metre basis.
  - b) Internal wiring between accessories.
  - c) Wiring for connecting the fixtures to the point through connection blocks.
  - d) All metal blocks to serve as base of fixtures.
  - e) Bonding with earth wires.
2. Drilling holes in supports where required.
3. Fixing clamps, GI bolts and nuts, brass screws, saddles, rawl bolts and other fixing accessories as required.

## **12.8 DRAWINGS**

General Arrangement drawings with constructional details shall be submitted to the Architect/ Engineer for all Distribution Boards etc and their approval obtained prior to commencement of fabrication. Equipment shall not be accepted unless the drawings have been approved by the Architect/Engineer/DFCCIL. These drawings shall be prepared and submitted within one month of the award of work.

- **WIRES AND CABLES**

ALL WIRES AND CABLES USED SHALL BE OF THE STIPULATED MAKE.

We confirm that the Special Instructions to Tenderers have been understood and our tender complies to the above in its entirety.

## **13. SPECIAL CONDITIONS OF ELECTRICAL WORK**

### **13.1 GENERAL**

All electrical work shall be carried out in compliance with specifications given hereunder in this section and in compliance with Indian Standard Specification 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/DFCCIL regarding rules to be followed or manner of execution of work shall be final and binding.

Work shall be executed through licensed electrical contractor approved by the Architect/Engineer/DFCCIL. These Conditions of Contract shall be read in conjunction with the General Conditions of Contract, Special condition 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.

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.

The contractors shall mobilize 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.

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/DFCCIL.

The work shall be executed as per the programme drawn or approved by the Architect/Engineer/DFCCIL 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.

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.

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 surfaces, but shall at once be carted away by the contractor free of charge to a suitable pit or place to be provided by him.

The contractor shall provide all equipment, instruments labour and such other assistance required by the Architect/Engineer/DFCCIL for measurement of the work, materials etc.

### **13.2 Materials**

All materials, equipments, fittings and fixtures used in electrical works shall conform to the BOQ attached as "Form 4". 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.

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/DFCCIL for approval. The contractor shall not commence the work until the samples are approved, in writing from the Architect/Engineer/DFCCIL. The contractor shall ensure that all the materials incorporated in the work are identical in all respects with the approved sample. The 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.

### **13.3 Drawings**

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 equipments 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 Client. 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, distance 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.

### **13.3.1 Clarifications of Discrepancies**

In case of any discrepancy between specifications and drawings etc furnished by the Consultant or disputes in respect thereof, the interpretation of Engineer/DFCCIL shall be final and binding.

### **13.3.2 Work and Workmanship**

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.

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 Engineer/DFCCIL.

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.

The contractor shall possess all the relevant and valid licenses as per the regulations as per the regulations of the Indian Electricity Rules and the Local Electrical Inspector's requirements.

The work shall have to be coordinated with the building work and other allied jobs/ trades to the entire satisfaction of the Architect/Engineer/ DFCCIL.

### **13.4 Certificate of Inspection**

The contractor shall be responsible for getting the installation inspected and approved by the Electrical Inspector and other local electric supply company as required.

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 the client on producing documentary proof.

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 reinspection 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.

The Consultant/Engineer/DFCCIL 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.

### **13.5 Miscellaneous**

A site order book will be maintained at site which will be in the custody of the Engineer/DFCCIL 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.

After completion of the work the whole installation shall be tested by the contractor in the presence of the Architect/Engineer/DFCCIL. The tests shall comply the following I.E.E. Regulations and shall be submitted alongwith 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 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 magger 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 employer till all the components of the work after being completed at site in all respects have been inspected/tested by the Architect/Engineer/DFCCIL to his entire satisfaction and a completion certificate issued by the Engineer/DFCCIL 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 contractor shall submit 6 sets of drawing and two tracing of each drawing and 2 Nos. soft copies CDs to Client of each layout drawings drawn at approved scale indicating the complete conduit wiring/cablings/earthing as installed. The contractor will submit within 15 days of the award of work, a detailed schedule of programme of work.

### **13.6 Preamble to schedule of quantities:**

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 NEC/IER and code 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.

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. Item rates shall remain valid for any variation in the estimated quantities given in schedule of quantities.

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.

Power supply shall be 3 phase, 4 wire, 415 and single phase 230 volts A.C. and frequency of 50 cycles per second. All consuming devices shall be suitable for voltage and frequency mentioned above.

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 and drawings and their compliance with the statutory and fire insurance provisions including local codes, where the drawings and specifications conflict, the more stringiest shall apply.

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.

The entire installation shall be guaranteed against defective materials or workmanship for a period of 18 months from the take over by the Client. During the guarantee period all the defects shall be rectified by the contractor free of cost.

The successful tenderer shall submit the shop drawings for wiring LT 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. Atleast 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 Client.

The position of distribution boards and switch boards 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.

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.

In single phase (230 V) A.C. supply system circuit wires of same phase shall be drawn in same conduit. For 3 phase, 4 wire wiring system wires of different colour shall be used and for insulated neutral only black colour wire shall be used.

The Contractor shall include in his rates for painting with three coats of synthetic enamel paint to match the surroundings or as directed by the Architect/Engineer/DFCCIL for all down rod hangers pertaining to light fixtures, fans, steel structure used for electrical work at no extra cost.

The contractor shall supply completion drawings of the entire installation as well as three prints of each drawing showing the complete wiring diagram as executed at site drawn to scale after the completion of work but before completion certificate.

After laying and jointing the cables shall be subject to necessary tests as stipulated in IS:5959 (Part-I): 1970.

All samples of all electric fittings and other accessories shall be approved by the Architect/Engineer/DFCCIL prior to their installation.

No alteration whatsoever is to be made to the text of quantities of this schedule of quantities, unless such alteration is authorised in writing. Any such alteration or addition shall, unless authorised in writing, be dis-regarded when tender documents are considered.

Any error in description or in quantity or omission of items from the contract shall not vitiate this contract but shall be corrected.

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.

The contractor shall provide, within one month after completion of the work or alongwith 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 equipments and showing method of setting controls.
- (d) Method of fault finding, 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.

**13.7 The contractor shall provide the following at no extra cost to the Client:**

- (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.

The contractor will remove all the debris and surplus earth from work site (belonging to his work) free of cost.

**14.0 EV CHARGERS**

**14.1 AC Slow Chargers for 2/3/4 Wheeler**

**Technical Details :**

**EVSE Type :** Type 2 AC,

**Energy Transfer Mode :** Conductive as per IEC-61851-22

**Charging mode:** AC Type -2 Mode-3

**Reliability and Serviceability:** The Charger shall be Modular in nature with easy serviceability in the field.

**System Structure.**

**Isolation :** In case of dual Output, each output shall be isolated from each other with proper insulation

**Environmental conditions :** Outdoor use with IP55 with preferably metallic enclosure.

**Operator :** Operated by a trained person or EV Owner

**Input Requirements**

**AC Supply System :** 1-Phase, 3 Wire or 3-Phase, 5 Wire AC system

**Input Frequency :** 50Hz,  $\pm 1.5\text{Hz}$

**Output Requirements :** AC Connector as per IEC 62196-2 Mode 3, Type 2

**Cable Requirements :** Charging Cable Length Usable 5 Meter, Straight Cable ; Charging cable and connector shall be permanently attached to EVSE.

### **Mechanical Requirements**

Ingress Protection : IP 55 or higher ; Cooling : Air Cooled ; Dimension(W\*H\*D)/Weight : As per manufacturer design ; Mounting : Wall Mounting or floor mounting with pedestal

### **User Interface & Display Requirements**

ON- OFF (Start-Stop) switches Mandatory ; Emergency stop switch : Mushroom headed Push button type, latchable type in Red Color.

### **Visual Indicators**

Error indication, Presence of input supply indication, State of charge process indication

### **Graphical User Interface**

The graphical user interface shall designed in such a way that user feels ease to use the charger with at-least 4" Display. ; Display Messages : EVSE should display appropriate messages for user during the various charging states like: Connected or not ; Duration since start of charge, kWh ; User authorization status ; Fault conditions ; Authentication : As per OCPP 1.6 or higher (through mobile application)

**Communication interface between charger and central management system (CMS) :** All of:

Ethernet, Wi-Fi, and 4G Options

Communication between EVSE and Central Server : Open Charge Point Protocol (OCPP) 1.6 protocol or

higher versions compatible to OCPP 1.6.

### **Billing Requirements**

Software Solution CMS and User App Billing

### **Protection & Safety Requirements**

Over current, under voltage, over voltage, DC Residual current protection through Type B RCCB, Short circuit, Earth fault, Protection against electric shock

## **14.2 DC Fast Chargers for 4 Wheeler**

### **Technical Details :**

**Number of Outlets:** 2 (30kW x 2)

**Operation:** Unmanned

### **AC INPUT**

**AC Power supply:** 3P + N + PE

**AC Voltage:** 400Vac +/-10%

**Nominal Input Current:** 45A

**Required Power Supply Capacity:** 31kVA

**Power Factor:** >0.96

**Efficiency:** >90%

**Frequency:** 50 Hz +/-5%

### **DC OUTPUT**

**Maximum Output Current:** 100A

**Maximum Output Power:** 60kW

**Output Voltage Range:** 50-500Vac

**Connector:** CCS 2 + CCS 2

### **COMMUNICATION PROTOCOL**

OCPP 1.6

### **ELECTRICAL PROTECTIONS**

**Over current Protection:** MCB, DC Fast Blow Fuse

**Safety Protection:** RCD, Surge Protection

### **CONNECTIVITY**

**Network Connection:** 3G/4G

### **GENERAL**



**Enclosure Rating:** IP54/1k10  
**Enclosure Material:** Powder – coated Aluminum  
**Operating Temperature:** <55°C  
**Humidity:** 30% to 90% RH non-condensing  
**Display:** 10’’ TFT  
**DC Cable Length:** 5 Meters  
**Accessibility:** By RFID system card / Mobile Application

## 15.0 FIRE EXTINGUISHER

### 15.1 Composite Portable Fire Extinguisher ABC Powder based

Type	Stored Pressure
Extinguishing Media	Powder Based
Class of fire for which Fire Extinguisher Class -A ,Class -B ,Class -C is suitable	
Cylinder/Vessel Material	HDPE with Aramid Winding
Warranty for the Complete Product 1 year	
Liner Material Type	Non Metallic liner
Number of gauges fitted on Fire Extinguisher	2 gauges
Material of Operating Valve	Nickel Plated Brass with Stainless Steel Handle
Expellant Medium	N2 Based
Corrosion Guarantee for vessel body	10 year

### 15.2 Fixed Clean Agent Gas Based Cylinderless Fire Suppression System

The scope of work shall cover supply of **CYLINDER LESS** auto fire detection fire suppression system based on polyamide/plastic tube.

The electrical panel fire suppression system shall be Cylinder less with clean agent gas stored in the tube itself to form a complete and working installation to protect the specified areas. This gas shall be UL listed and manufacturer confirmation or the same from the Gas manufacturer shall be provided. In absence of the same bid is liable to be rejected.

The fire extinguishing gas shall be a clean agent which shall be self contained in tube along with inbuilt pressure gauge for easy identification in case of leakage. Details of gas to be used in the system shall be furnished by bidder at time of offer.

### 15.3 SYSTEM DESCRIPTION AND OPERATION

The heat sensitive tubing acts as a detection device as well as extinguishing gas/ agent delivery system in case of direct system. When a fire is detected, the tube bursts at that point and forms a miniature nozzle through which extinguishing gas/ agent is sprayed and fire is suppressed.

The heat-sensitive polymer/Plastic tubing stores extinguishing agent in the tube itself eliminating the need for an external cylinder .It should also have an inbuilt pressure gauge which shows the pressure in the tube. In case of fire, when the temperature inside the panel reaches 95°C to 120°C, the heat-sensitive tubing bursts at the point it is in contact with the flame to form a miniature nozzle. The extinguishing agent is sprayed out of the tube through the miniature nozzle, flooding the localized area and instantly extinguishing the flame.

The system should extinguish fire at an early stage and should trigger automatically. The system should be safe against malfunction and should not need power supply for detection and extinguishing of fire.

System shall be cylinder-less eliminating the need for valves & other accessories does reduce the maintenance.

Suitable components shall be provided to monitor the pressure of the system like a pressure gauge which shall be attached to the tube eliminating the need for external components.

#### Heat Sensing Tube:

- The sensing tube must be made of special modified Plastic or Polyimide (PA) with 19 mm dia.
- The tube should be non – conductive, non- corrosive and flexible.
- Inner diameter of the tube: 15 mm
- Outer diameter of the tube: 19 mm
- Minimum and maximum operation temperature- from - 10°C to + 55°C

#### Extinguishing Agent/Gas:

Fire extinguishing gas medium shall be a clean agent & Non-ozone depleting HFC 227ea. UL and FM approved.

#### WARRANTY

1 year from the date of supply.

<b>Length of Heat Sensing Tube (HST) made of special modified polyamide (PA) in (meter) approved by ILAC / UL LISTED</b>	6.3 meter	5.23 meter	4.19 meter
<b>Clean agent Capacity in each Tube</b>	1.5 kilogram	1.25 kilogram	1 kilogram
<b>Type of Clean agent with zero ODP(ozone depleting potential) as per NFPA 2001 to be used for fire suppression</b>	HFC227ea For electric panels/ cabinets/Racks	HFC227ea For electric panels/ cabinets/Racks	HFC227ea For electric panels/ cabinets/Racks

<b>Volume of protected enclosed Area for which Cylinderless Tubing System is required (cubic meter)</b>	2.12 – 3.45 m <sup>3</sup>	0.98-1.45 m <sup>3</sup>	0.78-1.16 m <sup>3</sup>
<b>Burst Pressure at 20 °C for Clean Agent Filled Tube</b>	24 bar ±1 bar	24 bar ±1 bar	24 bar ±1 bar

## **TECHNICAL SPECIFICATIONS FOR FIRE FIGHTING WORKS**

## **SECTION I HAND APPLIANCES**

### **1 SCOPE OF WORK**

- 1.1 Work under this section shall consist of furnishing all labour, material, appliances and equipment necessary and required to install fire extinguishing hand appliances.
- 1.2 Without restricting to the generality of the foregoing the work shall consist of the following: -  
  
Installation of fully charged and tested fire extinguishing hand appliances CO2 foam, dry chemical powder type as required by these specifications and/drawings.

### **2 GENERAL REQUIREMENTS**

- 2.1 Fire extinguishers shall conform to the following Indian Standard Specifications and shall be with ISI approved stamp as revised and amended up to date:-
- 2.2 Fire extinguishers shall be installed as per Indian Standard "Code of Practice for Selection, Installation and Maintenance of Portable First Aid Appliances" I.S.2190-1962.
- 2.3 Hand appliances shall be installed in readily accessible locations with the appliance brackets fixed to wall by suitable anchor fasteners.
- 2.4 Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.
- 2.5 All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations.

### **3 MEASUREMENT**

Fire extinguishers shall be measured by numbers and include installation and all items necessary and required and given in the specifications.

## **SECTION II SPRINKLER SYSTEM**

### **1. SPRINKLER HEADS**

Sprinkler heads shall be quartzoid bulb type with gunmetal body fully approved and having current certification of the fire laboratory of the C.B.R.I. Roorkee, Underwriter's laboratory (UL) and under the approved certified list of the Fire Office Committee (FOC) of U.K. or NFPA of USA. Any one of the certifications as acceptable to the local fire authorities obtained prior to the procurement and approved and accepted by the Architect/Engineer/DFCCIL.

Sprinkler heads shall be installed in conformity with approved shop drawings and in co-ordination with electrical fixtures, ventilation ducts, cable galleries and other services along the ceiling. Following type of sprinklers shall be used:

S.No.	Type of Sprinkler	Temp rating
a)	Pendent /Upright type	68°C
b)	Sidewall	68°C

Spacing and coverage of sprinkler shall be in accordance with risk classification of area in which they are installed, design density and TAC regulation

#### **ANNUNCIATION PANEL**

- a) Provide one solid state electronic annunciation panel, fully wired with visual display unit to indicate:
- b) Flow condition in any flow indicating valve
- c) The panel should give a visual and audible alarm for any of the above conditions.
- d) The panel should be standard manufacturer's factory made. All details shall be submitted with the tender.

#### **TESTING**

All piping in the system shall be tested to a hydrostatic pressure of 1.5 times the working pressure or 14 kg/sq.cm (whichever is more) without drop in pressure for at-least 2 hours.

Rectify all leakages, make adjustments and retest as required and directed.

#### **CABLES**

Contractor shall provide control cables from supervisory valves and switches to the annunciation panels.

All control cables shall be copper conductor PVC insulated armoured and PVC sheathed 1100-volt grade.

All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

All cable joints shall be made in an approved manner as per standard practice.

#### **CABLE TRAYS**

All cables shall be routed in approved locations in coordination with all other services in a proper manner.

Cable trays shall be of galvanized steel and hung from the ceiling by galvanised rods supported by appropriate size and type of expandable expansion fasteners drilled into the slabs and walls by an electric drill.

## **2. FLOW SWITCH**

Flow switch shall have a paddle of suitable width to fit within the pipe bore. The terminal box shall be mounted over the paddle/ pipe through a connecting socket. The switch shall have potential free

contact of suitable rating with N O or N C 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 seat shall be stainless steel. The flow switch enclosure shall have IP:65 protection.

The flow switch shall work at a minimum flow rate of 100 LPM. Further, it shall have a 'Retard' to compensate for line leakage or intermittent flows.

### **3. INSTALLATION VALVE**

Installation valves shall be installed on the sprinkler circuits as shown on the drawings.

Contractor shall submit his detailed shop drawings showing the exact location, details of installation of the valve and alarm in all its respects.

Installation valve shall comprise of a cast iron sluice valve with gunmetal trim, pressure gauge, double seated clapper check valves as alarm valve with pressure gauge, test valve and orifice assembly and drain pipe with pressure gauge, bye pass on check valve to regulate differential pressure and false alarm, turbine water gong including all accessories necessary and required and as supplied by original equipment manufacturer and required for full and satisfactory performance of the system.

### **4. MEASUREMENT**

Mild steel pipes shall be measured in linear metres of the finished length correct upto one cm. and shall include all fittings, flanges, welding, jointing, clamps for fixing to walls or hangers, anchor fasteners, painting and testing complete in all respects.

Sluice and fullway valves, check valves, installation valves, air valves & flow switches shall be measured by numbers and shall include all items necessary and required for fixing and as given in the specifications and bill of quantities.

Fire hydrants, hose reels, fire brigade connections, orifice flanges shall be measured by number and include all items given in the specifications and bill of quantities.

Fire hose and boxes specified shall be measured by number and include all items given in specifications and Bill of Quantities.

Cables and cable trays shall be measured in linear metre correct upto cm shall include clamps, hangers, anchor fasteners complete in all respects.

## HAND APPLIANCES

### 1 SCOPE OF WORK

- 1.1 Work under this section shall consist of furnishing all labour, material, appliances and equipment necessary and required to install fire extinguishing hand appliances.
- 1.2 Without restricting to the generality of the foregoing the work shall consist of the following: -  
Installation of fully charged and tested fire extinguishing hand appliances CO2 foam, dry chemical powder type as required by these specifications and/drawings.

### 2 GENERAL REQUIREMENTS

- 2.1 Fire extinguishers shall conform to the following Indian Standard Specifications and shall be with ISI approved stamp as revised and amended up to date.
- 2.2 Fire extinguishers shall be installed as per Indian Standard "Code of Practice for Selection, Installation and Maintenance of Portable First Aid Appliances" I.S.2190-1962.
- 2.3 Hand appliances shall be installed in readily accessible locations with the appliance brackets fixed to wall by suitable anchor fasteners.
- 2.4 Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.
- 2.5 All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations.

### 3 Measurement

Fire extinguishers shall be measured by numbers and include installation and all items necessary and required and given in the specifications.

## SPRINKLER SYSTEM

### 1. SPRINKLER HEADS

Sprinkler heads shall be quartzoid bulb type with gunmetal body fully approved and having current certification of the fire laboratory of the C.B.R.I. Roorkee, Underwriter's laboratory (UL) and under the approved certified list of the Fire Office Committee (FOC) of U.K. or NFPA of USA. Any one of the certifications as acceptable to Architect/Engineer/DFCCIL.

Sprinkler heads shall be installed in conformity with approved shop drawings and in co-ordination with electrical fixtures, ventilation ducts, cable galleries and other services along the ceiling. Following type of sprinklers shall be used:

S.No.	Type of Sprinkler	Temp rating
a)	Pendent /Upright type	68°C



- b) Sidewall 68°C

Spacing and coverage of sprinkler shall be in accordance with risk classification of area in which they are installed, design density and TAC regulation

### **Spare Sprinklers**

Provide a lockable enamel painted steel cabinet including following type of spare sprinklers

- a) Pendent /Upright type 20  
b) Sidewall 10

The cabinet should also contain one pair of wrenches (of each size of the same are different) for the sprinklers.

Spare sprinklers shall be of the same specifications as that of the original sprinklers specified.

### **Annunciation Panel**

- a) Provide one solid state electronic annunciation panel, fully wired with visual display unit to indicate:  
b) Flow condition in any flow indicating valve  
c) The panel should give a visual and audible alarm for any of the above conditions.  
d) The panel should be standard manufacturer's factory made. All details shall be submitted with the tender.

### **Testing**

All piping in the system shall be tested to a hydrostatic pressure of 1.5 times the working pressure or 14 kg/sq.cm( whichever is more) without drop in pressure for at-least 2 hours.

Rectify all leakages, make adjustments and retest as required and directed.

### **Cables**

Contractor shall provide control cables from supervisory valves and switches to the annunciation panels.

All control cables shall be copper conductor PVC insulated armoured and PVC sheathed 1100 volt grade.

All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

All cable joints shall be made in an approved manner as per standard practice.

### **Cable Trays**

All cables shall be routed in approved locations in coordination with all other services in a proper manner.

Cable trays shall be of galvanized steel and hung from the ceiling by galvanised rods supported by appropriate size and type of expandable expansion fasteners drilled into the slabs and walls by an electric drill.

## **2. FLOW SWITCH**

Flow switch shall have a paddle of suitable width to fit within the pipe bore. The terminal box shall be mounted over the paddle / pipe through a connecting socket. The switch shall have potential free contact of suitable rating with N O or N C 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 seat shall be stainless steel. The flow switch enclosure shall have IP:65 protection.

The flow switch shall work at a minimum flow rate of 100 LPM. Further, it shall have a 'Retard' to compensate for line leakage or intermittent flows.

## **3. INSTALLATION VALVE**

Installation valves shall be installed on the sprinkler circuits as shown on the drawings.

Contractor shall submit his detailed shop drawings showing the exact location, details of installation of the valve and alarm in all its respects.

Installation valve shall comprise of a cast iron sluice valve with gunmetal trim, pressure gauge, double seated clapper check valves as alarm valve with pressure gauge, test valve and orifice assembly and drain pipe with pressure gauge, bye pass on check valve to regulate differential pressure and false alarm, turbine water gong including all accessories necessary and required and as supplied by original equipment manufacturer and required for full and satisfactory performance of the system.

## **4. MEASUREMENT**

Mild steel pipes shall be measured in linear metres of the finished length correct upto one cm. and shall include all fittings, flanges, welding, jointing, clamps for fixing to walls or hangers, anchor fasteners, painting and testing complete in all respects.

Sluice and fullway valves, check valves, installation valves, air valves & flow switches shall be measured by numbers and shall include all items necessary and required for fixing and as given in the specifications and bill of quantities.

Fire hydrants, hose reels, fire brigade connections, orifice flanges shall be measured by number and include all items given in the specifications and bill of quantities.

Fire hose and boxes specified shall be measured by number and include all items given in specifications and Bill of Quantities.

Cables and cable trays shall be measured in linear metre correct upto cm shall include clamps, hangers, anchor fasteners complete in all respects.

**TECHNICAL SPECIFICATION FOR  
HVAC & BMS WORKS  
(SECTION-IV)**

**CONTENT OF TECHNICAL SPECIFICATION**

1.0	SCOPE
1.1	Standards
1.2	Conformity to Statuary Acts
1.3	Safety Codes
1.4	System Requirements
1.5	Design Parameters
1.6	Drawings
1.7	Guarantee
2.0	VRV/VRF SYSTEM
2.1	Outdoor Units
2.2	Indoor Units
2.3	Refrigerant Piping & Insulation
2.4	Drain Piping & Insulation
2.5	Remote Controllers
2.6	Touch Screen Controllers
2.7	UVC
2.8	MESF Filter
2.9	REFNETS
3.0	AIR DISTRIBUTION SYSTEM
3.1	AHU
3.2	Duct & Insulation
3.3	Fresh/Exh. Louvers
3.4	Canvas
4.0	VENTILATION SYSTEM
4.1	Propeller Fan
4.2	In line Fans
4.3	Tube Axial Flow Fans
4.4	Air Washer
4.5	Air Scrubber
4.6	Air Curtains
5.0	ELECTRICAL WORK
5.1	Panels
5.2	Motors
5.3	Starters
5.4	LT Cables
5.5	Control Cables
6.0	PAC
7.0	INSPECTION, TESTING & COMMISSIONING
8.0	CAMC

**1.0 GENERAL****1.1 SCOPE OF WORK**

The Scope of Work covers the design, drawing submission, drawing approval, supply, installation, testing, commissioning, training, warranty and maintenance of HVAC system, BMS and services provided for the same. The HVAC system must be able to integrate seamlessly with BMS and provide all available data on Ethernet/BACnet or other open platform.

**1.2 REFERENCES / STANDARDS:**

- ❖ **National Building Code of India –2016**
- ❖ **HVAC Specifications from CPWD**
- ❖ **ANSI:** American National Standard institute (**Wherever applicable**)
- ❖ **BIS:** Bureau of Indian Standards (This code will supersede in case of any ambiguity or misinterpretation)
- ❖ **ASHRAE:** American Society of Heating Refrigeration and Air conditioning Engineers
- ❖ **ISHRAE:** Indian Society of Heating Refrigeration and Air conditioning Engineers
- ❖ **ASME:** American Society for Mechanical Engineers
- ❖ **SMACNA / BIS:** For Duct construction standards.

<b>IS Number</b>	<b>Title</b>
IS 196	Atmospheric conditions for testing
IS 325	Three phase induction motors
IS 8148	Packaged Air Conditioners
IS 2360	Voltage bands for electrical installations including preferred voltages and frequency
IS 3615	Glossary of Terms Used In Refrigeration And Air Conditioning
ISO 5151	Non- ducted air conditioners and heat pumps — Testing and rating for performance
ISO 15042	Multiple split system air- conditioners and air-to- air heat pumps — Testing and rating for performance
ISO 16358 – 1	Air cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors — Part 1: Cooling seasonal performance factor
ISO 16358 – 2	Air-cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors — Part 2: Heating seasonal performance factor
ISO 16358 – 3	Air-cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors — Part 3: Annual performance factor

ISO 5149 – 1	Refrigerating systems and heat pumps – Safety and environmental requirements – Part 1: Definitions, classification and selection criteria
ISO 5149 – 2	Refrigerating systems and heat pumps – Safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation
ISO 5149 – 3	Refrigerating systems and heat pumps – Safety and environmental requirements – Part 3: Installation site.
ISO 5149 – 4	Refrigerating systems and heat pumps – Safety and environmental requirements – Part 4: Operation, maintenance, repair and recovery
EN 14825	Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Testing and rating at part load conditions
EN 145111 – 1	Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling – Part 1: Terms, definitions and classification
EN 145111 – 2	Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 2: Test conditions
EN 14511 – 3	Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 3: Test methods
EN 14511 – 4	Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 4: Operating requirements, marking and instructions
IS / ISO 817	Organic refrigerants – Number designation
ISO 3744	Acoustics -- Determination of sound power levels and sound energy levels of noise sources using sound pressure -- Engineering methods for an essentially free field over a reflecting plane
ISO 9614 – 1	Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Intensity - Part 1: Measurement at Discrete Points
ISO 9614 – 2	Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Intensity - Part 2: Measurement by Scanning
AHRI 1230	Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment
BS 4718 : 1971	Method of test of silencer for air distribution systems.
BS 2750: Parts 1-9:1980	Laboratory and field measurement of airborne sound insulation of various building element.

BS 3638 : 1987	Method of measurement of sound adsorption in a reverberation room.
BS 4773: Part 2: 1976	Acoustic performance without additional ducting of forced fan convection equipment.
BS 4954: Part 2: 1978(1987)	Acoustic testing and rating of induction units.
BS 5643:1984	Glossary of Refrigeration, Heating Ventilation and Air Conditioning terms

### 1.3 SUBMITTALS:

**To cross check the Heat Load Estimations / Design Data Summary and point out any discrepancy at the time of bidding.**

- Under provisions of sample approval before the commencement of the project.
- Includes products mentioned in the Approved list of manufacturers as per the mode of approval mentioned in the list.
- Submit shop drawings and product data grouped to include complete submittals of related Systems products, and accessories in a single submittal.

### 1.4 SHOP DRAWINGS

Submit a copy of the shop drawings, including:

- Actual duct routes after the site survey.
- Automatic temperature /Pressure control system.
- Inertia pads and foundations for the various equipments.
- Fire protection systems (Fire / Smoke dampers: Motorized) (Relief dampers, smoke extract system, pressurization system)
- Layout of the AHU/IDU / Plant room including dimensions of the room and the foundations and the sizes and all necessary construction details required on site.
- Location of the allied equipments and the requirements from other agencies.
- Trench locations if any.
- Sump location and size.
- Sleeve location if any.
- Ventilation air / exhaust air locations.
- Location of wall mounted equipment (If any)
- Any structural inputs.

### 1.5 Brochures:

- Submit manufacturer's product data and brochure including :

- b. Complete description.
- c. Illustrations.
- d. Rating data, accessories, dimensional data.
- e. Capacities stated in the terms specified.
- f. Performance curves of the fans and pumps.

## 1.6 PROJECT/SITE CONDITIONS

Mechanical layouts indicated on drawings are diagrammatical. Co-ordination (final) shall be required with other trades prior to installation. Install all works as shown on the drawings, unless prevented by project conditions.

Prepare drawings showing proposed rearrangement of work to meet the project conditions, obtain permission from Engineer before proceeding.

Place anchors, sleeves and supports prior to pouring concrete on installation of masonry works.

Keep roads and site clear of debris and scrap.

## 1.7 DESIGN PARAMETERS

### Air Handling Units

Maximum face velocity across cooling coil	155 m/min
Maximum velocity across filters (Ordinary/Micro-vee)	155 m/min
Maximum outlet air velocity	610 m/min
Maximum fan speed for fans upto 300 mm dia	1450 RPM
Maximum fan speed for fans above 300 mm dia	1000 RPM

### Centrifugal Fans

Maximum fan outlet velocity for fans upto 450 mm dia	550 m/min.
Maximum fan outlet velocity for fans above 450 mm dia	700 m/min
Maximum fan speed for fans upto 450 mm dia	1450 RPM
Maximum fan speed for fans above 450 mm dia	1000 RPM

### Duct Design

	Main Duct	Branch Duct
Maximum flow velocity	400 m/min	250 m/min
Maximum Velocity at supply air grills/diffusers	150 m/min	
Maximum friction in duct	1 cm WG/100 m run	



## 1.8 PAINTING AND SERVICE IDENTIFICATION

The scope of this section comprises of identification of service for each piece of equipment and allied works.

### Duct work service :

For duct work service and its insulation the colour of the triangles shall comply with **BS. 1710 : 1971**. the size of the symbol will depend on the size of duct and the viewing distance but the minimum size should not be less than **150 mm** length per side. One apex of the triangle shall point of the direction of air flow.

Service	Color	BS 4800 Color Reference
Conditioned air	Red and Blue	04 E 53/ 18 E 53
Ward air	Yellow	10 E 53
Ventilation air	Green	14 E 53
Exhaust / extract Recalculated air	Gray	AA 0 09
Foul air	Brown	06 C 39
Dual duct system hot Supply air	Red	04 E 53
Cold supply air	Blue	18 E 53

In addition to the color triangle specified above all duct work shall be legibly marked with black or white letter to indicate the top of service identified as follows:-

Supply air	S
Return air	R
Ventilation air	F
Exhaust air	E

The color banding and triangle shall be manufactured from self-adhesive cellulose tape laminated with a layer of transparent ethyl cellulose tape.

## 1.9 GOOD ENGINEERING PRACTICES FOR HVAC WORKS

- Mechanical noise control:** All good engineering practices involved in controlling the noise of equipment within permissible limits shall be adopted by the contractor.
- Vibration Control:** All good engineering practices involved in controlling the vibrations of equipment within permissible limits shall be adopted by the contractor.
- Equipment at the best operating parameters and acoustical performance alongwith the necessary isolation devices for vibration control shall be adopted by the manufacturer and the contractor.

**1.9.1 INTENT in general pertaining to this section is as follows:**

The vibration isolators for certain equipment have been specified and quantified in the BOQ, however, if any additional safeties are required to fulfill the intent of this basic mechanical requirement, then the same shall be provided by the manufacturer/contractor at no additional cost.

Mechanical service shall generally be designed and installed with provisions to contain noise and the transmission of vibration generated by moving plant and equipment schedules to achieve acceptable noise rating specified for occupied areas.

In addition to the provision specified in the specification, particulars attention must be given to the following detail at time of ordering plant and equipment and their installation:-

- a. All moving plant, machinery and apparatus be statically and dynamically balance at manufactures work and certificate issued.
- b. The isolation of moving plant. Machinery and apparatus including lines equipment from the building structure.
- c. Where duct work and pipe work service pass through walls floor and ceiling or where supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimize the outbreak of noise from plant room.
- d. The reduction of noise breakout from plant room and the section of externally mounted equipment and plant to meet ambient noise level requirement of the specifications.
- e. Electrical conduits and connection to all moving plant and equipment shall be carried out in flexible conduit and cable to prevent the transmission of vibration to the structure and nullify the provision of anti-vibration mountings.
- f. All duct connection to fans shall incorporate flexible connections. Except in cases where these are fitted integral within air handing unit.
- g. All resilient acoustic absorbing materials shall be non flammable vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.
- h. Where practicable silencer shall be built into walls and floor to prevent the flanking of noise the duct work system (If Any) and their penetrations sealed in the manner previously described.
- i. Where this is not feasible the exposed surface of the duct work between the silencer and the wall subjected to noise infiltration shall be acoustically clad as specified.

**1.10 TENDER DRAWINGS, DRAWINGS FOR APPROVAL & COMPLETION DRAWINGS**

**1.10.1 Tender Drawings**

The drawings appended/ uploaded with the tender documents are intended to show the areas to be conditioned, space allotted for various equipments, tentative duct, cable and pipe routes. The equipments offered shall be suitable for installation in the spaces shown in these drawings.

**1.10.2 Drawings for approval on award of the work**

The contractor shall prepare & submit three sets of hard copy & one Digital/ soft copy in AutoCAD format of following drawings and get them approved from the Engineer-in-Charge before the start of the work. The approval of drawings however does not absolve the contractor not to supply the equipments/ materials as per contract, if there is any contradiction between the approved drawings and contract.

- a. Lay out drawings of the equipments to be installed in various rooms such as ODU, IDU, AHU rooms, ducts and other equipments.
- b. Drawings including section, showing the details of erection of entire equipments including their foundations, layout, etc.
- c. Ducting drawings showing sizes, locations of dampers, grilles & diffusers.
- d. Electrical wiring diagrams for all electrical equipments and controls including the sizes and capacities of the various cables and equipments,
- e. Dimensioned drawings of all electrical and control panels,
- f. Drawings showing the details of all insulations works,
- g. Drawings showing details of supports for pipes, cable trays, ducts etc.
- h. Any other drawings relevant to the work.

The contractor shall, use the soft copy of such drawings to prepare and examine the integrated services layout, resolve conflicts, and modify the execution drawings suiting & adjusting to all the services requirements. The contractor shall be bound to modify & execute accordingly.

### **1.10.3 Completion Drawings**

One set of Digital/ soft Copy and one set of the following laminated drawings shall be submitted by the contractor while handing over the installation to the DFCCIL. Out of this one of the sets shall be laminated on a hard base for display in the control room. In addition one set will be given on compact disc.

- a. Plant installation drawings giving complete details of all the equipments, including their foundations,
- b. AHU room installation drawings,
- c. Duct layout drawings with their sizes and locations, and sizes and locations of all dampers, grilles & diffusers,
- d. Line diagram and layout of all electrical control panels giving switchgear ratings and their disposition, cable feeder sizes and their layout,
- e. Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits,
- f. BMS drawings

### **1.11 SAFTEY CODES**

The following IS codes shall be followed in reference to the Safety:

Safety code for mechanical refrigeration	IS 660
Safety code for air conditioning	IS 659
Safety code for scaffolds & ladders	IS 3696
Code of practice for fire precaution in Welding & cutting operations	IS 3016
Code for safety procedures and practices In electrical works	IS 5216
Code of practice for safety and health Requirements in electrical & gas welding and cutting operations.	IS 3696

## 2.0 VARIABLE REFRIGERANT VOLUME/FLOW SYSTEM

### 2.1 SCOPE

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

### 2.2 TYPE

Unit shall be air cooled heat pump type, variable refrigerant volume/flow air conditioner consisting of one outdoor unit and multiple indoor units. Each indoor unit shall have capability to cool or heat. The indoor units on any circuit can be of different type and also controlled individually. Compressor installed in each modular outdoor unit shall be equipped with 100% inverter Scroll compressors for higher reliability, improved life, better backup and duty cycling purpose. Outdoor unit shall be suitable for mix match connection of all type of indoor units and capable of connecting minimum ten different types of indoor units to one refrigerant circuit and controlled individually. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load.

The refrigerant piping between indoor units and outdoor unit shall be possible to extend up to a minimum of 165m with maximum 50m level difference without any oil traps.

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivering at site.

Following type of indoor units shall be connected to the system:

- ❖ Ceiling mounted ductable type.
- ❖ Ceiling mounted cassette type.
- ❖ Floor mounted ductable type
- ❖ Wall mounted Hi-Wall type.

Oil recovery system shall be managed without disturbance to normal operation cycle of the system / compressor.

In the piping work, minimal brazing shall be done.

The minimum COP shall be as specified in BOQ. Contractor shall furnish the following information:

Sr. No	Parameters of VRF system	COP data as per ISHRAE
1	COP at 100% Loading	
2	COP at 75% Loading	
3	COP at 50% Loading	
4	COP at 25% Loading	

Separate data is to be provided for different VRF models such as 16 HP, 24 HP etc.

The COP values as indicated are required to be furnished in Original by the tenderer directly from the original equipment Manufacturer (OEM).

### 2.3 OUTDOOR UNIT

- a. The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge mild steel panels powder coated finish. The unit should be completely factory wired, tested with all necessary controls and filled with first charge of refrigerant before delivering at site.
- b. The outdoor unit shall have multiple inverter scroll compressors and be able to operate even in case of breakdown of one of compressors. The defective compressor can be bypassed on failure and rest ODU shall work with remaining compressor(s).
- c. The O/D units shall be capable to operate at ambient temperature range upto 49°C. The noise level shall not be more than 60 dB(A) at normal operation measured horizontally 1m away and 1.5m above ground.
- d. The outdoor unit shall be modular in design and shall be allowed for side by side installation.
- e. Each modular outdoor unit shall have multiple inverter Scroll type compressors with top throw. The compressors shall be designed and coordinated to achieve the highest efficiency. The unit shall be provided with its own microprocessor control panel. The outdoor units shall have anti-corrosion paint.
- f. The machine must have a sub cool feature to use coil surface more effectively thru proper circuit / bridge so that it prevents the flushing of refrigerant from long piping due to this effect thereby achieving energy savings. The unit shall provide at least 10 % higher heating capacity than cooling capacity at nominal conditions.
- g. The outdoor unit should be fitted with low noise aero spiral design fan with aero fitting grill for spiral discharge airflow to reduce pressure loss and should be fixed with DC/AC fan motor for better efficiency.
- h. The unit shall be designed in such as way that cleaning of drain Pan should be easy & inspection/ replacement of compressor should be easy.
- i. The outdoor unit shall have suitable cooling mechanism for better operation at high ambient temperature.
- j. The outdoor unit shall have feature to change the evaporative temperature with respect to load for better comfort.
- k. The systems shall have free phase technology & operation shall be continuous in case of phase reverse in supply electricity.
- l. The system shall have automatic refrigerant charge function for optimal charging of additional refrigerant.
- m. The fan static pressure of the outdoor unit shall be minimum 60-75 Pa to avoid hot air recirculation.
- n. The compressors, inverters and all electronics in outdoor units must withstand reliable operation in high ambient temperatures. The units must operate reliably without any safety device tripping.
- o. The Outdoor machines shall be preferably compact machines for purpose of space saving and smaller foot print shall be preferred.
- p. The outdoor unit control shall possess following features:
  - The controls must ensure duty rotation between connected outdoor units for run time equalization.
  - In case of multiple compressors in an outdoor unit, the electronics must have an algorithm to rotate the compressor cycling for run time equalization.
  - All necessary safety devices shall be provided to ensure safe operation of the system. Following safety devices shall be part of outdoor unit: High pressure switch, High Discharge Gas temperature switch, Fan motor overload protection, Inverter drive overload protection,

Inverter Temperature monitoring and safety cut off, Over load protection for compressor motor.

### **2.3.1 COMPRESSOR**

- a. The compressor shall be inverter type Scroll based control or Twin Rotary. The inverter shall be IGBT (insulated gate bipolar transistor) type for efficient and quiet operation. The inverter compressor shall change the speed in accordance to the variation in cooling or heating load requirement.
- b. All outdoor units shall have multiple steps of capacity control from 15%-100% to meet load variations / fluctuation and indoor unit individual control.
- c. PCB Chamber of outdoor unit should be refrigerant cooled.
- d. All parts of compressor shall be sufficiently lubricated stock.
- e. Forced lubrication may also be employed.
- f. Oil heater shall be provided in the compressor casing.

### **2.3.2 HEAT EXCHANGER**

- a. The Heat Exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fin coil and larger surface area.
- b. The aluminum fins shall be covered by anti-corrosion resin film. The treatment shall be suitable for areas of high pollution, moisture and salt laden air. The condensing coils shall also have anti corrosion treatment.
- c. The casings, fans, motors etc. shall also be with anticorrosion treatment as a standard features.
- d. The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical / horizontal discharge. Each fan shall have a safety guard.
- e. The heat exchanger shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by extruded collars forming an integral part of fins. The tubes shall be staggered in the direction of airflow. The tubes shall be mechanically expanded for thermal bonding with fins. Each coil shall be factory tested for leaks using dry nitrogen at a pressure at least 1.5 times the maximum working pressure.

### **2.3.3 REFRIGERANT CIRCUIT**

- a. The refrigerant circuit shall include liquid and gas shut-off valves and a solenoid valves at condenser end.
- b. The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.
- c. All necessary safety devices shall be provided to ensure the safe operation of the system.
- d. The system should be able to generate an alarm in case of refrigerant leak.
- e. Unit shall be equipped with an oil recovery and oil management system to ensure reliable operation of the system for its useful life.

### **2.3.4 SAFETY DEVICES**

All necessary safety devices shall be provided to ensure safe operation of the system. Whatever safety devices are required shall be part of the outdoor unit:

- High pressure switch,
- Low pressure switch,
- Fuse,

- Crankcase heater,
- Fusible plug,
- Fan drive overload protector,
- Over load relay,
- Over current protection for inverter, and
- Short recycling guard timer.

### 2.3.5 OIL RECOVERY SYSTEM

- a. Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths. The system shall have oil recovery cycle of 8 or more hours.
- b. The system must be provided with oil balancing circuit to avoid poor lubrication.
- c. The outdoor unit must include an oil recovery device to limit the oil flowing with refrigerant to the indoor units. The device shall separate oil from compressor discharge gas and return it back to compressor
- d. The system should have inbuilt oil balancing circuit to avoid poor lubrication.

### 2.4 INDOOR UNITS

- a. The type, capacity and size of indoor units shall be as specified in detailed Bill of Quantities. Indoor units shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or any other type. Units shall be factory assembled, wired, piped and tested.
- b. Each unit shall have electronic control valve to control refrigerant flow rate in response to load variations of the room. The fan shall have highly efficient BLDC (Brushless Direct Current) motor and statically and dynamically balanced direct driven DIDW multi-blade type blowers to ensure low noise and vibration free operation. The fan motors shall be thermally protected.
- c. The system should be designed such that in case of failure/trip of one indoor unit, the working of ODU and other indoor units should not be affected.
- d. Grills shall have auto swing feature for proper Air distribution.
- e. Units shall have DX coils made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water. Anticorrosion treatment shall be provided for avoiding corrosion of coils.
- f. Unit shall have cleanable type filter fixed to an integrally moulded plastic /aluminium frame. The filter shall be easily serviceable.
- g. Each indoor unit shall have computerized control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling and heating.
- h. Each unit shall be with wired/Remote LCD type remote controller (as per BOQ). The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self-diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap individually as per requirement.
- i. Concealed indoor units shall have sensor mounted on supply air grilles / diffusers which can be controlled with wireless remotes.
- j. All units shall have adequate insulation or Lining to avoid condensation.
- k. All interconnecting Copper piping, joints, U bends and Aluminum fins within the condensing/ evaporator unit shall be coated with two component, polysiloxane based coating with dry film thickness of about 25-35 microns on Cu and Upto 5 microns on Al fins. The coating shall be

strong, flexible and durable. It shall have good adhesion and abrasion resistance. It shall be resistant to moisture, UV, acid - alkali and other chemicals. The coating shall be applied using air assisted Spray gun or brush.

1. The indoor unit shall have a printed circuit board complete with address switches for a variety of operation controls, emergency operation switch and fault/ operation indication LEDs. The address of the indoor unit shall be set automatically in case of individual and group control.

#### **2.4.1 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.

#### **2.4.2 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.

#### **2.4.3 CEILING MOUNTED CASSETTE TYPE UNIT (MULTI FLOWTYPE)**

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. The cassette type unit having some parts in non-metallc construction must be UL-94-V0 certified.

The fan shall be aerodynamically designed diffuser turbo fan type. Unit shall have an external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grille in center. Each unit shall have high lift drain pump, fresh air intake provision, low gas level detection system and very low operating sound. All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view.

### **2.5 REFRIGERANT PIPING**

- a) All interconnecting pipe-work between the condensing unit & indoor units shall have quality seamless copper tubes with brazed connections and the appropriate distribution joints and headers shall be used. The piping should be routed at site in such a manner, that brazed joints in the Refrigeration Piping are kept to a minimum.
- b) All Copper Pipes must be coated with polysiloxane based coating for better anti corrosion coating properties.
- c) The Refrigerant pipe work shall be insulated with XLPE Class-O tubular insulation/ Class-O closed cell elastometric Nitrile rubber tubular sleeves sections to avoid condensation and shall have low thermal conductivity, high mechanical strength, non-combustible, resistance to Fungi, ozone, UV and any other environmental pollutant. Moulded tee joints of thermal insulating material shall be used at bends y-joints etc. Test certificate for the same shall be submitted.
- d) To protect nitrile rubber/XLPE insulation of exposed copper piping from degrading due to



ultra violet rays & atmospheric condition, it shall be covered with polyshield coating with at least two coats of resin and hardener above nitrile rubber/XLPE insulation. Fiberglass tape shall be helically wound & coated with two coats of resin with hardener to give smooth & plain finish.

- e) The refrigerant piping shall be extendable up to minimum 165 m with 50 m level without any oil trap. Distribution refrigeration pipe joints and headers shall be installed in an appropriate orientation to enable correct distribution of refrigerant. The Distribution joints shall be factory/site insulated. All pipe-work must be kept clean and free from contamination to prevent breakdown of the system. All pipe ends shall be kept sealed until immediately prior to making a joint.
- f) All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. For Copper to Copper joints, 15% Ag brazing rod shall be used. For Copper to other metal joints, 45% Ag brazing rod shall be used. 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 nitrogen.
- g) All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.
- h) Refrigerant charge must be calculated based on the actual length of the refrigerant pipe work. The refrigerant charging process must be carried out with an appropriate charging station and under supervision of manufacturer or his representative.
- i) The insulated refrigerant piping and control wiring (in conduit) shall run on GI tray properly supported by GI rods. The exposed tray shall be covered by openable GI covers.
- j) Bend of copper piping shall be done by proper mechanical bending machine.
- k) The copper tubes shall be of two types: Soft drawn and Hard drawn as specified in BOQ. The chemical composition will confirm to grade C12200 designated as "Phosphorus Deoxidized High Residual Copper" grade having minimum Copper % of 99.9 % with Phosphorus % of 0.015 to 0.040%. The Mechanical properties should also be as per ASTM B280. Test certificate for the same shall be submitted.
- l) The OD and wall thickness of the refrigerant piping should be as specified in BOQ. Minor variation as per recommendation of OEM may be allowed. The air-conditioning system supplier shall design piping sizes and erect proper interconnections of the complete refrigerant circuit.
- m) The copper tubes shall be supplied with end Caps at both ends.
- n) The copper tubes must be packed & sealed in polyethylene bags to protect them from any atmospheric degradation/contamination.
- o) All copper tubes shall be 100% eddy current tested.
- p) All the Tubes shall be RoHS (Restriction of Hazardous Substances) Complaint and each lot of supply shall be provided with routine test certificate.

**Testing Max. Permissible Content Limit (PPM)**

Cadmium (Cd)	100ppm
Lead (Pb)	1000ppm
Mercury (Hg)	1000ppm
Chromium	1000ppm

- q) Each lot of copper tubes shall be inspected physically for any physical defects and the sizes shall be checked as per specification.
- r) All connections, tees, reducers etc. shall be standard make fittings. The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be

insulated with 19mm /13 mm thick elastomeric nitrile rubber Class-O insulation. For individual Piping 50 / 100 mm wide Aluminium Tape shall be used at joints of Piping with Bands for identification.

- s) After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 38Kg per sq. cm. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum of 700mm hg and held for 24 hours.

## **2.6 UPVC DRAIN WATER PIPE**

Providing and fixing in position UPVC drain plumbing pipes of APPROVED Make or equivalent as per ASTM D-1785 (SCH-80) including cost of Specials as per ASTM D-2466 (SCH-80) including jointing with approved solvent cement, chase, cutting holes in walls roofs or floors etc. and making good to its original condition complete as per manufacturer's specifications and satisfaction of Engineer In-charge.

The condensate drain pipe connection of each fan coil unit to the main header should be rigid PVC pipe of heavy gauge with 25 mm dia /32mm dia as required. The header pipe should be of 50 mm dia/32 mm dia as required. The drain piping should be insulated with 9 mm thick tubular nitrile rubber insulation. For proper drainage of condensate U trap shall be provided in the drain piping wherever required. All pipe supports shall be prefabricated and pre-painted slotted angle supports, properly installed with clamps. The condensate drain pipe arrangement for disposal of condensate water be made in such a way that there should not be any leakages of condensate water inside rooms as well in the route of drain water pipe line & water should be discharged at the location jointly decided with Engineer-in-Charge of work.

All associated Civil Engineering works as per requirement at site in above connection like making chase in the wall & restoring it original shape by re -plastering & repainting, etc. are included in the scope of work. The arrangement of drain- pipe shall be made in such a way that it should not affect the aesthetic of the building as well as is maintenance friendly & easily accessible.

## **2.7 CENTRAL REMOTE CONTROLLER**

A multi-functional compact centralized controller (central remote controller) shall be supplied with the system. The System Controller shall provide proven air conditioning management system to give complete control of VRF Air Conditioning equipment. It should be user friendly. It shall be able to control minimum no of indoor units specified in BOQ.

The Centralized Remote Controller shall perform the following minimum functions.

- a. Starting/stopping of Air-conditioners as a zone or group or individual unit.
- b. Temperature setting for each zone, or group, or indoor unit.
- c. Switching between temperature control modes, switching of fans speed and direction of airflow.
- d. The address of the indoor unit shall be set automatically in case of individual and group control.
- e. Monitoring of operations status such as operation mode and temperature setting of individual indoor units, maintenance information, trouble shooting information.

- f. Scheduling of both indoor and outdoor units as per the requirement.
- g. Indication of operating condition.
- h. Select ON of all operation modes for each zone.
- i. The controller shall have user friendly color LCD Touch screen display. The centralized remote controller should be able to control the indoor units with control wiring upto a total distance of 1 KM.
- j. In case of power fluctuation or power failure, the addressing and other settings such as temperature of individual indoor units should not be affected. Alpha-numeric addressing of each indoor unit should be possible to facilitate the location of individual indoor unit.
- k. The controller shall be integrated to BMS system through 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 BMS Software.

## **2.8 Air Purifier For Floor Mounted /Ceiling Mounted AHU**

The Micro electrostatic filter has to be accompanied with collector technology which shall comprise of 7 layers of filtration. Layer 1 shall be of a black honeycomb woven polypropylene. Layer 2 shall be of a white honeycomb woven polypropylene. Layer 3 shall be polyether 45ppi foam. Layer 4 shall be same as layer 1 and Layer 5 shall be same as layer 2.

The media shall consist of material which have high electrostatic potential. Airflow across the filter will cause the layer of self-charge with an higher electrostatic charge to enhance filtration capabilities. The media retainer shall consist of ½” back powder painted 20 gauge welded wire on both the up stream and down side of the filter.

The 5th and 6th filtration shall be ionized and charged collection plate. The Average Dust Holding capacity shall be greater than equal to at least 190 grams (in accordance to ASHARE Standard) having an efficiency of MERV 14. The performance of the filter has to be as per ASHARE 52-76 or 52.1-92 and shall carry UL certification.

## **2.10 UVGI SOLUTION**

The scope of this section comprises the SITC of HYBRID UVGI system conforming to these specifications and in accordance with the site requirements.

HYBRID Ultraviolet Germicidal Irradiation (UVGI) disinfection should use a UV light of wavelength 254nm and reactive oxygen species based on Bi-Polar Ionization technique to kill or inactivate micro-organisms by destroying/disrupting their DNA, leaving them unable to perform their vital cellular functions, thus achieving disinfection and also reducing the VOCs and other chemical gasses with particulate reduction filtration system for reducing the PM 2.5 & PM 10 particles.

The scope of work shall include supply, installation, testing & commissioning of the followings:

- HYBRID UVGI system should be able to improve complete indoor air quality through maintain the following levels
- Air Quality Index – Less than 50

- PM 2.5 – Less than 30  $\mu\text{g}/\text{cm}^3$
- PM 10 – Less than 50  $\mu\text{g}/\text{cm}^3$
- HYBRID UVGI system in indoor units with germicidal UV lamps of adequate capacity & quantity.
- UV lamps should be Quartz glass. Soft glass UV tubes which are designed for residential use will not be accepted due to its Unstable & Low UV output.
- Bi-Polar Ionization system should be of needle/brush type plasma producers producing equal amounts of positive & negative reactive oxygen species for actively reducing the pathogens from the surfaces.
- Electronic type ballast with minimum life of 15000 starts.
- Ballast should be flicker-free pre-heat (rapid start) lamp ignition which enables the lamps to be switched on and off without reducing useful life.
- Should offer low mains-current harmonic distortion <10%
- Ballast operating specifications should comply the following

Ignition Method	–	Rapid Start
Crestfactor(Max)	-	1.7
Power factor	-	Load (Nom) 0.98
Main Voltage Performance (AC)	-	221-254 V
Mains Voltage Safety (AC)	-	216 – 264 V
Earth Leakage Current(Nom)	-	0.7 mA
Power Losses (Nom)	-	4 W

- The ballast should have a energy efficiency EMI 9 kHz ... 30 MHz EN 55015 edition 7.1
- Safety standards IEC 61347-2-3, IEC 61000-3-2, IEC 61547
- Performance standards IEC 60929, IEC68-2-6 F c, IEC 68-2-29 Eb
- Approval marks of CE marking should be there on ballast
- All the components of power-pack shall be sealed in a protective casing. Open ended power-pack will not be allowed and automatically disqualified.
- The system shall prevent yeast and mould growth on cooling coil or ducts.
- The unit must not have any residual charge upon shutdown or cutoff.
- The design of the unit shall be independent of the main air handler and its electrical connections shall not have any inter-linkage with the air handler.
- All components must follow electrical safety and fire protection standards.
- Aluminum Reflectors should be of high quality and to be provided for
- Mounting hardware for UV lamps.
- Digital run hour meter for checking the life of the lamps
- Any other allied work activities/items required for successful installation, operation of the UVGI system for the intended purpose.

#### 2.10.1 Design Criteria

- The lamps used should produce short-wave UV radiation with a peak at 253.7 nm (UVC) for disinfection.
- The lamps used should be Quartz
- The lamps should have a protective inside coating which ensures almost constant UV output over the complete lifetime of the lamp.

- The lamp base should be ceramic bases for UV-resistance and high temperature.
- Warning signs on lamps indicating the lamp radiates UVC and harmful incase of direct exposure.
- The system must not create any pressure drop in the air flow.
- The lamps used should be of T5 type. Bi-pin tubes with ceramic ends on both sides.
- The lamps should be designed to achieve a minimum 90% effectiveness in single pass.
- The design should be effective in killing the airborne bacteria, virus and prevent mold growth in the cooling coil.
- The UV output should be designed for a minimum 500 microwatts/cm<sup>2</sup> at all the corners and surface of the cooling coil.
- The UVGI system should be installed in the upstream of the HVAC units.

#### 2.10.2 Technical Details

- UV Output Type - UV-C (254 nm)
- Lamp Type - T5 (15 mm dia)
- Lamp Life - 9000 Working Hours
- Ballast Type - Electronic
- Ballast Life - 15000 Starts
- Reflector Material - Aluminium
- Reflector Shape - Parabolic
- UV Intensity on Coil - Minimum 500 microwatts/cm<sup>2</sup>
- Tenderers must submit a clause-by-clause Compliance Summary and provide full documentation, technical literature, data sheets, etc. to confirm compliance for each clause for approval.
- The warranty, service and support of all parts must be locally available to ensure system performance at all times. Each unit should have an Indian warranty.
- The manufacturer's authorized personnel shall ensure correct application, supervise system start-up and train the owner's personnel for efficient field operations.
  - a. UV Lamps shall be ISO certified.

#### 2.10.3 AIR QUALITY MONITOR

It is the intent of these specifications to describe a highly accurate air quality monitoring system for monitoring the indoor air quality at every floor.

- The air quality monitor should have a PM 2.5, PM 10, VOCs, CO<sub>2</sub>, Temperature & Humidity sensors, HCHO.
- The sensors should be calibrated and should have good accuracy.
- The air quality monitor should be wi-fi based system.
- The air quality monitor should have a inbuilt SIM slot & SD card slot for operating independently in-case of non availability or bad wifi signal.
- The air quality monitor should be capable of sending the data to BMS system through RS 485 port.
- The air quality monitor should have a digital display showing the real time air quality values.
- The display should be user friendly with color indications for easy understanding.
- The system should show the real-time & historic air quality data in hourly, weekly and monthly formats.
- The device should meet the WELL building standards.

- The data should be easily accessible via web & mobile app through wifi connectivity.
- Should have app available on Play Store, istore for easy accessibility to client.
- Should have health recommendations features according to the current air quality.
- Should have a reliable dashboard facility to log-in
- Should have a data export function to easily export the data of the device in an excel sheet format for future reference.
- Convergence of multiple devices at one place. Pair one or multiple air quality monitors with the dashboard through wifi/gsm sim connectivity.  
Graphical representation for comparative ease.

## **2.11 REFNET Joint (Y Branch Fitting)**

VRF system shall not allow the use of a standard refrigeration T joints. The VRF system shall use specialty fitting that is called a Refnet or Y-Branch Fitting (terminology depends on manufacturer). In addition to the specialty fitting itself each manufacturer has specific piping requirements for this fitting that must be adhered to for proper system function. In view of this, REFNET joints along with insulation shall be supplied by OEM only.

Use of the particular branch fitting (Refnet) appropriate to each individual unit type not only permits the pipes to be laid with ease but also increases the reliability of the system as a whole.

Units can be added by connecting them directly to the REFNET header or REFNET joint. Further branches cannot be included in the system below the REFNET header branch.

Special purpose REFNET pipe components must be used for all the pipe work. For reliable and efficient system, selection of components shall be made from REFNET and Piping Selection Rules of the OEM.

REFNET kits shall be supplied with insulation intended to fit over the main body of the REFNET joint after installation of the REFNET kit is complete.

## **3.0 AIR DISTRIBUTION SYSTEM**

### **3.1 EUROVENT CERTIFIED DOUBLE SKIN AIR HANDLING UNITS**

#### **3.1.1 SCOPE**

The scope of this section comprises the supply, erection, testing and commissioning of double skin construction factory assembled air handling units, conforming of these specifications and in accordance with requirements of Drawings & of the Schedule of Quantities.

Unit performance, coil performance and Mechanical Characteristics shall be EUROVENT certified.

The unit & its components should conform to following standards

EN 1886	Air handling unit mechanical performance.
EN 13053	Ratings and performance for units and components.

EN 308	Test procedure for heat exchangers.
EN 779	Particulate air filters for general ventilation.
EN 1751	Aerodynamic testing of dampers.
EN 60204.1	Electrical equipment of machines.
EN ISO 3741	Determination of sound power level in reverberation rooms.
AMCA 210	Aerodynamic performance testing of fans.
AMCA 300	Reverberant room method of sound level testing
ISO 1940	Static & dynamic balancing for fans.

Minimum acceptable parameters according to above standards shall comply with the following:

A) Mechanical Characteristics :

a) Casing Strength Classification : D1

The casings to withstand the maximum fan pressure at the selected design fan speed. The maximum relative deflection should not exceed 4 mm/m. No permanent deformation of the structural parts (structures and supports) or damage of the casing may occur.

b) Casing Air Leakage : L1

Air leakage of the air handling unit should be tested under positive & negative pressure & should not exceed the values given below

Max. Air leak rate at - 400 Pa test pressure	:	0.15 l/sqm
Max. Air leak rate at +700 Pa test pressure	:	0.22 l/sqm

c) Filter Bypass Leakage : F9

The maximum allowable filter bypass leakage rate shall be 0.5% of design flow rate at 400 Pa positive test pressure.

d) Thermal Transmittance : T2

The unit should be designed to have a heat transfer coefficient given below

Heat transfer coefficient U :  $0.5 < U < 1.0 \text{ W/sqm.K}$

The test should be conducted in an environment chamber of Eurovent accredited laboratory & the readings should be taken after the steady state temperature difference of 20 K is established.

e) Thermal Bridging Factor : TB2

The unit should be designed to have a thermal bridging factor as given below.

Thermal bridging factor kb :  $0.6 < kb < 0.75$

The lowest difference of temperature at any point on the external surface and the mean internal temperature shall be established. The ratio between the lowest temperature difference and the

mean air to air temperature difference defines the thermal bridging factor.

The test should be conducted in an environment chamber of Eurovent accredited laboratory and the readings should be taken after the steady state temperature difference of 20 K is established.

**B) Air Handling Unit Performance as per EN 13053**

The performance of air handling units should be tested in a Eurovent accredited laboratory in accordance with EN 13053.

The tests would be carried out for

- Air flow – static pressure data - power consumption
- Heat recovery
- Cooling duty
- Heating duty
- Air – side & water - side pressure drop

**3.1.2 TYPE**

The air handling units shall be double skin construction, draw / blow - thru type comprising of various sections such as mixing box (wherever the Return air & Fresh Air are ducted) filter section, chilled water coil and hot water coil section, humidification section, fan section, fine filter plenum fabricated (wherever required ) as per details given in Drawings and Schedule of Quantity.

All the components of Air Handling unit should be supplied by AHU manufacturer.

**3.1.3 CAPACITY**

The air flow rate, static pressure, motor rating, cooling /heating capacity (TR/KW) shall be as shown on Air Flow Drawing and in Schedule of Quantity.

**A. CASING**

The casing of the air handling unit shall be of double skin construction, complying with Eurovent standard for mechanical characteristics as per EN 1886. The structure shall be made of Extruded Aluminium sections with polyamide thermal break profile for ensuring thermal bridging performance. The polyamide strip should be crimped to extruded aluminium sections for leak proof fitment. The structure shall be assembled using die cast Glass filled Nylon joints to make a sturdy, strong & self-supporting frame work for various sections. The profile shall have built in coved aluminium profile having smooth curvature from inside to avoid dust accumulation.

Double Skin Panels shall be minimum 50 mm thick constructed as follows:

- Outer skin  
Pre painted Galvanised Sheet Steel of 0.8 mm thickness with PVC guard film.
- Inner skin  
Aluzinc Sheet of 0.8 mm thickness.



The outer and inner skin shall be sandwiched with self-extinguishing CFC – HFC free PUF/ PIR insulation (density 38 +2 kg/m<sup>3</sup> with K factor not exceeding 0.02 Watt/m<sup>2</sup>) / Rockwool insulation (density not less than 96 kg/m<sup>3</sup>). The panels shall be screwed to the structure using soft food grade gasket to make it leak proof. Air tight access doors/panels with die cast zinc hinges shall be provided for access to various sections for maintenance.

The door shall be fitted with double wall inspection window of 200 mm diameter and robust glass filled nylon handles operational from both sides with optional locking arrangement. Each section should have inspection doors with duly wired marine lights and on/off switch mounted on wall of the unit. The entire housing shall be mounted on GSS channel frame work with provision for handling the units at site.

Drain Pan shall be constructed of 18 G 304 Stainless Steel with dual slope to facilitate immediate discharge of condensate. Specially designed drain pan with all round edges allow complete cleaning & avoid microbial growth as per ASHARE 62- 1999 standard. The drain tray will be insulated externally with 19 mm nitrile rubber & extended at least 300 mm beyond the coil. Necessary arrangement will be provided to slide the coil in the drain pan.

Mechanical performance of AHU casing shall be tested in Eurovent accredited laboratory as per EN1886 and should meet the following characteristics

Mechanical Strength : D1

Thermal Bridging : TB2

Thermal Transmittance : T2

Air Leakage : L1

Filter bypass leakage : F9

The air leakage thru the AHU casing shall not exceed the specified limits while tested as per class B of DW 143 standard.

## **B. PLUG FAN WITH EC MOTOR**

The complete EC Fan unit shall be of rugged bolted construction made of sheet steel, statically and dynamically balanced.

Fan: The fan section shall be equipped with a Single Inlet Centrifugal Impeller with High Efficiency Backward curved blades and external rotor EC (Electronically Commutated) motor, energy optimized for operation without spiral housing for high efficiency and favourable acoustic behaviour. The high efficiency backward curved impeller with rotating diffuser, made of high performance composite material / welded aluminium sheet material, with external rotor motor balanced together statically and dynamically according to DIN ISO 1940 Part 1.

The EC fan should be capable of being fitted in horizontal or vertical position in the AHU, depending on the application. Inlet cone shall be provided with a nozzle for volume flow measurement of the fan.

Motor: the motor shall be permanent magnet external rotor motor with integrated electronics and suitable for continuous operation. The speed of the motor shall be variable depending on an external control signal. The fans shall be Modbus RTU compatible for communication with BMS (Building Management System). The fan in totality shall be of most efficient type so that the power consumption and noise level is minimal. The EC motor shall have a wide voltage input range: 3~380...480V, 50/60 Hz. The motor shall be minimum IP55 protection class, with Thermal class

155 (Insulation class F). The EC motor shall be provided with suitable protection from moisture & hot climate. The ball bearing shall be provided with long time lubrication for maintenance free operation.

Integrated Electronics: The device electronics shall be protected from overload by the Active Temperature Management, so that if the ambient operating temperature exceeds the design limit then the fan is not switched off immediately. In such a condition the fan should be operational at lower speeds, till the time the operating ambient temperature drops down.

The EC motor shall meet all necessary EMC (Electromagnetic Compatibility) directives. The EC motor should comply to applicable EMC standards: Interference Emission Standard EN 61000-6-3 / 2. EC Motor shall be Integrated with VSD (Variable Speed Drive) for speed modulation of fans.

Fan characteristic curves shall be related to measurements on a fan test rig with inlet silencing chamber in accordance with DIN 24163 Part 2 OR ISO 5801.

The performance data of the fan shall correspond to precision class 2 as defined by DIN 24166.

The EC motor shall have the following protective features integrated in the controller:

- Overvoltage protection
- Short Circuit protection
- Under voltage/ Over voltage detection
- Locked rotor protection
- Line fault detection
- Active Temperature Management for thermal protection of motor and electronics
- Alarm relay 250V/2A
- Over temperature protection of electronic and motor
- External LED display shall be provided for indication of the status of the fan

### **C. COOLING/HEATING COILS**

Chilled/hot water coil shall have 12.7 mm dia tubes minimum 0.4 mm thick with 0.15 mm thick waffle/ripple aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame.

Face & surface areas shall be such as to ensure rated capacity from each unit & 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. Each coil shall be factory tested at 21 Kg per sq.cm (300 psig) air pressure under water. Tube shall be mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 10 to 12 fins per inch (4 to 5 fins per cm). Coils shall be provided with copper header and MS adaptor. Water pressure drop in coil shall not exceed 3 mt. of WC . Performance of Coil in accordance as per EN 1216 standard with a maximum tolerance of 5%.

### **D. HEAT RECOVERY WHEEL ( EUROVENT Certified )**

Heat Recovery Section shall house wheel matrix of pure aluminium foil so as to permit quick and efficient uptake of thermal energy, sufficient mass for optimum heat transfer and maximum

sensible heat recovery at a low rotational speed of 20 - 25 rpm. Non-metallic substrate will not be accepted for construction of wheel. The desiccant should have selectivity of a 3A molecular sieve desiccant for the 2.8A water molecules, and has the higher diffusivity of the 4A molecular sieves, so as to ensure the exclusion of contaminants in the air stream, while transferring only water vapour molecules, resulting in selective and fast latent recovery.

The desiccant, of sufficient mass, shall be coated with non-masking porous binder adhesive on the aluminium substrate so as to allow quick and easy uptake and release of water vapour.

The rotor/wheel matrix shall have equal sensible and latent recovery.

With optimum heat and mass through matrix formed by desiccant, of sufficient mass, coated on an aluminium foil, the rotor shall rotate at lower than 20 - 25 RPM, thereby also ensuring long life of belts and reduced wear and tear of seals.

The rotor shall be made of alternate flat and corrugated aluminium foil of uniform width.

The rotor honeycomb matrix foil should be so wound and adhered as to make a structurally very strong and rigid media which shall not get cracked, deformed etc., due to change of temperature or humidity.

The rotor having a diameter up to 2800 mm shall have spokes to reinforce the matrix. From 2000mm diameter upwards, the option of a special wing structure, to prevent the rotors from wobbling or deforming due to the successive pressure differentials, will be available.

Sectioned wheels, with pie segments, capable of being assembled in the field, shall be available as an option, above 2000 mm in diameter.

The surface of the wheel/rotor should be highly polished to ensure that the run out does not exceed □ 1mm for every 1 metre diameter, thereby ensuring, negligible leakage, if labyrinth non-contact seals are provided, and minimal drag, if contact wiper seals are provided.

The radial run out also shall not exceed □ 1mm for every 1 meter diameter, thereby minimising the leakage/drag on the radial seals, and minimise the fluctuation in the tension of the drive belt.

The number of wraps (of alternative corrugated and flat foil) for every inch of rotor radii shall be very consistent so as to ensure uniform air flow and performance over the entire face in the air stream. Flute height and pitch will be consistent to a very tight tolerance to ensure uniform pressure drop and uniform airflows across the rotor face.

The rotor shall be a non-clogging aluminium media, having a multitude of narrow aluminium foil channels, thus ensuring a laminar flow, and will allow particles up to 800 microns to pass through it.

The media shall be cleanable with compressed air, or low pressure steam or light detergent, without degrading the latent recovery.

The recovery wheel cassette/casing shall be manufactured from tubular structure to provide a self-supporting rigid structure, complete with access panels, purge sector, rotor, bearings, seals, drive mechanism complete with belt.

The rotor/wheel should have a field adjustable purge mechanism to provide definite separation of air flow minimising the carryover of bacteria, dust and other pollutants, from the exhaust air to the supply air. It shall be possible, with proper adjustment, to limit cross contamination to less than 0.04% of that of the exhaust air concentration.

The face and radial seals shall be four (4) pass labyrinth seals for effective sealing between the two air streams, and also for a minimum wear and tear ensuring infinite life of the seals.

#### **E. UVC Emitters**

The specified products will be packaged with a plan and drawing for the installation of the lamp assemblies as supplied by the manufacturer's installation manual, indicating the orientation (upstream, downstream, or both sides of the coil) of the installation.

Each UV-C lamp will be attached to a reflector that will reflect the UV-C energy in order to effectively irradiate the HVAC coil surface and drain pan.

The reflector will be built from a high UV reflectivity material capable of withstanding air velocities of up to 2000 ft/min. without excessive noise, wobble, or vibration.

The electronic power supply will be mounted on a rigid surface outside of the AHU in an adequate enclosure protecting it from moisture and humidity.

#### **F. FILTERS**

##### **Primary Filters**

G4 Filter Should be washable type with a classification according to EN 779. Filter depth should not be less than 50 mm. The clean filter pressure drop should not be exceeding 75 Pa @0.94m<sup>3</sup>/s (2000 CFM), but the system should be designed for washable filters.

##### **Secondary Filters**

F7 Filter Inherently rigid filter element fastened into filter frame. The Filter media shall be washable type & pleated into mats in a zigzag format. The depth of filter should be 300mm. The filter should be designed for non-washable / disposable type filters.

F9 Filter Inherently rigid filter element fastened into a quick change filter frame, material PCGI. Filter medium synthetic glass fibre temperature resistant up to 120°C. The endurance should be up to max final pressure difference of 800 Pa, The depth of filter should be 300mm. The filter should be designed for non-washable / disposable type filters.

Filter integrity test (with EMERY 3004 oil mist or as stated in ISO guideline 14644-2) should be carried out on all HEPA filter banks. A penetration of 0.01% on filter media and seals should not be exceeded. HEPA filter frames should be well sealed with a sealant to prevent any particles by-passing the HEPA filters. The filters should be mounted by SS wing nuts. The filter integrity tests should involve individually scanning filter media, filter frames and frames to plenum seals. Filters should be easily accessible.

## **G. ELECTRONIC AIR FILTRATION SYSTEM**

### **a) 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.

The EAC shall be Underwriter Laboratories (UL) Listed. The EAC shall also be EMC (Electromagnetic compatibility) certified and should meet safety and environmental criteria with reference to ES164468, UL 867 and DA 6.2.1. Ozone level of EACs provided must be within the acceptable limit of 0.05ppm.

The average capacity of the EAC shall be at least 1000cfm for the single cell unit and 2000cfm for the double cells unit. The initial atmospheric dust spot efficiency (ASHRAE 52-76) of the EAC shall be at least 67% at 2000cfm and up to 95% at 800cfm. The proposed equipment shall be capable of capturing sub-micron particulates/contaminants down to 0.3 microns. All tenderers shall submit test results of filtration efficiency by Air Filter Testing Laboratories for efficiency verification.

The solid state power supply shall provide dual voltage to the ionizer and collector section. The voltage to the ionizer shall be atleast 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 atleast 4000V DC.

The EAC must have factory test report to ensure that it meets the following

### **Performance Testing**

- Dielectric test
- Ambient and voltage extremes
- E-field test
- Oscillatory transient test
- Lightning test
- EFT (fast transients) test
- ESD (high voltage transients) test
- EMI susceptibility test
- EMI radiation test

### **Environmental**

- Humidity
- Condensation
- Vibration

**b) 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 desired.

**c) 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). The following status shall be allowed for remote monitoring by the building management system as common fault:

1. Normal operation of solid-state power supply (ON)
2. Any malfunction of the system that shall cause an alarm activation (CHECK)
3. 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.

**H. FRESH AIR INTAKES**

Extruded Aluminium construction duly anodised (20 microns and above ) fresh air louver with bird screen and extruded construction dampers shall be provided in the clear openings in masonry walls of the air handling unit rooms having at least one external wall. Louvers, damper, pre-filters, ducts and fresh air fan with speed regulator shall be provided as shown on Drawings and in Schedule of Quantities. Fresh air dampers shall be of the interlocking, opposed blade louver type. Blades shall be made of extruded aluminium construction and shall be rattle-free. Fresh air fans and fresh air intakes shall be per the requirements of Schedule of Quantities.

**I. ELECTRICAL & CONTROL PANEL**

The air handling unit shall have inbuilt integrated electrical starter panel with AUTO/Manual override switch for operation. Control cabinet to be provided with IP 65 enclosure which should be mounted on AHU surface/flushed inside the AHU casing. The electric panel provided for the unit must be equipped with main incoming contactor additionally the unit must be provided with MCBs with busbar for single incomer provision , additionally SMPS must be provided for power supply to the unit controller. Potentiometer shall be an integral part of the panel for manual speed control. Each unit shall have an Internal mounted Power cum control marshalling box of IP 65 protection with door and hinges with provision to mount power and control wirings with DDC controller.

Provision for 24 V DC power supply for PIBCV valve shall be part of the control panel.

## **J. MICRO PROCESSOR CONTROLLER**

The controller should have minimum 20 I/O points and RS485 ports for BMS Connectivity using Modbus RTU protocol / BACnet IP connectivity. The power input to the controller shall be 24 v DC and provision shall be made for the same in the control panel by AHU manufacturer. Each Unit shall be equipped with minimum 7” HMI with touch screen for monitoring and controlling the AHU which shall be IP 65 protection.

Touch screen HMI shall be default option even not specified in the BOQ. As a standard the controller / DDC must be compatible to connect to a laptop or display for configuring or viewing unit performance parameters.

Marshalling box should be factory fitted with termination of all control cables and RS 485 output of fan duly mounted inside the AHU panel. All wiring should be carried out by the AHU manufacture at factory with proper ferule for tagging purpose.

The control panel for EC fans should be in the scope of AHU manufacturer and should be factory fitted.

The controller to have the following inputs / outputs (To be incorporated as per control logic):

- Temperature / RH / Pressure connectivity as per devices options.
- Integration to fire panel
- Provision for fire damper integration
- Fan wall program for EC fans with individual status of fans thru Modbus
- Run hour status of each fans
- Kw / amp consumption of each fan on the fan wall
- CO2/VOC sensor connectivity – optional, if mentioned in the BOQ
- VFD connectivity via Rs485 (Modbus slave) – optional, if mentioned in the BOQ
- I/O summary
- Multiple controller (Slave) connectivity.
- Modbus RTU (485/IP) compatible output to BMS.
- Feedback from sensor etc and regulate the fan speed/ valve opening.
- Automatic load / time and alarm sequencing function to be performed by the unit.
- Microprocessor must have output point for ON/OFF of motorized outlet damper and must be suitable to be integrated with fire point for unit shut off in case receiving signal from fire panel or fire detectors.

Instrumentation: The following sensors shall be part of AHU package for modulation of fan and control valves

1. CHW temperature Sensor
2. Pressure Sensor/ DP sensor for fan speed control
3. DP switch across all filters
4. Co2 sensor for damper modulation
5. Velocity Sensor for Flow measurement

### **Important Guidelines**

A minimum gap of 800 mm shall be maintained between Microvee filter and HEPA filter. A

minimum gap of 800 mm shall be maintained between HEPA filler & Plenum dead end.

Plenum, housing of HEPA filters shall be extended at least 700mm on both sides (Upstream and Downstream) of HEPA Filters for easy testing and maintenance of filters.

Access Door (Minimum 600 mm) Wide in each section and in each Plenum housing. Limit switches shall be provided in Fan section doors and shall be interlocked with AHU Fan motor(s) and inspection lamp.

Required number of Compression glands for Power/Signal Cable should be provided.

Plastic nozzles with plug should be provided for DOP testing of HEPA Filters. Pressure measuring nozzles shall be provided in Upstream as well as in downstream side of each filter set and fan section.

## **K. SAFETY FEATURES**

Each Air Handling Unit must have safety features as under:

- a) The Fan Access Door shall be equipped with micro-switch inter locked with fan motor to enable switching off the fan motor automatically in the event of door opening.
- b) The Access Door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.
- c) Fan and motor base shall be properly grounded.

## **L. ACCESSORIES**

Each air handling unit shall be provided with manual air vent at high point in the cooling/heating coil and drain plug in the bottom of the coil. In addition, the following accessories may be required at air handling units, their detailed specifications are given in individual sections, and quantities separately identified in Schedule of Quantities.

- a) Motorised three way mixing valves located in chilled/hot water lines connecting to the coil. This valve shall be operated by the cooling/heating thermostat & shall control the flow of chilled/hot water.
- b) Cooling/heating thermostats.
- c) Insulated butterfly valves/balancing valves, 'Y' strainer, union & condensate drain piping upto sump or floor drain in air handling unit room.
- d) Thermometers in the thermometer wells & pressure gauge (with cocks) within gauge ports in chilled/hot water supply and return lines.

## **M. PERFORMANCE DATA**

Air handling units shall be selected for the lowest operating power consumption and noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicating shall be submitted and verified at the time of testing/ commissioning of the installation.

## **N. Factory Acceptance Test ( FAT )**

- One unit of each type of unit shall be inspected at factory for
- Run Test for Air quantity v/s static pressure



- Casing Leak Test as per DW 143 standard
- Pneumatic pressure test of Heat Transfer coil at 21Kg/sq.cm
- Vibration of unit
- Noise level at 1.5 m distance at factory condition
- Power consumption
- Dimensional check of unit
- Verification of Test certificates of components / calibration certificates of all instruments used during inspection.

## 3.2 DUCT WORKS

### 3.2.1 GENERAL

Sheet Metal Duct Works shall be carried out in accordance with either SMACNA or B.I.S. (IS 655) guidelines, as asked for in BOQ. SMACNA guidelines (upward modified in this specification) shall be adopted for factory fabricated ducts, and BIS Codes shall be adopted for site fabricated ducts.

### 3.2.2 Duct Material

- a. All ducts shall be fabricated either from Galvanised Sheet Steel (GSS) conforming to IS: 277 or aluminium sheets conforming to IS:737. The steel sheets shall be hot dip galvanized with MAT finish with coating of minimum 120 grams per square meter (GSM) of Zinc, GI sheets shall be lead free, eco friendly and RoHS compliant
- b. The thickness of sheets for fabrication of rectangular ductwork shall be as under. The thickness required corresponding to the longest side of the rectangular section shall be applicable for all the four sides of the ductwork.

Longest side (mm)	Minimum sheet thickness	
	For GSS	For Al.
750 mm and below	0.63	0.80
751 mm to 1500 mm	0.80	1.00
1501 mm to 2250 mm	1.00	1.50
2251 mm & above	1.25	1.80

- c. Contractor shall prepare shop drawings, coordinated with the working drawings and the ceiling plans made by Architect.
- d. Contractor shall fabricate, supply, install, test and balance air system and establish the air balance schedule.
- e. Contractor shall include in his costing all supporting, suspension and air balancing devices.
- f. Supply/ return air outlets, F.A. grilles and accessories shall be constructed from extruded aluminium sections.
- g. Flanges for matching duct sections, stiffening angles (braces) and supporting angles shall be of rolled steel sections, and shall be of the following sizes:

Application	Duct Width	Angle size
Flanges	Upto 1000 mm	35 mm x 35 mm x 3 mm
-do-	1001 mm to 2250 mm	40 mm x 40 mm x 3 mm
-do-	More than 2250 mm	50 mm x 50 mm x 3 mm
Bracings	Upto 1000 mm	25 mm x 25 mm x 3 mm
-do-	More than 1000 mm	40 mm x 40 mm x 3 mm
Support angles	Upto 1000 mm	40 mm x 40 mm x 3 mm
-do-	1001 mm to 2250 mm	40 mm x 40 mm x 3 mm
-do-	More than 2250 mm	Size and type of RS section shall be decided in individual cases

- h. Hanger rods shall be of mild steel and of at least 10 mm dia for ducts upto 2250 mm size, and 12 mm dia for larger sizes.
- i. All nuts, bolts and washers shall be zinc plated steel. All rivets shall be galvanised or shall be made of magnesium - aluminium alloy. Self tapping screws shall not be used.

### 3.2.3 LIST OF BUREAU OF INDIAN STANDARDS CODES

IS: 1234 (Part - I) - 1474	Mild steel tube
IS: 1234 (Part - II) - 1482	Mild steel Tubulars and other Wrought steel pipe fittings
IS: 4736 - 1468	Hot-dip zinc coatings on steel tubes
IS: 823 - 1464	Code of procedure for manual metal arc welding of mild steel
IS: 780 - 1480	Sluice valves for water works purposes
IS: 778 - 1480	Copper alloy gate, lobe and checks Valves for water works purposes
IS: 1536 - 1476	Flanges configuration
IS: 5312 (Part-I) - 1484	Swing - check type reflux Non Return valves for water works
IS: 2374 - 1463	Colour code for the identification of pipelines
IS: 554 - 1475	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS: 655 - 1463	Metal air ducts
IS: 277 - 1477	Galvanized steel wire for fencing.
IS: 4064 - (Part -II) - 1478	Specific requirements for the direct switching of individual motors.
IS: 3854-1464	Switches for domestic & similar Purpose

IS: 644-1477	PVC insulated (HD) electric cables For working voltage upto and Including 1100 Volts.
IS: 4224 (Part II) - 1474	HRC cartridge fuse links upto 650 volts.
IS: 8544 (Part-I to IV)-1474	Starters
IS: 732 (Part-III)-1482	Inspection and testing of installation.
IS: 654-1464	Air Conditioning (Safety Code)
IS: 660-1463	Mechanical Refrigeration (Safety Code)
IS: 4844-1487	Test Code for Centrifugal Fan.
IS: 3103-1475	Code of practice for Industrial Ventilation
IS: 7240-1481	Application & Finishing of thermal insulation material

In case of any revision in above BIS code. The REVISED one shall only be applicable.

**a. DUCT DESIGN PARAMETERS (Rectangular / Square)**

Maximum Flow Velocity	1100/1500 FPM	450 MPM
Maximum Friction	0.08 WG/100 FT Run	5MM WG/100 M Run
Maximum Velocity at SA outlet	500 FPM	150 MPM
Maximum flow velocity in exhaust duct	1800 FPM	550 M

**3.3 CONSTRUCTION**

**a. Ducts**

- i) Ducts shall be fabricated at site or factory fabricated and shall be generally as per IS: 655 "Specifications for metal air ducts", unless otherwise deviated in these General Specifications.
- ii) The interior surfaces of the ducting shall be smooth.
- iii) All the ducts upto 600 mm longest side shall be cross broken between flanges by a single continuous breaking. Ducts of size 600 mm and above shall be cross broken by single continuous breaking between flanges and bracings. Alternatively, beading at 300 mm centres for ducts upto 600 mm longest side, and 300 mm centres for ducts above 600 mm size shall be provided for stiffening.
- iv) As far as possible, long radius elbows and gradual changes in shape shall be used to maintain uniform velocity accompanied by decreased turbulence, lower resistance and minimum noise. The ratio of the size of the duct to the radius of the elbow shall be normally not less than 1:1.5.
- v) Flanged joints shall be used at intervals not exceeding 2500 mm. Flanges shall be welded at corners first and then riveted to the duct.
- vi) Stiffening angles shall be fixed to the sides of the ducts by riveting at 1.25 meters from joints for ducts of size 600 mm to 1500 mm, and 0.6 mm from joints for ducts of size larger than

- 1500 mm. Bracings for ducts larger than 1500 mm can alternatively be by diagonal angles.
- vii) Plenums for filters shall be complete with suitable access door of size 450 mm x 450 mm.
  - viii) All factory fabricated duct shall be supplied in L sections, the length of any piece shall not be more than 1800 mm for duct with longest side of cross section as 600 mm and above and 3000 mm for rest.

**b. Air Outlet and Inlets (Supply and Return)**

- i. All air outlets and intakes shall be made of extruded aluminium sections & shall present a neat appearance and shall be rigid with mechanical joints.
- ii. Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminium sheet. The louvers shall be of aerofoil design of extruded aluminium section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminium sheet. Louvers may be spaced 18 mm apart.
- iii. Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminium sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminium section.
- iv. Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.
- v. Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.
- vi. Grilles and diffusers constructed of extruded aluminium sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.
- vii. All supply air outlets shall be fitted with a volume control device, made of extruded aluminium gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any access panel. The volume control device for circular outlets shall be opposed blade radial /shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/wall outlets and intakes.
- viii. All the products supplied by contractor should supplement in performance by selection curves of product ratings from the manufacturer.

- ix. Laminar supply air diffusers shall be made of 2mm thick powder coated aluminium sheet duly insulated with 5mm thick closed cell polyethylene foam insulation having factory laminated aluminium foil and joints covered with self adhesive aluminium tape and having holes 2/3 mm dia including frame work.

**c. Fresh Air Intakes Louvers with Bird Screen**

- i. Fresh air intake louvers at least 50 mm deep shall be made of powder coated extruded aluminium sections.
- ii. A flanged frame using RS sections shall be provided on front face to conceal the gap between the louvers and the adjoining wall face. Corners of frame shall be welded. The frame shall be made structurally rigid.
- iii. Louvers made from extruded aluminium section shall be in modular panel form for ease of handling. These shall be free from waves and buckles. Vertical blades shall be truly vertical and horizontal blades shall be truly horizontal. Butt joints in blades shall not be accepted.
- iv. Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging/ vibrating of the louvers, at not more than 750mm centres where the louver's length is longer than 750mm.
- v. A bird wire screen made of 12 mm mesh in 1.6 mm steel wire held in angle or channel frame shall be fixed to the rear face of the louver frame by screens.

**d. Flexible Ducting**

Flexible Duct is a round, flexible light weight duct and is preliminary used for

- i. Speedy completion of project
- ii. Offers a high degree of flexibility, which allows it to be easily connected to any desired position.
- iii. A quick and economical means of correcting misalignment between system components.
- iv. Allows ducting around obstacles where fabricated and fitted ducts would be difficult and costly to install.

Flexible duct is constructed as described below:

- i. An uninsulated flexible duct shall be made of double lamination of metalized polyester film permanently bonded to a coated spring steel wire helix. Duct shall be in tear & puncture resistant construction.
- ii. For insulated flexible duct where specified, inner core for the same should be made of double lamination of metalized polyester film permanently bonded to a coated spring steel wire helix. Fiberglass insulation of minimum 14 kg/cu.m density, 25 mm thickness shall be wrapped over the inner core & covered with strong outer jacket cum vapour barrier made of fibre glass reinforced metalized polyester film laminate.
- iii. Care must be taken to install all the flexible duct in fully extended position & bends made with adequate radius as per manufacturer recommended practices.

### **3.3 FIRE DAMPERS**

- i) Fire dampers shall be provided in all the supply air ducts and return air ducts (where provided), return air passage in the air-handling unit room and at all floor crossings. Access

- door will be provided in the duct before each set of fire dampers.
- ii) Fire dampers shall be multi blade louvers type. The blade should remain in the air stream in open position & shall allow maximum free area to reduce pressure drop & noise in the air passage. The blades and frame shall be constructed with minimum 1.6mm thick galvanised sheet & shall be factory fitted in a sleeve made out of 1.6mm galvanised sheet of minimum 400mm long. It shall be complete with locking device, motorised actuator & control panel.
  - iii) Fire dampers shall be motorised smoke & fire dampers type. It shall be supplied with spring loaded UL stamped fusible link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters.
  - iv) Fire dampers shall be CBRI tested & certified for 90 minutes rating against collapse & flame penetration as per UL 555-1995.(Under writers laboratories)
  - v) Fire dampers shall be compatible with the fire detection system of building & shall be capable of operating automatically through an electric motor on receiving signal from fire alarm panel.
  - vi) Necessary wiring from fire alarm panel up to AHU electric panel shall be provided by the department & further from AHU electric panel to fire damper shall be provided by air conditioning contractor.

### 3.4 INSTALLATION OF METALLIC DUCT

#### a. Ducting

- i. The fabrication and installation shall be in a workmanlike manner. Duct work shall be rigid and straight without kinks.
- ii. All exposed ducts within the conditioned space shall have slip joints. Flanged joints shall not be used.
- iii. All joints shall be airtight.
- iv. Ducts shall be supported independently from the building structure and adequately, to keep the ducts true to shape. The support spacing shall be not more than 2 m. where ducts cannot be suspended from ceiling, wall brackets or other suitable arrangements, as approved by the Engineer-in-charge shall be adopted. Neoprene or other vibration isolation packing of minimum 6 mm thickness shall be provided between the ducts and the angle iron supports/brackets. Vertical duct work shall be suitably supported at each floor by steel structural members.
- v. Where metal ducts or sleeves terminate in woodwork, tight joints shall be made by means of closely fitting heavy flanged collars. Where ducts pass through brick or masonry openings, wooden frame work shall be provided within the openings and the crossing ducts shall be provided with heavy flanged collars on either side of the wooden frame work, so that duct crossing is made leak-proof.
- vi. Duct connections to the air-handling unit shall be made by inserting a double canvas sleeve 100 mm long. The sleeve shall be securely bonded and bolted to the duct and unit casing.
- vii. Dampers shall be provided in branch duct connections for proper volume control and balancing the air quantities in the system, whether indicated in the drawings or not. Suitable links, levers and quadrants shall be provided for proper operation, control and setting of the dampers.  
Every damper shall have an indicating device clearly showing the position of the dampers at all times.

- viii. Where electrical heaters are mounted in the duct, these shall be of low temperature totally enclosed type fitted with radiation fins. A removable panel for access to the heaters shall be provided in the duct. Any hole in the duct for electrical wiring must be provided with suitable bushes to avoid leakage. 6 mm thick asbestos board lining shall be provided all around the inside of the duct for a distance of 30 cms. on either side of the electrical heaters. A manually reset thermostatic safety switch shall be provided near the duct section having heaters. In addition, the heaters must be interlocked with the connected fan motor of the AHU.

**b. Air Outlets and Inlets**

- i. The locations of the air outlets and intakes shall be shown in the tender drawings and necessary openings and the wooden framework for fixing the grilles shall be provided by the air conditioning contractor. The location of these outlets/ inlets is subject to change and the approval of the Engineer-in-Charge shall be obtained before finally fixing the grilles/diffusers in position.
- ii. In installing fresh air intakes, no fixing device shall be visible from the face of the frame. Where louvers are to be fixed in masonry or concrete, fixing shall be with either expanding plugs or raw plugs. Where the louvers are to be fixed in steel or wood, non-ferrous screws or bolts shall be used.
- iii. Supply air outlets and return air intakes shall be anodized/ powder coated aluminium to the desired colour to match the surroundings wall/ceiling. The fresh air intakes shall be anodized/ powder coated aluminium as approved by the Engineer-in-Charge. The paint colour shall be approved by the Engineer-in-Charge.
- iv. All damages to the finish of the structure during the installation work shall be made good by the air-conditioning contractor before handing over the installation to the Department.

**3.5 Access Doors**

- a. All main work shall be accessible throughout using tight fitted hinged access doors. Doors shall be provided with neoprene rubber gaskets. Angle joints shall be provided with neoprene rubber gaskets for leak-tightness of the joints.
- b. Access door / panels shall be provided at following places.
- c. Any other places specifically mentioned in the drawing or if envisaged by the owner / consultants during execution stage.
- d. In case access doors are to be installed in the insulated ducts, the access door panel shall be double skin construction with insulation filled in such that it can be operated without damaging the duct insulation.

**3.6 Balancing**

Air systems shall be balanced in a manner to minimize throttling losses. The entire air distribution system shall be balanced with the help of an anemometer. The measured air quantities at fan discharge and at the various outlets shall be within + 5 percent of those specified/quoted. For fans greater than 0.75 KW (1.0 HP), fans must then be adjusted to meet design flow conditions. Branch duct adjustments shall be permanently marked after the air balancing is completed so that these can be restored to their correct position if disturbed at any time.

### 3.7 Measurement

- i) Duct measurements (for insulated ducts) shall be taken before application of insulation.
- ii) Duct work shall be measured section wise on the basis of external surface area by multiplying the axial length from flange face to flange face for each section by the corresponding duct perimeter in the centre of that section length.
- iii) Uniformly tapering straight sections shall also be measured as in (ii) above. However, for special pieces like tees, bends etc. area computations for surface areas shall be done as per the shape of such pieces.
- iv) The quoted unit rate for external surfaces of ducts shall include all wastage allowances, flanges, gaskets for joints, vibration isolators, bracings, hangers and supports, inspection chambers/access panels, splitter dampers with quadrants and levers for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the specifications. These accessories shall not be separately measured.
- v) Grilles and diffusers (except linear diffusers) shall be measured by the cross sectional areas, perpendicular to the airflow, and excluding the flanges. Volume control dampers, where provided shall not be separately accounted for.
- vi) Linear diffusers shall be measured by linear measurements only, and not by cross-sectional areas, and shall exclude flanges for mounting of the linear diffusers. The supply air plenum for linear diffusers shall be measured as described above for ducting.
- vii) Fire dampers shall be measured by their cross sectional area perpendicular to the direction of the airflow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, fusible link/solenoid with wiring, but excluding the fire detectors, etc.

### 3.8 Leakage Test

Test duct for leakage by using test kits containing test blowers, two U tube manometers, and calibrated curve attached to the orifice tube assembly.

The above mentioned test would be a pilot test, and subsequently, if the construction manager / consultant asked for then Halogen / Metal Halide damp test / smoke test could be carried out, prior to branch / collar works.

### 3.9 Mechanical Noise and Vibration Control

- a. Flexible connections shall be provided on all duct work connections to fans, rotating plant and equipment isolated from structure and anti-vibration materials or mountings. Pipe work and duct work crossing building movement or construction joints shall be installed with flexible connections.
- b. Flexible connection on duct work to fans etc. Shall be a minimum/ maximum free length of **100mm / 200mm** respectively to minimize noise transmission and noise break out. They shall be completely free from stress and shall not be required to accept any weight.
- c. Thickness and strength of flexible connection materials shall be suitable to withstand the positive and negative fan pressure to which they will be subjected to and shall not allow perceptible leakage. The materials shall be durable, non flammable having good acoustical quality.



### 3.10 Silencers

- a. Duct sound attenuators / silencers of the following specifications would be installed wherever asked for in the drawings and the BOQ.
- b. All plant attenuators shall be selected to maintain noise criteria given in this specification.
- c. The outer casing shall be out of min. 22G galvanised steel in accordance with ASHRE (ISI) recommendations for high pressure rectangular duct work. Seams shall be lock formed on pittsburg lock machine.
- d. Interior elements of silencers shall be out of min. 22 G galvanised perforated steel.
- e. Acoustic fill shall be Fibre glass of density not less than 48 kg/m<sup>3</sup> sufficient to obtain specified acoustic performance and shall be packed under 10% compression to eliminate voids due to vibration and setting. Material shall be inert, vermin and moisture proof. All material of construction and acoustic fill shall be incombustible as per IS 3144.
- f. All silencer shall be selected against a maximum allowable air pressure drop of **10mm**. Air tight construction shall be provided by use of duct sealing compound at site by the air conditioning contractor.
- g. Acoustic Performance Silencer acoustic ratings shall include insertion loss and self-noise power levels and shall meet or exceed minimum performance. Contractor shall provide computer selection for the silencer supplied at site which will indicate db reduction at different octave band frequency.
- h. Aerodynamic Performance Static pressure drop through silencers shall not exceed those listed in the silencer schedule at the indicated airflows.
- i. Transitions Where transitions are required to adapt silencer dimensions to connecting duct work, they would be supplied by the installing contractor.

### 3.11 AIR REGISTERS

Scope included following:

- a. Air Distribution Registers, grilles, diffusers.
- b. Fire / Smoke Dampers
- c. Access Doors
- d. Outside Air Louvers
- e. Flexible Ducts

The quality control of these items are governed as specified below:

- a. Air Diffusers/Grilles: As per ratings by Air Diffusion Council / As per approved manufacturer.
- b. Fire / Smoke / Combination dampers : UL , NFPA 90A / 90 B.

#### i. Air Register

The scope of this section includes supplying, installation, testing, balancing and commissioning of various air distribution products as specified here under. All air distribution products shall have guaranteed performance rating as regards to air quantity, throw, noise level and pressure drop etc. Contractor has to provide selection curves at the time of supply.

#### ii. Supply and Return Registers and Ceiling Terminals

Supply and return air registers and ceiling terminals shall be made of extruded aluminum section as specified in BOQ. The registers/terminals shall be either anodized or powder coated in finish as given in BOQ. Supply air registers/terminals shall be provided with screw operated opposed blade volume control device of extruded aluminum in mill finish. The registers shall be suitable for fixing arrangement concealed or visible screw as approved by architect/Engineer.

All registers shall be selected as per selection curves and in consultation with architect/Engineer. All registers shall have soft continuous rubber/ foam gasket between the periphery of the registers/terminals and the surface on which it has to be mounted.

**iii. Linear Registers**

Linear continuous supply or return air register shall be extruded aluminum construction with fixed horizontal bars at 0 ° or 15 ° inclination with one way or two way deflection and flanges on both sides. The thickness of fixed bar louvers shall be 5 mm in front and the flange shall be 20 mm wide with round edges. The register shall be suitable for concealed fixing and horizontal bars of the register shall be mechanically crimped from the back to hold them.

Volume control device of extruded aluminum construction in mill finish shall be provided in S.A. duct collars.

**iv. Single Individual Adjustable Louvered Supply or Return Air Register**

Single individual adjustable horizontal /vertical supply or return air register shall be made of extruded aluminum construction. The louvers shall hold deflection settings under all conditions of velocity and pressure since mounted on Nylon bushes. The register shall have 20 mm wide flange all around with front screw fixing. Volume control device of extruded aluminum / GI construction in mill finish shall be provided in S.A. duct collars.

**v. Double Adjustable Louvered Supply/Return Air Register with Horizontal / Vertical or Vertical/Horizontal Louver Arrangement**

The register shall be adjustable as each louver shall be pivoted to provide pattern with 0° to plus or minus 15° arc up to 30° deflection down towards. The louver shall hold deflection settings under all conditions of velocity and pressure. The Rear louver of the register shall be in black shade.

Volume control device of extruded aluminium construction with mill finish shall be provided in S.A. duct collars.

**vi. Rectangular Fixed Bar Register**

Supply/Return air all side flange air register shall be extruded aluminium construction with fixed horizontal bars at 0° or 15° inclination with one way or two way deflection and flanges on both sides. The thickness of fixed bar louvers shall be 5 mm in front and the flange shall be 20 mm wide with rounded edges. The register shall be suitable for concealed fixing and horizontal bars of the register shall be mechanically crimped from the back to hold them.

**vii. Exhaust Air Register**

Exhaust air register shall be made of extruded aluminium with fixed horizontal louvers at 40° angle setting on a 20 mm louver pitch. The register shall have 20 mm wide flange with round edges all around. The register shall be suitable for front screw fixing.

Volume control device of extruded aluminium construction in mill finish shall be provided in S.A. duct collars.

**viii. Square Ceiling Air Terminals**

Square/Rectangular ceiling air terminals shall be made of extruded aluminium construction with flush fixed pattern. The terminals shall have Anti-Smudge ring and spring loaded removable central core in various pattern for air flow direction. The terminal shall be mounted by concealed screw fixing arrangement. The supply air terminal to be supplied with Volume control device of extruded aluminium construction in mill finish.

**ix. Curved Blade Ceiling Terminals**

Square /rectangular curved blade ceiling terminals shall be made of extruded aluminium. The terminals shall have individual adjustable blades mounted on nylon bushes which facilitate to adjust the direction of air as per site conditions. The terminals shall have 20 mm wide flanges all around and concealed screw fixing arrangement. The supply air register to be supplied with Volume control device of extruded aluminium construction in mill finish.

**x. Volume Control Device**

Opposed blade volume control device shall be made of all extruded aluminium construction in mill finish. Opposed blades shall be pivoted to extruded aluminium frame with Nylon bushes . Specially designed blade have an overlapping lip which ensure a tight closure.

**xi. Ventilation Air Intake Louvers**

Ventilation air intake louvers 50 mm deep wherever required as per shop drawing will be made of extruded aluminium construction duly Anodised or Powder coated. Bird/insect screen will be provided with the intake louvers. The blades are inclined at 45 °on a 40 mm blade pitch to minimise water ingress. The lowest blade of the assembly shall extended out slightly to facilitate disposal of rain water without falling in door/wall on which it is mounted.

Wherever specified, the intake louvers shall be provided with factory fitted all aluminium construction volume control dampers in mill finish.

**xii. Storm Proof Louvers**

80mm deep wherever required as per shop drawing will be made of extruded aluminium construction. The blades are inclined at 45 degree on 75 mm blade pitch to minimise water ingress. The lowest blade of the assembly shall extended out slightly to facilitate disposal of rain water without falling in door / wall on which it is mounted.

**xiii. Air Transfer Door Register**

Extruded aluminium construction air transfer door register will be provided as per approved shop drawings. The register will be complete with single /double register frame to be mounted on door panel from both sides. The central core shall be NO- SEE-THRU type. The register shall be anodised or powder coated as per Architect/Engineer requirement. The register shall be provided with insect screen to prevent movement of insects from inside to outside or vice versa.

**xiv. Motorised Combined Smoke & Fire Dampers - Spring Return**

All Supply and Return Air Ducts at AHU room crossings and at all floor crossings shall be provided with approved make fire and smoke dampers of atleast 120 minutes fire rating certified by CBRI Roorkee as per UL 555:1973.

**xv.** Fire Damper blades & outer frame shall be formed of 1.6MM galvanised sheet steel. The damper blade shall be in pivoted on both ends using chrome plated spindles in self lubricated bronze bushes. Stop seals will be provided on top and bottom of the damper housing made of 16 G galvanised sheet steel. For preventing smoke leakage side seals will be provided.

**xvi.** In normal position damper blade shall be held in open position with the help of a 24V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

**xvii.** The damper shall be actuated through electric actuator. The actuator shall be energised with the help of a signal from smoke detector (supplied by others) installed in AHU Room/R.A.Duct/Damper. The Fire Damper shall also close due to Temp.rise in S.A. Ducts thru the Electric Temp.sensor factory set at 165° F micro switches with bakelite base will be provided to stop fan motor and give open & close signal at remote panel in case of motorised actuator.

**xviii.** Each Dampers in case of motorised Smoke-cum-Fire Damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from UPS or Emergency Power Supply to shown status of the damper (open or close), to allow remote testing of damper & indication in event of damper closure due to signal from smoke sensor/Temp.sensor & reset button. Additional Terminal will be provided to have signal (sound beep or visual) in Central Control Room.

**xix.** Damper Actuator shall be spring return so as to close the damper in the event of power failure automatically and open the same in case of power being restored.

**xx.** The Fire Dampers shall be mounted in fire rated wall with a duct sleeve 400MM long. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be Slip on type. Minimum thickness of G1 Sheet shall be 18 G.

**xxi.** The damper shall be installed in accordance with the installation method recommended by the manufacturer.

**xxii.** After installation of Fire Dampers, contractor will co-ordinate with the civil contractor on site and get the extra openings sealed, and then finally finish the installation by sealing the area, using approved make of mastic fire sealant.

### **3.12 INSULATION**

This scope covers the specifications for insulation of Exposed, Concealed, Outdoors and Underground works.

Insulation, adhesives, coatings, sealant, tapes, shall have a flame spread rating of 25 or less and smoke development of 50 or less in accordance with UL 723.

**a. Pipe and Equipment Insulation**

Provide factory pre-molded of material specified in section type insulation material for pipes and equipment.

- The Pipe insulation basic material shall be cross linked closed cell Class-O Oxide Acetate Foam or Class-O closed cell elastometric nitrile rubber. Insulation should be of minimum thickness as mention in the BOQ.
- The Pipe insulation shall be with Factory pre-laminated Aluminum foil for mechanical protection where the men approach to damages the Oxide Acetate foam surface. Insulation should be of minimum thickness as mention in the BOQ.
- Density of Material shall be between  $30 \pm 3 \text{ Kg/m}^3$ .
- Thermal conductivity of Oxide Acetate foam shall not exceed  $0.029 \text{ W/mK}$  at mean temperature of  $0^\circ \text{C}$  and  $0.35 \text{ W/mK}$  at  $27 \pm 2 \text{ Deg C}$ .
- Insulation material shall be UV resistive, anti-microbial and anti-fungal with zero rating fungal growth as per ASTM –G -21
- Insulation material should not have any effect of acids and alkalis as per IS:9845-1998
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class ‘O’.
- Water vapor permeability shall be negligible as per DIN EN ISO : 12572 , i.e. Moisture Diffusion Resistance Factor or ‘ $\mu$ ’ value should be minimum 12800.
- The insulation material passes Smoke and Toxicity test as per (IMO Resolution MSC -307 (88) (2010 FTP Code): Annex 1: Part 2
- Material shall be CFC/ HCFC free as per US EPA 5021 A(2014 ).

**b. Recommended Adhesive**

Adhesive used for sealing the insulation shall be based on polychloroprene with special rosin and tacky fire. The adhesive shall be R-242 grade nonflammable in dry form and solid 26% ( $\pm 2\%$ ) with heat, water & chemical resistance with the determination of ASTM-D 903, ASTM-D 3960 ( $\leq$  **less than** or equal to  $264 \text{ gm/ltr.}$ ). The application method of adhesive strictly follows as per adhesives manufacturer’s technical data sheet.

**Following installation procedure should be adopted:**

- The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.
- The pipes shall be treated with coats of adhesive properly.
- The insulation preformed section shall be fixed tightly to the surface taking care to seal all joints with 50mm wide aluminum adhesive tape (transverse and circumferential). (If any)
- The insulation shall be tied with PVC band not less than 6mm width and 25 Gauge 4 bends per meter or equivalent plastic band using G.I. sheet clamp crimped at the joints.

**c. Duct-in-Line Thermal Insulation**

External thermal insulation shall be provided as follow:

- The duct insulation Basic material shall be cross linked closed cell Oxide Acetate Foam. Insulation should be of minimum thickness as mention in the BOQ.

- The duct insulation shall be with Factory pre-laminated Aluminium foil for mechanical protection where the men approach to damages the Oxide Acetate foam surface. Insulation should be of minimum thickness as mention in the BOQ.
- Density of Material shall be between  $30 \pm 3 \text{ Kg/m}^3$ .
- Thermal conductivity of Oxide Acetate foam shall not exceed  $0.029 \text{ W/m.K}$  at mean temperature of  $0^\circ\text{C}$  and  $0.35 \text{ W/mk}$  at  $27 \pm 2 \text{ Deg C}$ .
- Insulation material shall be UV resistive, anti-microbial and anti-fungal with zero rating fungal growth as per ASTM –G -21
- Insulation material should not have any effect of acids and alkalis as per IS:9845-1998
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class ‘O’.
- Water vapor permeability shall be negligible as per DIN EN ISO : 12572 , i.e. Moisture Diffusion Resistance Factor or ‘ $\mu$ ’ value should be minimum 12800.
- The insulation material passes Smoke and Toxicity test as per (IMO Resolution MSC - 307 (88) (2010 FTP Code): Annex 1: Part 2
- Material shall be CFC/ HCFC free as per US EPA 5021 A(2014 ).

**Following installation procedure should be adopted:**

The thickness of the cross linked closed cell Oxide Acetate Foam shall be as mentioned below and in the in the schedule of quantity. Following installation procedure should be adopted:

- Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.
- One coat Adhesive must be allowed to tack on the surface of the ducts to dry and then press surface firmly together starting from one end and working towards centre.
- Measurement of surface dimensions shall be taken properly to cut Oxide Acetate Foam sheets to size with sufficient allowance in dimension.
- Material shall be fitted under compression and no stretching of material should be allowed.
- A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface.
- When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.
- All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.
- The adhesive shall be strictly as recommended by the manufacturer.
- The detailed Application specifications are as per the manufacturer’s recommendation.

**RECOMMENDED THICKNESS OF CROSS LINKED CLOSED CELL OXIDE ACETATE FOAM BASED UPON DUTY CONDITIONS FOR COASTAL AREAS**

Supply air duct (Line temperature : 14 Deg C)	Use 25 mm thickness
Return air duct (Line temperature : 22 Deg C)	Use 9 mm thickness

### RECOMMENDED THICKNESS OF CROSS LINKED CLOSED CELL OXIDE ACETATE FOAM BASED UPON DUTY CONDITIONS FOR NON-COASTAL AREAS

Supply air duct (Line temperature : 14 Deg C)	Use 19 mm thickness
Return air duct (Line temperature : 22 Deg C)	Use 9 mm thickness
Supply Air Duct in Return Air Path (Line Temp. 14 Deg.C)	Use 9 mm thickness

#### d. Acoustic Duct Lining

Acoustic material for Duct Acoustic Lining basic material shall be open cell oxide acetate foam. The Thermal conductivity of Oxide acetate foam for air-conditioning application shall not exceed 0.029 W/m K at 0 deg C mean temperature and 0.35 W/mk at 27±2 Deg C and average Noise Reduction Coefficient (NRC=0.50 for 10mm, NRC =0.65 for 15mm and NRC =0.84 for 25mm thickness at frequency range from 125 Hz to 4000Hz ). The density of Acoustic material shall be between 30 to 60 kg/m<sup>3</sup>.

#### The installation guideline for Acoustic Isolate Foam in Duct Acoustic Lining:

- The inside duct surface should be cleaned with suitable solvents and rendered free from all physical and chemical impurities. Thoroughly clean the entire surface with denatured alcohol. This must be done for new sheet metal in order to remove the oil residue off the entire surface.
- The Use of retaining pins is not required when using Rubber based adhesive.
- Measure all sides of the duct, then adding 5 mm approximately to the measurement to ensure a compression fit, cut isolate foam accordingly.
- Using an adhesive roller or a short, stiff bristle brush, apply a thin, uniform coat of adhesive to both the isolate foam as well as to the metal duct surface. Be certain there is 100% coverage on both surfaces.
- Once the adhesive is tacky (finger nail test) the top piece should be adhered. Start at one edge of the duct & align the outside edge of the Acco foam down to the duct. Continue along, applying pressure to the entire length & press firmly. When approximately 90% adhered, align the opposite edge tightly against the duct & press firmly, then press balance of foam flat.
- This will ensure a tight compressed fit at the edges when all the Acco foam has been applied.
- Be certain to apply full, even pressure along the entire surface with your hands or a weighted roller for best adhesion.

#### e. Exposed Duct Thermal Insulation

Duct insulation shall be applied as follows:

- Apply hot bitumen 85/25 over the surface after cleaning the ducts.
- Rigid extruded polystyrene 50 mm thick insulation material to be fixed tightly to the surface with joints well butted and secured.

- Cover the insulation with 24 gauge x 19 mm GI wire mesh with necessary overlapping.
- Apply 2 layers of 1:3 sand cement plaster mixed with water proofing compound each of 10 mm thickness achieving smooth surface finish.
- Apply 2 coats of synthetic paint of approved shade.

**f. Exposed Roof Thermal Insulation**

- The Under Deck insulation basic material shall be cross linked closed cell Oxide Acetate Foam
- Insulation should be of minimum thickness as mention in the BOQ.
- The insulation material shall be with Factory pre-laminated Aluminium foil.
- Density of Material shall be between  $30 \pm 3 \text{ Kg/m}^3$ .
- Thermal conductivity of Oxide Acetate foam shall not exceed  $0.029 \text{ W/m.K}$  at mean temperature of  $0^\circ\text{C}$  and  $0.35 \text{ W/mk}$  at  $27 \pm 2 \text{ Deg C}$
- Insulation material shall be UV resistive, anti microbial and anti fungal with zero rating fungal growth as per ASTM –G -21
- Insulation material should not have any effect of acids and alkalis as per IS:9845-1998
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class ‘O’.
- Water vapour permeability shall be negligible as per DIN EN ISO : 12572 , i.e. Moisture Diffusion Resistance Factor or ‘ $\mu$ ’ value should be minimum
- The insulation material passes Smoke and Toxicity test as per (IMO Resolution MSC - 307 (88) (2010 FTP Code): Annex 1: Part 2
- Material shall be CFC/ HCFC free as per US EPA 5021 A(2014 ).

**Application**

Under-deck surface of ceiling shall be cleaned with brush to remove all dirt, cement etc. If the surface is uneven it should be made smooth prior to carry out Insulation work. A layer of rubber based adhesive (Zero flame , UL listed – Pedilite SR 998 or Magic 81-10) should be applied on the ceiling with help of brush so that all the pores are filled & surface becomes smooth & allow it to dry.

Insulation material sheet of specific size (1.5mtr x 2mtr ) & ceiling surface shall have all over adhesive coverage.

A thin film of adhesive shall be applied on the ceiling with brush & then on the plain side of the insulating material with brush/small piece of sheet metal having smooth edges. When adhesive is tack dry, insulating material sheet shall be placed in position, pressed firmly & no gap shall be left.

During installation avoid air bubbles. Always apply pressure while fixing the insulation sheet, this action will ensure maximum bond strength.

Insulation material shall be fixed under compression, no stretching of material shall be permitted.

Once insulation material sticks with ceiling, fastener shall be applied at gap of every 400 to 500 mm distance to provide the permanent fixing of insulation material with ceiling. To



avoid the risk of screw head going right through the insulation material, insulation fixing washer of minimum 60 mm diameter shall be used.

**g. Fire Breaks in Insulation**

Fire breaks shall be provided in all ducts (for internal lining / External thermal insulation) after a run of 10 M (Centre to Centre). Fire breaks in insulation simply mean that there will be a discontinuity of the insulating material in form of a MS angle of a minimum of 50mmx50mm x 3mm size. At the interface of the MS angle and the insulating material, proper care of tucking in of the insulating material shall be taken, so as to prevent erosion.

**h. Preamble to Mode of Measurement**

**IS 655 / SMACNA (AS ASKED FOR IN THE BOQ) SHALL BE ADOPTED FOR THE CONSTRUCTION PROCEDURES/ SPECIFICATIONS IN DUE ESSENCE OF THESE GUIDELINES ALSO.**

- All equipment described hereafter, shall be in accordance with the specifications.
- All equipment shall be selected and installed for the lowest Operating noise level.
- Supply of various equipment shall include all expenses for correspondence with manufacturers, submission of shop drawings, documents and their approval by the Consulting Engineer, procurement of equipment, transportation, shipping, payment of all taxes and levies, storage, supply of equipment at the point of installation, furnishing all technical literature required, replacement of defective components, and warranty obligations for the individual equipment.
- Installation of various equipment shall include all material and labor associated with hoisting and lowering of equipment in position, insulation of the components and vibration isolation as required, grouting and anchoring or suspension arrangements and all incidentals associated with the installation as per the specifications and manufacturer's recommendation.
- Vibration isolators as specified or as recommended by the manufacturer shall be installed with each component. Performance ratings, power consumption and power data for each component shall be verified at the time of testing and commissioning of the installation, against the data submitted with the tenders.
- Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.
- Testing and commissioning shall include furnishing all labour, materials, equipments, instruments, and incidentals necessary for complete testing of each component as per the specifications and manufacturer's recommendations, submission of test results to the Consulting Engineer and obtaining their approval and submission of necessary documents and completion drawings.
- All ducts shall be fabricated and installed conforming to the relevant Indian standards, approved shop drawings and the specifications.
- Duct installation shall include fabricating and installing the ducts, splitter dampers, turning vanes, and distribution grids within the ducts in position, and providing, installing and making air tight all joints with slips, bonded felt insertions, nuts, bolts and screws as required. In addition multi-louvered manually adjustable dampers shall be provided in various branch ducts as required or shown on drawings for proper balancing of air flows.
- All registers and diffusers shall be provided with a soft continuous rubber gaskets between

their periphery and the surface on which these have to be mounted.

- Registers and diffusers shall be given, at the factory, a rust resistant primer coat and enamel paint finish of approved color.
- After completion of the installation, the entire air distribution system shall be tested for air leaks and balanced in accordance with the specifications.

**i. Mode of Measurement**

The mode of measurement for the various item, unless otherwise specified, shall be as follows:

**Ducting**

- Payment for ducting shall be made on the basis of the external surface area of the ducting including all material and labor for installed duct.
- The rates per sq. ft. of the external surface shall include flanges, gaskets for joints, bolts and nuts, duct supports and hangers, vibration isolation pads or suspenders, flexible connection, inspection doors, dampers, turning vanes, and any other item which will be required to complete the duct installation except external insulation and acoustic lining.
- The external area shall be calculated by measuring the overall width and depth (including the corner joints) in the center of the duct section and overall length of each duct section from flange face in case of duct lengths with uniform cross section. Total area will be arrived at by adding up the areas of all duct sections.

- In case of taper pieces average width and depth will be worked out as follows;

**W1** = Width of small cross section **W2** = Width of large cross section **D1**

= Depth of small cross section **D2** = Depth of large cross section

Average width =  $(W1 + W2)/2$

Average Depth =  $(D1 + D2)/2$

- Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct sections fitted with angle iron flanges, otherwise at the bottom of the flange where flanges are of duct sheet.
- For the circular pieces the diameter of the section mid-way between large and small diameters shall be measured and adopted as the mean diameter for calculating the surface at the taper piece.
- For the face length of taper piece shall be the mean of the lengths measured face to face from the centre of the width and depth flanges.
- Duct measurements for calculation of area shall be taken before application of insulation.
- For the special pieces like bends, branches, and tees etc. same principle of area measurement as for linear lengths shall be adopted except for bends and elbows, the length of which shall be the average of the lengths of inner and outer periphery along with curvature or angle of the piece.

**Duct Insulation**

This item is provided separately for various thickness and shall be paid for on area basis of un-insulated duct. The area of the duct to be insulated shall be measured before application of insulation.

## 4.0 VENTILATION SYSTEM & ASSOCIATED WORKS

### 4.1 PROPELLER FAN

- a. Fans shall be of the ring-mounted type and the blades constructed from heavy gauge metal. An aerodynamically designed bell mouth constructed from heavy gauge metal shall be provided. The fan speed shall not exceed 1450RPM at 50Hz operation.
- b. Propeller fans shall be direct driven type, the motor either a single-phase capacitor start-run or a three-phase squirrel cage induction type. The motor shall have inbuilt inherent protection against overloading. Motor with shaded pole or centrifugal switch type is not acceptable
- c. Bearings shall be maintenance free permanently lubricated type. Fans shall be complete with wire guards. External grilles, fan chambers and volume control damper shall be provided where indicated in the specification drawings.

### 4.2 IN-LINE CENTRIFUGAL DUCT FAN

- a. Fan shall be of SISW, **backward** curved centrifugal, direct driven type.
- b. Casing shall be of Galvanized steel with Oven-baked epoxy coating. Impeller material shall be either Galvanized Steel or Glass Reinforced Polypropylene
- c. Motor shall be external rotor type for power supply 220~240V/50Hz/Single Phase.

### 4.3 AXIAL FLOW FANS (DIRECT DRIVE)

- a. Fans shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal.
- b. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51- 1985 “Laboratory.
- c. Method of Testing Fans for Rating” and AMCA 300 “Reverberant Room Method for Sound Testing of fans”.
- d. Casing shall be constructed of heavy gauge sheet steel. Casing shall be provided with hinged door enabling easy replacement of wheel, shaft and bearings. A small inspection door with handle and neoprene gasket shall also be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts.  
Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be de-rusted, cleaned, primed and finish coated with enamel paint.
- e. Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be in accordance with applicable standards. The speed of fan shall be as per OEM. However it is desired that speed shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1450 RPM for fans with impeller diameter of 450 mm and less.
- f. Base shall be provided for each fan. Base for both fan and motor shall be built as an integral part and shall be mounted on a concrete foundation through cushy foot vibration isolators. The concrete foundations shall be at least 15 cm above the finished floor level and shall be further isolated from the structural floor through 5 cm. Thick layers of sand all around, topped with bitumen. In case ceiling hung fan within the ceiling shall be provided Vibration Isolation Suspension (VIS) shall be provided in each of string.
- g. Fans shall be oven-baked with polyester coating for minimum thickness of 60 microns or hot-dipped galvanized.
- h. Fan motor base support shall be properly secured (locked and sealed) to the fan housing and

be of adjustable type to have precise control of motor shaft central position as well as running clearance between blade tips and casing.

- i. Fans supplied shall be complete with factory fabricated mounting bracket (ceiling or foot mounted) and suction/discharge matching flanges as accessories.
- j. All hubs shall be cast Aluminium alloy (Grade LM2) unless for Smoke spill Fans where high temperature (250°C, 2.0 Hr. Fire Duty) air is expected then Aluminum alloy or steel fan impeller blades are required. Otherwise impeller blade material with Polypropylene (PP), Glass-reinforced Polypropylene (PPG) and Glass-reinforced Polyamid (PAG), to provide self-balancing, anti-static, anti-sparking characteristic is preferable. Fan blade mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided.
- k. Running clearance between blade tips and casing shall not exceed 1% of the impeller diameter, and 2% for smoke spill high temperature fan where mechanical expansion coefficient is different from normal ambient temperature. Fan manufacturer shall provide the fan assembled with the same clearance between blade tips and casing of the tested prototype. Note that the air performance and pressure loss are greatly affected by this clearance.
- l. Impellers shall be secured to the drive shaft by a key and keyway. Axial location shall be provided by a collar or shoulder on the drive shaft together with a retaining washer and screw fitted into a tapped hole at the end of the shaft and locked in position. Blades shall be secured in place to the angle setting by setscrews, locking nuts or setting pins.

#### **4.4 AIR WASHER–PACKAGED TYPE**

##### **4.4.1 Scope of Work**

Supply, installation, testing and commissioning of packaged type air washer as per specifications. Manufacturer's product data for review shall be supplied for certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

##### **4.4.2 General Requirements**

- a. Statically and dynamically balance rotating parts
- b. Construction to permit complete servicing without breaking any connections
- c. Provide flanged pump connections
- d. Provide mono–block pumps/submersible and strainers of adequate capacity.

##### **4.4.3 General**

The Evaporative Cooling Machine will be self contained and will consist of the following component parts listed in the following paragraphs. The entire unit shall be WEATHER PROOFED and Highly CORROSION PROTECTED with 18 Ga SS 304 with FRP lining shall be provided to all the sections or automotive paint, as hereinafter specified. The unit shall have a horizontal submersible/monoblock self priming pump assembly to provide recirculate tank water and a pressurized flow via a piping system for proper pad (Munter) and media water distribution. The unit shall be factory fabricated.

#### **4.4.5 Blower Section**

The blower section shall include Centrifugal Forward Curved DIDW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be mounted C Channel frame and Cushy Foot Mounts or as per OEM standard. The fan shall have a capacity not less than the one specified in the catalogues and shall be constructed and rated based on delivery against the rated static pressure with the media and filters in place. The fan will be of riveted construction and made with GI sheet of required thickness. The fan wheel will be of the multiblade type and mounted on two self aligning pillow block bearings of the requisite size. The fan shall be run with the help of “V” Groove drives as per the recommendation of the drive supplier. The blower housing will be of the pittsburg joint construction and the drive will be provided by a motor of adequate capacity. The motor plate will be constructed out of 12 Ga MS or heavier metal with slotted holes which permit belt adjustment in both the directions. The material used will be 16 Ga GI. The outlet velocity of the blowers will be kept low.

#### **4.4.6 Evaporative Section**

The wet section will have 16 Ga GI Tank with folded construction with the bolted openable sides in 16 Ga GI sheet. The section will be of welded construction. 300 mm thick Cooling pads (Munter) will be provided designed @ 2.5 m/s to give 90% adiabatic efficiency. 2mm thick FRP specially fabricated header will be provided for the water distribution using 20 mm PVC perforated piping. All wet sections will include 5 layer 30 micron Aluminum Wire mesh filters of 50 mm thickness including the mounting channels for the same. 15 mm Brass Bleed off cock, 20 mm heavy duty Brass Float. PVC drain/overflow and bleed off outlet are standard on all wet sections.

18 Ga SS 304 with FRP lining shall be provided to all the sections or automotive paint.

Double/Single skin construction similar to air handlers (except for internal sheet which shall be SS 304 with FRP lining/automotive steel) shall be provided. If double skin than Panel will be 43+/-2 mm thick. Wherever exposed to atmosphere., otherwise the panel thickness shall be 23 +/-2 mm thick.

### **4.5 AIR SCRUBBER DRY TYPE (KITCHEN SCRUBBER)**

#### **4.5.1 Scope of Work**

The specification for package type dry scrubber for kitchen exhaust covers the design requirement, constructional feature, supply, installation, testing & commissioning. It shall have electrostatic air cleaner, Activated Carbon Filter Bank Unit as Odor Absorber Section, Automatic Wash Unit & Detergent Tank as specified in the BOQ. Odor Absorber Section.

#### **4.5.2 Type**

The unit shall be modular in construction and shall have individual sections of inlet, pre- filter, Dust collector section. Unit shall be supplied with control panel and one point wiring.

#### **4.5.3 Principle of Operation**

The pre-filter shall remove of large grease particles. The electronic filter shall remove the smaller grease and smoke particles. The principle of operation shall be based on electrostatic deposition. The particle shall pass by an ionizing wire, which will induce a positive charge on the particle. The particle then shall pass between closely spaced aluminum plates, which are held at a positive charge and a ground. As the charged particle travels between the two aluminum plates it shall be forced away from the plate held at the identical polarity and drawn towards the grounded plate. Once attached the particle shall remain on the plate until cleaned off during washing.

#### **4.5.4 Equipment Specification**

The air filtration system shall be a modular system. Multiple units can be joined together for increased volume. The system shall be a single pass. Particulate filtration efficiency shall be evaluated on the basis of ASHRAE 52-72 & DOP Test Method. The specified unit shall have demonstrated a removal efficiency of at least 95% and above. Ozone Generation concentration shall not exceed 0.05 PPM.

#### **4.5.5 Housing**

Housing shall be 16 gauge (1.6mm) Electro galvanized steel with powder coat / PU paint finish construction. Each section shall include single door access, located on one side of the unit. The access door shall be mounted on hinges and secured with appropriate arrangement allowing for component access and removal. All doors shall be gasketed to prevent air and water leakage. High voltage contacts on the housing shall be made of appropriate material like phosphor/bronze etc. Enclosure for electrical components shall be included to prevent leaks to the power supply. Unit shall have flanges / collar on the inlet and outlet for connecting ductwork. Unit shall be provided with appropriate drainage arrangement. Electrical contacts shall be in the door for ease of maintenance. Each unit shall have track guides for proper alignment of cell, making it possible to change the direction of airflow by reversing the orientation of electronic collector cell(s).

#### **4.5.6 Finish**

The external casing finish shall be a durable industrial grade semi gloss Baked on epoxy ester / PVC / Nylon, not less than 3-mil minimum thickness or PU paint finish with same thickness. The pre-filter shall be Washable type Honeycomb filters of Aluminum mesh are used to optimally remove larger particles of grease and dust before the main filter and shall be secured in stainless steel frame. Face of each prefilter shall be min 2.75 square feet.

#### **4.5.7 Pre-filter**

Access to the prefilter shall be from the side through the same hinged door to gain access to the electronic cells. Separator section shall be designed for an equal airflow across the entire Air cleaning unit.

#### **4.5.8 Electronic Cells**

Electronic cells described in this section refer to a full size cell. Half size shall not be acceptable. Ionizing-Collecting cell shall be of one-piece construction min 254 mm deep in direction of

airflow. Face area of each cell shall be min 0.24 square meters and the effective collecting area min 44 square feet (4.1 square meters). Frame- All support framing, end plates and ionizer ground electrodes shall be 0.080-inch (2.03-mm) thick stainless steel 316 and the distance between each plate should not be more than 7 mm. Handle shall be located on the side of the cell for removal of the cell from the air cleaner. The handle shall be grounded to the frame of the cell. Contacts shall be made of any suitable material like phosphor bronze or eq. on the front of the cell. They shall make contact with the ionizing, collector and ground sections of the cell.

#### **4.5.9 Ionizer Section**

Ionizing wires shall be minimum of 8 per electronic cell, with a length of min 15.35 inches (390 mm) each. Ionizing wires shall be constructed of 0.010 inches diameter (0.25 mm) Tungsten for prevention of corroding or breaking. Wires shall be fixed at one end and spring mounted on the other for ease of maintenance. There shall be min 7 grounding plates between the wires stabilize the ionization field for better performance. Grounding plates shall be no greater than 1.89 inches (48 mm) apart, and 0.07 inches (1.8 mm) thick. Insulators for the Ionizer shall be made of Teflon.

#### **4.5.10 Collector Section**

Grounding plates shall be a minimum of 0.02 inches (0.5 mm) thick aluminum. The plates shall be 9.65 inches (245 mm) deep in the direction of airflow.

Grounding plates shall be a minimum of 23 quantities per cell. Spacing between grounding plates shall be at 0.67 inches (17 mm). Spacing between the grounding plates and the charged plates shall be at not more than 7 mm. Charged plates shall be a minimum of 0.02 inches (0.5 mm) thick of Stainless Steel 316. The plates shall be 7.68 inches (195 mm) deep in the direction of airflow. Separator rods shall be made of Stainless Steel 316 with notches to hold the ground and charged plates apart at given lengths. Rods shall be 0.47 inches (12 mm) in diameter. The separator rods shall run the length of the cell to the frame of the cell. There shall be at least 12 rods total per cell. Insulators for the collector shall be made of PTFE (Teflon). Markings shall be on the cell to inform indicating direction of the airflow.

#### **4.5.11 Power Supply**

Power supply shall be of a 100% solid state type. Power supply shall be mounted within the air cleaner out of the air stream. Input voltage shall be 220 Volt, 50 HZ, 1 phase. Output High frequency with built in short circuit and arc protection, providing a dual high voltage output of (+) 12 KVDC for the ionizer and (+) 6 KVDC for the collector. The Power Supply shall be of capable of min 120 watts and 10 mA. The power supply shall operate over a temperature range of -20 to 140 degrees F (-38 to 85 degrees C).

#### **4.5.12 Fan**

The blower shall be Centrifugal Backward Curved DIDW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be mounted on C Channel frame and Cushy Foot or Spring Mounts. Each Scrubber shall comprise of one / two no. fans to handle air quantities as stipulated in BOQ. Each fan shall be driven by suitable HP TEFC motor. The fan wheel will be of the multiblade type and mounted on two self-aligning pillow block bearings of the requisite size. The fan shall be run with the help of "V" Groove drives as per the recommendation of the drive supplier.

#### 4.5.13 Motor

The TEFC motor shall be suitable for  $415 \pm 10\%$  volts, 3 phase,  $50 \text{ Hz} \pm 5\%$ , A.C supply. The motor shall be with class B/E insulation confirming to IS 325. The motor speed shall be 1440 RPM maximum designed and guaranteed for continuous operation at the nameplate rating. It should confirm to IP 55.

#### 4.5.14 Installation

The fans, scrubber etc. shall be provided with necessary vibration isolation cushy foot mounts. All necessary accessories such as nut bolts etc. shall be arranged by the contractor. The contractor shall arrange his own labour with material for completion of assembly.

The contractor, if specifically specified in bill of quantities, shall cast the RCC foundations for equipment. Anti-vibration pads of adequate efficiency shall be provided.

#### 4.5.15 Testing

The AC contractor shall compute the unit air quantity with the help of velocity meter. The computed results shall be tallied with specified capacities and power consumption shall be tallied with the indicated figures in the technical data furnished with the bid by the contractor.

All necessary instruments of proper accuracy and services needed for the tests required for the computation of capacities and power consumption as required by the Engineer shall be provided by the contractor at his own cost.

It shall also be the responsibility of the Contractor to supply the motors and starters to satisfy the local regulations pertaining to the limitation of starting current and indemnify the Department from all liabilities arising out of any objections raised by the local authorities in this regard.

#### 4.6 Air Curtain

- a. Air curtains shall be AMCA certified models.
- b. They must meet ASHRAE Standard 90.1-2019 and the NBC code.
- c. Air curtains shall help promote the perfect environment whether warm, cool or ambient.
- d. Air curtains shall promote open door trading in building and provides uninterrupted access for passing trade.
- e. Air curtains shall over open doors promote significant energy savings.
- f. Air curtains shall help to ensure a clean and healthy environment.
- g. Air curtains shall be easy to install and also easy to maintain throughout their serviceable life.

#### 4.6 VENTILATION FANS

The contractor shall supply install, test and commission ventilation fans wherever shown on the drawings and as scheduled. The system shall be complete in all respects and comply with the specification given.

- a. Fans shall be of the type, size, arrangement and capacity as indicated in the schedule and/or as shown on the drawings
- b. Unless specified, fans performance rating data shall be tested accordance with AMCA Standard 210-85 (Air Moving and Conditioning Association), ANSI/ASHRAE Standard 51-1985 "Laboratory Methods of Testing Fans for Rating". Sound ratings shall conform to AMCA Standard 300-85, "Reverberant Room Method for Sound Testing of Fans"
- c. A computer printout of fan performance rating corresponding to the AMCA licensed data,



- with corrected ratings for altitude and temperature, fan operating speed, bearing life, etc. shall be submitted for approval.
- d. All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly. A computer printout with the vibration spectrum analysis shall be attached to the fans.
  - e. Fan motors shall comply in all respects with continuous rating in accordance with IEC34 or equivalent. Motor bearings shall be of ball or roller type, grease or lubricant sealed for life. Fan and drive shall be earthed to prevent accumulation of static charge.
  - f. Kitchen exhaust fan shall be of bifurcated axial or SISW centrifugal direct or belt driven type. DIDW centrifugal and direct drive axial flow fan where belts or motor are in the air stream are not acceptable.
  - g. Fans for elevated temperature (smoke spill duty) with components rated for high temperature (250°C, 2.0 hrs duty, tested and certified by any independent international fire laboratory, certificate of conformity shall be provided for the same) service shall be provided.

#### 4.7 CENTRIFUGAL FANS

- a. Fans, forward or **backward** curved, SISW or DIDW, shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51- 1985 “Laboratory Method of Testing Fans for Rating” and AMCA 300 “Reverberant Room Method for Sound Testing of fans”.
- b. All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly.
- c. Fans shall be oven-baked with polyester coating for minimum thickness of 60 microns, unless the housing scroll and side frame is constructed from galvanized steel sheet (G.I.), Stainless Steel, Aluminum and etc.
- d. Fans must be physically capable of operating safely at every point of rating at or below the “minimum performance” limit for that class as defined in AMCA standard 99-2408-69 “Performance Class of Operating Limits for Centrifugal Fans”.
- e. Shafts shall be made of carbon steel (C45) machined and polished to tolerance of standard ISO 286–2–grade g6. Protective coat of anti-rusting shall be applied to all bare surfaces of the shafts at the factory.
- f. Bearings shall be of self-alignment (concentric) type with adaptor sleeve bearing. Bearings of eccentric locking collar with grub screw type are not acceptable. Bearing shall be maintenance free with permanently lubricated sealed ball bearing type. Bearing life shall be at least 75,000 hours based on basic rating life, L10 of ISO 281 standard. Calculation sheet of Bearing Life shall be submitted for approval.
- g. Motor installed shall be of a minimum 130% of the fan power absorbed (Brake horsepower) and shall have sufficient torque available for starting and continuous operation.
- h. Belts and pulleys shall be sized for a minimum 150% of the installed motor horsepower. The belt speed shall not exceed 30m/s. The pulley shall be of Taper Lock SPZ, SPA, SPB or SPC type. Conventional type of pulley is not acceptable. Both fan and motor pulley shall be balanced to the quality grade G2.5.

#### 4.8 VENTILATION UNITS (FAN SECTIONS)

- a. The scope of this section, comprises the supply, erection, testing and commissioning of double / single skin construction Ventilation units, conforming of these specifications and in accordance with requirements of Drawings & of the Schedule of Quantities.
- b. The Ventilation units shall be double /single skin construction, draw-thru type comprising of

various sections such as plenum chamber (wherever the Exhaust Air is ducted ) filter section and filter, fan section as per details given in Drawings and Schedule of Quantity.

#### 4.8.1 Capacity

The air handling capacities, maximum motor H. P., static pressure shall be as shown on Drawing and in Schedule of Quantity

#### 4.8.2 Housing / Casing (Single Skin)

The housing/casing of the air handling unit shall be of Double skin construction. The Frame work shall be of Extruded Aluminum hollow sections.

Frame work for each section shall be jointed together with soft rubber gasket in between to make the joints air tight. Suitable air tight access doors/panels with Nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on Rolled Formed GSS channel frame work .

#### 4.8.3 Motor and Drive

Fan motors shall be 415 for 10% volts, 50 cycles, 3 phase, squirrel- cage, totally enclosed fan cooled with IP - 55 protection. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type.

#### 4.8.4 Fan

The fan shall be **backward** curved, double inlet double width type. The wheel & housing shall be fabricated from heavy gauge galvanised steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame & pillow block heavy duty ball bearings.

The fan shall be selected for a noise level less than 80 db (A). The impeller & fan shaft shall be statically and dynamically balanced. The Fan outlet velocity shall not be more than 10.0 Meter/Sec. Fan housing with motor shall be mounted on a common base mounted in side the air handling housing on anti-vibration mounts. The fan outlet shall be connected to casing with the help of fire retardant fabric acting as a flexible connection for anti-vibration.

#### 4.8.5 Filters

Each unit shall be provided with a factory assembled filter section containing washable synthetic type air filters having extruded aluminium frame as specified in BOQ. The media shall be supported with HDP mesh on one side and aluminium mesh on other side. Filters face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Whenever fine filter are required to be installed, unit shall be provided with factory fabricated plenum chamber in double skin construction as described above for casing specification. The fine filter shall incorporate pocket filters which will have an efficiency of not less than 95% by ASHRAE standard corresponding to Eurovent standard EU-5.

#### 4.8.6 Safety Features

Each Ventilation Unit must have safety features as under:

- a. The Fan Access Door shall be equipped with micro-switch inter locked with fan motor to

- enable switching off the fan motor automatically in the event of door opening.
- b. The Access Door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.
- c. Fan and motor base shall be properly earthed from the factory
- d. All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

#### 4.8.7 Performance Data

Ventilation units shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicating shall be submitted and verified at the time of testing commissioning of the installation.

#### 4.8.8 Testing

Air-flow measurements shall be made by an anemometer and computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

### 5.0 ELECTRICAL ITEMS

This section deals with supply, installation, testing & commissioning of Motor Control Center (MV panel) & shall be manufactured by CPRI approved vendors. The power / control cabling & earthing work shall be carried out as per the specification given below:

#### 5.1 SCOPE

All work shall conform to Indian Electricity Act (amended up to date), I.S. code of practices local rules and regulations etc. Power cabling shall be carried out with approved make of cables as indicated in the **List of approved make of equipment / materials** and shall be of grade 1100 volts, PVC insulated & sheathed, armored aluminum conductors cables. Control cabling shall be of approved make and shall be of grade 1100 volts, PVC insulated & sheathed, copper conductor armoured multicore cables as specified in B.O.Q

#### 5.2 MOTOR CONTROL CENTER (MV PANEL)

Motor control center (MV Panel) floor mounted extendable type & wall mounted AHU sub-panel shall be fabricated out of 14G C.R.C.A. Sheet. These panels shall be cubical sectionalized type, totally enclosed dust & vermin proof. Gaskets shall be provided in all joints to prevent dust to reach the internals of the panels to make it completely dust proof. The degree of protections for panels shall be IP 52 for indoor applications and IP 55 for outdoor applications as per IS:2147.

These panel (MV) shall be suitable for voltages up to 500 volts, three phase 50 Hz, 4 wire supply capable of functioning satisfactorily in temperature ranging up to 45 to 50 degree centigrade and rupturing capacity suitable for connected load & design should be type tested for 42 KA fault level. All joints of panels shall be welded and braced as necessary to provide a rigid support for all components. The base channel provided in the floor mounted MV panel shall be 75mm high & a clear space of 200mm between the floor and the bottom most part of the unit shall be provided. The panel shall be correctly positioned. Self- threading screws shall not be used in the construction of control panels. Appropriate knock-out holes of proper sizes shall be provided for incoming and outgoing cables. The facility for bottom or top entry of cables in the panels shall be provided. Necessary cables clamps shall be provided for holding the cables in position.

All power/control wiring inside the panel shall be color coded and control wiring ferruled for identification purpose. All labeling shall be provided in engraved anodized aluminum strips on the front face of the panel.

Each circuit breaker shall be housed in separate compartments. It shall have steel sheets on top and bottom of compartment. The steel sheet hinged door shall be interlocked with the circuit breaker on the "ON" position. When the breaker is on the "ON" position, suitable preventive measures shall be provided, such as interlocks, to prevent the breaker from being drawn out. When the breaker is in "ON" position steel sheet shall be provided between the tiers in the vertical section. The door of this compartment shall not form part of the draw out arrangements.

### **5.2.1 BUS-BARS**

The bus-bar and its connections shall be Copper Electrolytic grade and shall be of rectangular section. The amperage capacity of Copper bus bar shall 1.25A / Sq. mm. These should be suitable for full load current for phase bus-bar and neutral bus-bar shall be of half rated current capacity. The bus-bar should have provision on either side for extension. The bus-bar should be sleeved with color coded heat shrinkable PVC sleeve. Bus-bar supports shall be of fibre glass reinforced thermosetting polyester having in built and tracking barriers to break the path of conducting dust through molded ribs.

In panels bus-bar connections shall be done by drilling holes with cadmium coated bolts and nuts. Extra cross section shall be provided to compensate drilling of the holes. Insulated aluminum strips of suitable size of full rated current capacity shall be used for interconnecting bus-bar and breaker.

A horizontal / vertical wire way shall be provided for interconnecting control wiring between different vertical sections.

The terminal blocks shall be used for outgoing terminals and neutral link at a suitable located place in the control panel. Separate compartments for outgoing and incoming cable shall be provided. The current transformers of all instruments shall be mounted with terminal blocks.

All live parts including incoming and outgoing link / terminals should be totally shrouded by means of non-hygroscopic and fire retardant material.

### **5.3 ROTARY SWITCH / SELECTOR SWITCH / SWITCHES / HRC FUSES / STARTERS / SINGLE PHASE PREVENTERS / TOGGLE SWITCH.**

These shall be of approved make and conforming to relevant ISI standard. The rupturing capacity of HRC fuses should not less than 80 KA and in case of switches it should be 60 Amps maximum.

### **5.4 CURRENT TRANSFORMER**

The current transformers shall have accuracy of class I and 5P10 / 10P10 and suitable VA burden for operation of the connected meters and relays.

### **5.5 OVERLOAD RELAYS**

All the motors shall have overload relay protections conforming to relevant IS.

### **5.6 TIME DELAY RELAYS**

These shall be adjustable type with time delay adjustments of 0-180 or as per manufacturer's standards.

## **5.7 INDICATING LAMPS AND METERING**

These shall confirm to BS37 & BS39. All meters shall be flush mounted and draw-out type. The indicating lamp shall be LED type.

## **5.8 MULTI FUNCTION METER**

Motor Control Center (MV Panel) shall have flush type MFM of class 1.0 as detailed in B.O.Q.

## **5.9 PUSH BUTTON STATIONS**

These shall be suitable for panel mounting and accessible from front without opening. These shall be provided for manual starting and stopping of motors/equipment as per normal practices. The contacts shall be suitable for 6A current capacity.

## **5.10 CONDUITS**

These shall be preferable made of mild steel, stove enameled from inside and outside with minimum wall thickness of 1.6 mm for conduits up to dia of 25mm and 2 mm for conduits above 25 mm diameter.

## **5.11 CABLES**

These shall be PVC insulated, pre-sheathed, copper conductor armored cables as per IS:694 and as per **list of approved make of equipment / materials**. Control Cables shall be multi-core PVC-insulated PVC sheathed copper conductor and armoured cables of approved make only.

## **5.12 LAYING OF CABLES**

These shall be laid as per Indian Standard code of practice. All cables shall be laid on existing cable trays. In case more than one cable is running, then proper space in between the two cables shall be provided to avoid loss of current carrying capacity. While cables are running on walls, proper saddles must be provided. Necessary accessories like cable termination Glands, requisite size Lugs and Ferrules for proper cable connection shall be provided.

## **5.13 WIRE SIZES**

Single stand PVC-copper conductor wires shall be used inside the control panel for interconnecting different components. All wires shall be neatly dressed and colored beads shall be provided for easy identification in control wiring. The minimum size of control wiring shall be 1.5 sq.mm, each HVAC ODU shall be given power supply through 16 sqmmX4C copper cable (by laying new cable) and each AHU shall be provided with a newly laid 6 sqmmX4C copper cable. Testing of panels as per code of practice shall be done at works by AC contractor before inspection & dispatch to site.

## **5.14 DRAWINGS**

Necessary drawings of all control panels and wiring of equipment etc., shall be submitted by the A.C contractor for approval of the Engineer in Charge. On final completion of job and before handing over of AC System As Built Drawings shall be submitted to the Department.

**5.15 TESTING**

The complete electrical installation shall be tested in accordance with relevant ISI codes in presence of Electrical Supervisor of the Department before commissioning of plant.

**5.16 PAINTING OF PANELS**

All sheet metal enclosures shall be powder coated only after de-rusting & hot-dip phosphate degreasing etc. at works only.

DFCCIL shall provide 3-phase 415V, 50Hz power at a single point ((ie. Sub-AC panel on terrace) for all VRF outdoor units. The tenderer shall lay all required XLPE armored cables, cable trays, necessary protection to connect all equipment on rooftop including VRF Outdoor Units from Sub AC Panel to ODUs. Electrical connections to individual IDUs shall be carried out with FRLS cables from DB on each floor.

**5.17 CAPACITY OF RELAYS AND CONTACTS**

The following capacity relays and contacts shall be used for various rating of motors:

a) 50/60 HP Motor	Star Delta Starter	65 Amp.	30 - 50 Amp.
b) 40 HP Motor	Star Delta Starter	45 Amp.	20-33 Amp.
c) 30 HP Motor	Star Delta Starter	45 Amp.	20-33 Amp.
d) 25 HP Motor	Star Delta Starter	32 Amp.	14-23 Amp.
e) 20 HP Motor	Star Delta Starter	32 Amp.	14-23 Amp.
f) 15 HP Motor	Star Delta Starter	25 Amp.	9-15 Amp.
g) 10 HP Motor	Star Delta Starter	16 Amp.	6-10 Amp.
h) 7.5 HP Motor	D.O.L. Starter	16 Amp.	9-15 Amp.
i) 5 HP Motor	D.O.L. Starter	16 Amp.	6-10 Amp.

**5.18 EARTHING**

System shall be complete with electrical panel board with cabling & earthing. The earthing of all equipments shall be carried out by Copper strips / wires. All panels / three phase motors shall be earthed with two number distinct and independent Copper strips / wires. HVAC ODU modules & AHU units shall be provided with 8 SWG GI wire for body earthing (double earthing to be provided). The earthing connections shall be connected to main earth station or main earth grid. The earth connections shall be connected to equipment's after removal of paint, grease etc.

The earthing of all equipment's shall be carried out by Copper strips / wires. All HVAC ODUS's and F.A.H.U's shall be provided with two different visible G.I Earthing wires of 8 SWG and the same wires shall be connected to the nearby earthing grid/mesh available. All panels / three phase motors shall be earthed with two number distinct and independent Copper strips / wires of the following sizes:

1. Motor upto 5.5 KW                      3 sq. mm Copper Wire

- |                       |                      |
|-----------------------|----------------------|
| 2. Motor 7.5 to 12 KW | 4 sq. mm Copper Wire |
| 3. Motor 12 to 50 KW  | 25x3 mm Copper Strip |
| 4. Motor 51 to 89 KW  | 32x6 mm Copper Strip |

The earthing connections shall be connected to main earth station or main earth grid. The earth connections shall be connected to equipment's after removal of paint, grease etc.

## 6.0 PRECISION AIR CONDITIONER (PAC)

### 6.1 SCOPE OF WORK

The Scope of Work covers the supply, installation, testing, commissioning and warranty of Precision Air conditioner (herein referred to as "product") and services provided for the same.

### 6.2 GENERAL

The AC Units should have high sensible heat ratios, to match the low latent loads of Computer/Server Rooms/ Switch room/UPS/VFD rooms. A Microprocessor controlled package AC system with **R-410A/407C refrigerant** shall have de-humidified air quantity of minimum 500 to 650 CFM/TR.

The cold aisle temperature shall be maintained at 22 Deg C and RH at 45% +/-5% at ambient temperature of 44 Deg C DBT.

The Indoor unit complete with Digital Scroll compressor with individual circuit (Mandatory), Evaporator blower & coil, Heater, Humidifier, Microprocessor controller, electrical switchgear components and Thermostatic expansion valve (TXV) and shall be housed in a single cabinet. The outdoor unit shall be comprised of Condenser fan, motor, fan speed controller (if applicable) & cooling coil.

The air-cooled precision Package unit shall be designed as per following conditions:

	Inside Design condition	21 deg C to 23 Deg C and 50% $\pm$ 5% RH
	Ambient air design temperature	44 Deg C
	Actual Capacity	As per requirement
	Flow Direction	Bottom discharge, tor return, based on BOQ
	Air inlet Temp & RH	Set Point $\pm$ 1 Deg C (DB) & Set Point $\pm$ 5% Return Air
	Air Quantity	500 to 650 CFM/TR
	Filters	Filters to be provided on the Package unit, having 95% efficiency down to 5 microns
	No of Compressor	12 kW to 34.2 kW – One Circuit (One Compressor) 37.6 kW to 68.4 kW – Two Circuit (One Compressor in each circuit)
	Type of load	High sensible heat load (Sensible head factor above 0.95)

- The Units shall be designed for 68-69 DBA at 1.5 meter from the unit outlet quiet operation with all moving parts mounted on anti-vibration mounting and carefully balanced to ensure minimum vibration.
- The unit shall be tested at site for performance rating before acceptance. Performance test

shall be a heat load test using heater supplied by the Precision unit supplier.

### **6.3 SYSTEM DESCRIPTION:**

Customer is proposed to have High Performance Precision type DX air-cooled units, which is of Floor discharge type. Precision AC units shall be of Variable capacity type. The cold & de-humidified air shall be pumped into the space between true floor and false floor and fed to the Equipments thru' floor grilles with Volume control damper.

The capacity of Equipment, specified is actual capacity at operating condition during peak summer. Package shall have the air-cooled condenser for 45 deg C ambient condition to avoid any de-rating during peak summer condition.

Room shall be air-conditioned with Variable Capacity Precision Air-conditioning Unit each of capacity (As per BOQ) & De-humidified air quantity of capacity (As per BOQ). The air-conditioning unit shall be designed specifically for high sensible heat ratio (>0.90) applications.

The system shall contain Digital Scroll compressor, Evaporator blower (Backward curved Centrifugal Fan with EC Motor) & coil, Heater, Humidifier, Specific De-humidification cycle, Microprocessor & electrical and Expansion valve all of which shall be contained within the cabinet of the unit. The outdoor condenser unit shall be air-cooled type comprising of coil, fan, motor and fan speed controller (Variex).

### **6.4 TECHNICAL SPECIFICATIONS**

The Precision Environmental Control Systems shall be of self contained factory assembled unit with down flow air delivery. The Precision Air conditioner shall be High sensible cooling capacity and high Sensible Heat Ratio (i.e. the sensible to total cooling capacity ratio).

#### **a. FRAME & CASING:**

The frame shall be constructed of 2.5, 2.0 and 1.2 mm folded galvanized steel. The external panels shall be constructed of 1.2mm zinc coated sheet steel. Front, rear and end panels shall be fitted with 25 mm glass fiber insulation, fire rated to Australian Standard 1530 (indices 0,0,0,3). The cabinet shall powder coated with charcoal grey color and have a texture finish. The hinged front panels shall be removable and include captive ¼ turn fasteners. The cabinet shall be assembled with pop rivets providing ease of disassembly.

#### **b. FILTER:**

The filter chamber shall be an integral part of the system and withdraw able from the front of the unit. Filtration shall be provided by dry media disposable filters capable of filtering air to 95% down to 5 micron efficiency and shall be replaceable from the top of the unit. Filtration shall be provided by deep V form G4 performance dry disposable media to ASI324.

#### **c. EVAPORATOR FAN:**

Units should be offered with backward curve direct drive Fan, High efficiency, external rotor electronically commutated (EC) motor with integrated electronics, True soft start



characteristics (inrush current lower than operating current), Backward curve, corrosion resistant aluminum fan wheel, Maintenance free design and construction. The fan section shall be designed for higher air flow. The unit shall be fitted with one (two, three) direct-driven, high efficiency, single inlet, backward curved; the fan motors shall be Electronically Commutated (EC), IP54, with internal protection and speed regulation via controller signal. They shall be statically and dynamically balanced.

**d. COMPRESSOR:**

One refrigeration circuit, incorporating a high efficiency, fully hermetic Variable Capacity Scroll Compressor (Digital Scroll) with crankcase heater. Two compressor machines must have independent circuit for each compressor. The compressor shall be charged with R407C. The compressor solenoid valve shall unload the compressor & allow the variable capacity operation, i.e. the Scroll compressor shall modulate its capacity from 20% to 100% without any frequency variation. Each compressor is equipped with pre-set high and low pressure switches for protection against high condensing and low evaporating temperatures. Each compressor shall have internal motor protection and be mounted on vibration isolators.

**e. REFRIGERATION CIRCUIT:**

The refrigeration system shall be of the direct expansion type and incorporate one compressor, complete with crankcase heaters for each circuit. The system shall include a manual reset high pressure control, auto reset low pressure switch, externally equalized expansion valve, high sensitivity refrigerant sight glass, large capacity filter drier and charging/access ports in each circuit. Each refrigeration circuit shall include rigidly mounted isolation valves in the discharge and liquid lines to aid servicing and installation.

**f. EVAPORATOR COOLING COIL:**

The evaporator coil shall be incorporating draw-through air design for uniform air distribution. The coil shall be constructed of rifled bore copper tubes and louvered aluminum fins, with the frame and drip tray fabricated from heavy gauge aluminum. All metal parts in contact with condensate shall be the same material to prevent electrolytic corrosion. The drip trays shall ensure the collection of condensate and be accessible for cleaning. The cooling coil shall be maximum of 4 rows and minimum 11 fins per inch and the face velocity shall not be more than 2.5 m/s.

**g. REMOTE AIR-COOLED CONDENSER:**

The Air-cooled condenser shall be the low profile, weatherproof type incorporating high efficiency, direct drive, external rotor motors with axial blade fans & fan speed controller. The condenser shall be constructed from heavy duty aluminum and corrosion resistant through special anti corrosive epoxy coatings for any specific polluted areas. Heavy duty mounting legs and all assembly hardware shall be included. Condensers shall be suitable for 24 hours operation and be capable of providing vertical or horizontal discharge. The condenser shall be fully factory wired and require a 230 volt, single phase, 50 Hz electrical service. The high performance heat exchanger shall include mechanically expanded cross-hatched copper tubes and louvered aluminum fins for maximum heat transfer.

**h. HUMIDIFIER:**

The humidifier shall be of the infrared type consisting of high intensity quartz lamps mounted above and out of the water supply. The humidifier pan shall be stainless steel and arranged to be removable without disconnecting high voltage electrical connections. The complete humidifier section shall be pre-piped, ready for field connection to water supply. The humidifier shall be equipped with an automatic water supply system and shall have an adjustable water-overfeed to prevent mineral precipitation. A high-water detector shall shut down the humidifier to prevent overflowing.

**i. ELECTRICAL HEATING:**

The electrical heating elements shall not operate at a level exceeding 60 W/Sq. m. The low watt density elements shall be of finned tubular construction. The heating circuit shall include dual safety protection through loss of air and high temperature controls. Electric heating shall be provided in a single stage. The elements shall be low watt density, 304/304 stainless steel fin tubular construction, protected by thermal safety switches. The heating system shall include dual safety protection through loss of air and manual reset high temperature controls.

**j. UNIT SIZE:**

Precision AC Indoor units shall be placed inside the Equipment room only. Hence the Footprint area of the Unit is extremely important to accommodate the same inside the existing Equipment Room. The unit shall require front access only for routine service and installation work.

**k. MICROPROCESSOR CONTROLLER:**

The unit control shall be factory-set for Intelligent Control which uses "fuzzy logic" and "expert systems" methods. Proportional and Tunable PID shall also be user selectable options. Internal unit component control shall include the following:

**l. SYSTEM AUTO RESTART**

The auto restart feature will automatically restart the system after a power failure. Time delay is programmable.

**m. SEQUENTIAL LOAD ACTIVATION**

On initial startup or restart after power failure, each operational load is sequenced with a minimum of one second delay to minimize total inrush current

**n. PREDICTIVE HUMIDITY CONTROL**

Calculates the moisture content in the room and prevents unnecessary humidification and dehumidification cycles by responding to changes in dew point temperature. The control shall be compatible with all remote monitoring and control devices. Options are Available for BMS interface via Modbus, BACNet and SNMP. The control processor shall be microprocessor based with a 128x64 dot matrix graphic front monitor display and control keys for user inputs mounted in an ergonomic, aesthetically pleasing housing. The controls shall be menu driven. The display & housing shall be viewable while the unit panels are open or closed. The display shall be organized into three main sections: User Menus, Service Menus and Advanced Menus. The system shall display user menus for: active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in % of each function, date and time), total run hours, various sensors and display setup and service contacts. A password shall be required to make system changes within the service menus. Service menus

shall include: set points, standby settings (lead/lag), timers/ sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards and diagnostics/service mode. A password shall be required to access the advanced menus.

**o. USER MENUS SHALL BE DEFINED AS FOLLOWS:**

**ACTIVE ALARMS**

Unit memory shall hold the 200 most recent alarms with time and date stamp for each alarm

**EVENT LOG**

Unit memory shall hold the 400 most recent events with id number, time and date stamp for each event

**GRAPHIC DATA VIEW**

Two graphic records shall be available: return air temperature and return air humidity

**UNIT VIEW - STATUS OVERVIEW**

Simple or Graphical. Unit View summary displays shall include temperature and humidity values, active functions (and percent of operation) and any alarms of the host unit.

**TOTAL RUN HOURS**

Menu shall display accumulative component operating hours for major components including compressors, fan motor, humidifier and reheat.

**MICROPROCESSORS SHOULD BE INTELLIGENT ENOUGH TO DO THE FOLLOWING TASK:**

- Save Energy using Predictive Humidity Control
- Built-in Lead/Lag Functions for enhanced system reliability
- Wellness Calculation alerts service personnel before problems occur
- Unit to Unit (U2U) Communications allows Lead/Lag and optional teamwork settings for maximum flexibility and control
- Optional IntelliSlot cards offer external monitoring through Modbus RTU and HTTP/SNMP protocols

**STANDBY SETTINGS/LEAD-LAG**

Menu shall allow planned rotation or emergency rotation of operating and standby units.

**TIMERS/SLEEP MODE**

Menu shall allow various customer settings for turning on/off unit.

**TEAMWORK MODES OF OPERATION**

It saves energy by preventing operation of units in opposite modes multiple units.

**AUXILIARY BOARDS**

Menu shall allow setup of optional expansion boards.

**p. DIAGNOSTICS/SERVICE MODE**

Control input and output values and status shall be displayed to aid in unit diagnostics and troubleshooting.

Control inputs shall be indicated as on or off at the front display. Control outputs shall be able to be turned on or off from the front display without using jumpers or a service terminal. Each control output shall be indicated by an LED on a circuit board.

The unit shall also incorporate the following protections:

- Single phasing preventers.
- Reverse phasing
- Phase unbalancing
- Phase failure
- Overload tripping (MPCB) of all components

**q. SAFETY INTERLOCKS:**

Operation of heaters & humidifiers shall be possible only when blower fan is in operation.

Fire detection signal from fire detector system shall be able to switch off the package unit operation in event of fire in conditioned space.

**r. REFRIGERANT PIPING:**

Each refrigerant circuit shall be suitable for operation on R-410A/407C and shall include the following items:

- a. Expansion valve with pressure equalization;
- b. Removable liquid line drier / filter.
- c. Liquid line sight glass with moisture indicator.
- d. Hand shut off valves.

**6.5 SEQUENCING OF OPERATION OF UNIT:**

The Precision AC units for the room shall be clubbed in individual group, so that Stand-by unit should start on after specific time of operation of working unit, as well as during break down of working unit. This sequencing operation feature should be integral part

**6.6 ELECTRICAL WORK:**

Each Precision AC unit should be provided with in-built electrical panel. Necessary 415 Volts +/- 10%, 3 Phase, 4 Wire (With Neutral), 50 Hz +/- 5% Power shall be provided by Customer at each unit's electrical panel. Balance distribution of Power is in the Scope of Bidder. All Electrical cabling should be of armored Copper.

**6.7 OEM of PAC:**

- Manufacturer should have experience in manufacturing & installation of Precision AC units in India for last 10 (Ten) years;
- Manufacturer should have ISO 9001, ISO 14001 Certification;
- Manufacturer should have fully equipped Service center (For Precision AC units) to give prompt & efficient service.

## **7.0 INSPECTION, TESTING AND COMMISSIONING**

### **7.1 SCOPE**

This scope covers initial inspection and testing of VRV/VRF system & AHUs at manufacturer's works, initial inspection of other equipments/ materials on receipt at site, final inspection testing & commissioning of all equipment at site & description of testing requirements & procedure.

### **7.2 INITIAL INSPECTION AT MANUFACTURER'S WORKS**

#### **7.2.1 Scroll Compressor**

- a) Salient features such as model, capacity control, type of lubrication etc. shall be verified against the requirements visually without opening the compressors.
- b) Manufacturer's internal test certificates shall be scrutinised to check compliance with the requirements as specified in the contract.
- c) Free running test shall be carried out at the speed for which the motor is available with manufacturer but the speed shall not be less than that specified in contract. This test shall be carried out for 30 minutes in open space. During this running test following operations are to be noted :
  - a) Manual operation of capacity control
  - b) Lubrication oil pressure

#### **7.2.2 Condenser**

- a) Salient features like number of tubes, inside diameter of tubes (from which the gauge of the tube can be verified), no. of passes, material of fins, length of condenser, provision of fittings like safety valve, water, gas connection shall be verified during stage inspection. The tube thickness shall be checked.
- b) Manufacturer's internal test certificates shall be furnished and it shall be verified against contract requirements.

### **7.3 Factory Testing:**

The complete unit shall be factory tested at 25%, 50%, 75% and 100% capacity and witnessed by *Representatives of the Engineer or as given in bid document* for performance at the rated conditions by simulating the actual design conditions. One unit of each capacity shall be tested.

All controls and switchgear shall be tested for proper functioning and set of design values.

The capacity in TR / kcal/hr shall be calculated from measurements. The power consumption shall be checked from current measurement of the motor. All calculated and checked results shall match the specified data within tolerances as stipulated by ARI.

All instruments and personnel for tests shall be provided by the contractor. Contractor shall inform the client about the testing schedule min. 10 to 15 days before the machine is ready for factory testing.

#### **7.4 Air Handling Units :**

- a) Salient features such as model, size, physical dimensions, and other details of various sections, fan motor details, fan dia, static pressure etc. shall be verified against the contract requirements.
- b) Manufacturer's internal test certificates for the motor and air handling unit shall be furnished and scrutinized as per contract requirements.
- c) Test certificate for static and dynamic balancing of the fan/ blower should be furnished. Fan balancing may be witnessed by Engineer-in- Charge or his authorized representative.
- d) Salient features like, type, material, no. and gauge of fins and tubes and no. of rows of cooling coil shall be furnished and verified with reference to contract requirements during stage inspection.
- e) Hydraulic pressure to the extent of 10 Kgf/sq.cm or pneumatic pressure of 21 kgf/ sq.cm shall be applied to cooling coil and this pressure should be maintained for 1 hour and no drop should be observed indicating any leaks.

#### **7.5 INITIAL INSPECTION AT SITE**

##### **7.5.1 Ducting:**

- a) The sheet used for ducting shall be checked for physical test at site. The physical test should include the sheet thickness and bend test as per relevant IS specifications.
- b) Zinc coating of GSS sheet as mentioned in the tender documents may be got tested from a laboratory to verify that same meets the contract requirements.

##### **7.5.2 Switch Gear, Control Gear, and Measuring Instruments**

These should be of specified make. For air circuit breaker manufacturer's test certificate shall be furnished by contractor and the same shall be verified as per contract requirements.

##### **7.5.3 Electric Motors**

Electric motors should be of specified make, manufacturer's test certificate for electric motor shall be furnished.

##### **7.5.4 Refrigerant Pipes**

- a) It should be checked that the same is as per makes specified in contract.
- b) Dimensions shall be checked for pipes against the requirements of contract.
- c) Insulation and acoustic lining
- d) Physical verification for thickness and make should be made as per contract before application of insulation.
- e) Manufacturer's test certificate for density, thermal conductivity, sound absorption and class of fire retardation wherever applicable should be furnished.

Note: Accuracy of testing instruments shall be as mentioned in the final inspection procedure.

## 7.6 FINAL INSPECTION

- i) After completion of the entire installation as per specification in all respects, the AC contractor shall demonstrate trouble free running of the AC equipments and installation for a period of minimum 120 hours of running. The plan will be said to have successfully completed the running-in period, if no breakdown or abnormal/unsatisfactory operation of any machinery occurs during this period.
- ii) The equipment capacity computations shall be carried out to verify the Tender Document requirements.
- iii) The Input KW of the unit / TR at full load shall also be checked against contract requirements, if any.
- iv) All instruments for testing shall be provided by the AC contractor . The accuracy of the instruments shall be as follows:
  - a. Temperature: Liquid in glass thermometer having accuracy + 1 deg. C as per IS: 4825.
  - b. Wet bulb Temperature : Sling psychrometer conforming to IS:6017.  
Scale Error:  
For less than 0 deg. C : 0.3 deg C + 0.2 deg. C. For over 0 deg. C :  
0.2 deg. C + 0.1 deg. C.
  - c. Pressure Gauge: With the accuracy of + 1% for maximum scale value from 10 to 90%, and + 1.9% for maximum scale value for rest of the scale conforming to IS: 3695.

## 7.7 TESTING REQUIREMENTS AND PROCEDURES

**7.7.1** Balancing of all air and water systems and all tests as called for in the specification shall be carried out by the HVAC contractor in accordance with the specifications and relevant local codes if any. Performance tests of individual equipment and control shall be carried out as per manufacturer's recommendation. All tests and balancing shall be carried out in the presence of Engineer-in-charge or his authorized representative.

The whole system balancing shall be tested with microprocessor based hi-tech instruments with an accuracy + 0.5%.

The instrument shall be capable of storing data and then down loading into a P.C. The HVAC contractor shall provide a minimum but not limited to the following instruments:

- i) Microprocessor based calculation meter to measure DB and WB temperature, RH and Dew point
- ii) Velo meter to measure air volume and air velocity
- iii) Pitot tube
- iv) Electronic rotary vane Anemometer
- v) Accubalance flow measuring hood

The contractor shall be responsible to provide necessary sockets and connections for fixing of the testing instruments, probes etc.

### 7.7.2 Air Systems:

Systems are to be balanced by first adjusting the total flow at the fan, then by adjusting main dampers and branch dampers. Only final minor adjustments are to be made with register and diffuser

dampers. Balancing of the air system shall be accomplished without causing objectionable air noise. Baffles and orifice plates required for proper air balance shall be furnished and installed by the contractor. Basically the following tests and adjustments are required.

- a) Test all fan systems to provide proper cfm/ cmh.
- b) Adjust fresh air, return air and exhaust dampers to provide proper air quantities in all modes of control.
- c) Test and record fresh air, return air and mixed air temperature at all air handling units. Test and record data at all coils after air and hydronic systems are balanced. Measure wet and dry bulb temperature on cooling coils.
- d) Make point tube transverse at all main supply and return ducts to set proper air quantities. Adjust all zone and branch dampers to proper cfm/cmh.
- e) Test and adjust each register, grills, diffuser or other terminals equipment to within 5% of design air quantity. Each opening shall be defined on the test report by size, manufacturer's model, room location, design cfm and actual cfm. Outlets shall be adjusted to minimize objectionable drafts.
- f) Test and record static pressure drop across all filters and major coils.
- g) High velocity duct systems shall be tested for leakage. If excessive or audible leakage is detected, the defect shall be repaired by the contractor. Sufficient static pressure readings shall be taken from the air handling units to the terminal units to establish system static pressure.

### 7.7.3 Balancing Tolerance:

Systems shall be balanced within the following tolerances ;

- i) Duct leakage Rates (at operating pressures) :
 

Low pressure ducts	5% of full flow (0 to 0.5 kPa)
Medium Pressure Ducts	1% of full flow (0.5 to 3 kPa)
High Pressure Ducts	1% of full flow (Greater than 3 kPa)
- ii) Air flow rates :
 

Under 70 L/S	10% of flow
Over/ at 70 L/S	5% of flow
- iii) Heat flow rates :
 

Heat exchangers	5% of design capacity
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#### Procedure:

Review all pertinent plans, specifications, shop drawings and other documentation to become fully familiar with the systems and their specified and intended performance.

Furnish equipment and instruct sheet metal trade on proper use for conducting duct leakage tests. Conduct first test as a way of instructing the above trades in the presence of the Department's representative.

Test relative barometric pressures in various building area, as deemed necessary by the Department's representative and at least in all areas served by different systems.

Test performance and continuously record on a 24 hour basis, temperature and humidity levels where control equipment is provided for that purpose in certain critical areas.



Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report shall be furnished by a qualified and authorized person.

#### **7.7.4 Reports**

Provide 3 copies of the complete balancing and testing reports to the department. Report shall be neatly typed and bound suitable for a permanent record. Report forms shall contain complete test data and equipment data as specified and safety measures provided to ensure safety of the operating personnel at all times.

#### **7.7.5 Final documentation**

The contractor shall leave the system operating in complete balance with air quantities as shown on drawings. Set stops on all balancing valves and lock all damper quadrants in proper position. Secure all automatic damper and valve linkages in proper positions to provide correct operating ranges. Proper damper positions shall be marked on ducts with permanent indication. Notify the department of any areas marginal or unacceptable system performance.

The above tests and procedures are mentioned herein, for general guidance and information only, but not by way of limitation to the provisions of conditions of contract and design/ performance criteria.

Upon commissioning and final handover of the installation, the HVAC contractor shall submit (within 4 weeks) to the engineer-in-charge/ department 6 (six) portfolios of the following indexed and bound together in hard cover ring binder (300 x 450 mm) in addition to the completion drawings.

- a) Comprehensive operation and maintenance manual
- b) Test certificates, consolidated control diagram and technical literature on all controls.
- c) Equipment warranties from manufacturers.
- d) Commissioning and testing reports
- e) Rating charts for all equipment
- f) Log books as per equipment manufacturers standard format
- g) List of recommended spares and consumables.
- h) Any special tools required for the operation or the maintenance of the plant shall be supplied free with the plant.

At the close of the work and before issue of final certificate of completion by the Engineer-in-charge, the contractor shall furnish a written guarantee indemnifying the department against defective materials and workmanship for the Defects liability period. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the department.

- i) Any defective material or equipment supplied by the contractor
- ii) Any material or equipment supplied by the department which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

### **8.0 COMPREHENSIVE ANNUAL MAINTENANCE CONTRACT (CAMC)**

- 8.1** The Contractor shall submit the Performance Guarantee (PG) in the form of Irrecoverable BG or DD amounting to 3% of the CAMC amount. Agreement for subject CAMC shall be executed between Contractor/OEM/Authorised Channel Partner of OEM and DFCCIL.

**8.2** Apart from PG, there will be a Security Deposit @ 5% of the CAMC contract value. Security Deposit may be deposited by the Contractor before release of first on account bill in cash or Term Deposit Receipt issued from Scheduled Bank, or may be recovered at the rate of 6% of the bill amount till the full Security Deposit is recovered.

**8.3** The scope of comprehensive annual maintenance contract includes carrying out all sort of Scheduled/unscheduled maintenance of complete HVAC system including Building Management System (BMS) and provision of Spares and consumables for the same as per OEM guidelines, National Building Code (NBC) 2016 guidelines and DFCCIL requirement. **All items covered in BOQ under Schedule (HVAC Works) are included in the scope.**

It mainly involves routine maintenance, repair/replacement of defective components, providing of spares and all other associated accessories which are not covered otherwise and attention to all types of defects, necessary for smooth operation of the system to the satisfaction of Engineer-in Charge/DFCCIL. The Contractor should also carry out any other schedule jointly decided by Engineer-in-charge/DFCCIL and the Contractor for any equipment of the HVAC system to ensure smooth and trouble-free functioning.

The period of Comprehensive AMC is Seven (07) years after completion of 12 months warranty period (maintenance period) and include timely supply/provision of all consumable items like Oil, Compressor Refrigerant etc.

**8.4** The Contractor shall carry out all checks and Preventive maintenance schedules like Daily, Weekly, Monthly, Quarterly Yearly, Hour based etc of the HVAC system including BMS. The maintenance schedules and the work to be done in each schedule & service report format shall be jointly decided by the Engineer-in-Charge/DFCCIL & the Contractor. Breakdown if any are also to be attended swiftly by the contractor.

**8.5** Quarterly Payment for CAMC Contract shall be made after submission of service report during the quarter jointly signed by the Contractor and by Engineer-In-Charge/DFCCIL. All the reports with summary shall be got approved from DFCCIL by Contractor. If the prescribed schedules/routine maintenance for the above CAMC are not carried out by the Contractor as jointly decided as per Para 8.3, the Contractor will not be entitled to get the full payment for this period and deductions shall be made on pro-rata basis as per weightage of the schedule as jointly decided within 07 (seven) days of commissioning/handover and decision of DFCCIL in this regard shall be final and binding.

**8.6 The CAMC work includes all items covered in the Schedule of HVAC work. It shall inter-alia include but not limited to following:**

- 1 Indoor Units (**IDUs**) including AHU of various type/size complete with electric/electronic components, wiring, power cord, remote & accessories.
- 2 Outdoor Units (**ODUs**) of various capacities complete with, compressors, piping, electric/electronic components, consumables, supports & any other associated work for proper & specified functioning of outdoor units.
- 3 Refrigerant piping including ducting along with all joints etc. including detection/repairing of leakage, pressure testing, vacuum purging, gas recharging/ topping including supply of refrigerant and repair of damaged insulation.
- 4 Regular cleaning of IDU filters and AHU filters (every 21 days) and replacement as prescribed by **OEM**. Wet cleaning of IDU's shall be done once in every 06 (Six) months and complete Dry cleaning of IDU, once in every 03 (three) month. Record of filter cleaning shall be maintained.
- 5 The repair and maintenance work shall be carried out in a professional manner with good industrial practice. This shall also include restoration of insulation after repair, any other

associated work for proper & specified functioning of air conditioning system. The scope also includes supply & charging of refrigerant due to any unforeseen circumstances.

- 6 Condensate drain water pipe cleaning, detection/repairing of these pipes for any leakages, insulation etc. any other associated work for proper and required functioning of drain water disposal system.
- 7 All control & power wiring between indoor & outdoor units.
- 8 Maintenance & upkeep of AC Electrical panels on the roof and other places including switchgear, cabling from the panel up to outdoor units, feeder pillars etc (excluding incoming cables to AC panels). This includes supply of consumables etc.
- 9 Maintenance of complete BMS, including all Controllers of HVAC, displays, hardware & software etc. including central remote control. Any other associated work for proper, required & specified functioning of complete BMS monitoring/control system.
- 10 In order to attend breakdown/maintenance of the HVAC system, minor civil works (eg. False ceiling, any kind of structural/masonry work, opening and closing) required if any, shall be in the scope of CAMC.
- 11 As soon as any defect of technical nature is noticed by the Contractors staff, it shall be informed to the Engineer-in-Charge/DFCCIL in writing with details, whether it is of minor or major fault and possible time of rectification.
- 12 Any other item/activities associated with proper functioning of complete HVAC system and BMS is deemed to have been included in the scope of work.

#### **8.7 Deployment of CAMC Staff:**

- a. The contractor shall depute trained, technically qualified, competent and experienced staff having required competency/licence in adequate number for the schedule/unschedule maintenance. Normally schedule maintenance should be carried out on Saturday & Sunday or any Gazetted Holidays for which the contractor will give at least 24 hours advice to the Engineer-in-Charge/DFCCIL.
- b. For health check, operational assistance, quick redressal of complaints regarding HVAC system and to maintain CAMC work record, one experienced Graduate/Diploma holder Supervisor along with one Technician (HVAC-ITI holder) and one Technician (Electrical-ITI holder) with necessary tools shall remain present from 8:00AM to 8:00 PM in DFCCIL-CO Building site during all working days with approval of DFCCIL will be taken for each staff. However if required, they can be called on non working days/ holidays/off hours also for which no extra payment shall be admissible. Necessary communication facility should be available with the staff deployed. In case of absence of any staff as mentioned above, the suitable replacement shall be provided otherwise penalty will be imposed as per Clause 8.9.
- c. Additional staff shall be deputed to reduce the downtime for attending major breakdowns as desired by DFCCIL.
- d. The work is to be carried out as per OEM guidelines/best industry practices and in such a manner that all premises always look Neat & Clean.
- e. The staff of contractor should be well behaved and should keep themselves in decent upkeep. The staff deputed should not be frequently changed and any change should be with consent of DFCCIL.

**8.8 Attending to complaints:**

- a. List of minimum spares with quantity, in addition to the list at Para (h) below to be available at site for smooth operation shall be prepared by the Contractor and Engineer-in-charge/DFCCIL within 07 days of start of work and accordingly all spares shall be made available within **07 days**. Further any spare considered necessary by DFCCIL to be also kept as per direction of DFCCIL. Must change spares with periodicity will be identified out of the the complete list of spare including those at Para h and same should be replaced accordingly.
- b. At start of CAMC work, the Contractor shall submit list of authorised contact person in ascending order of hierarchy (Escalation Matrix) to whom complaints can be lodged.
- c. All defects and deficiencies should be rectified promptly after lodging of complaint. The complaint can be lodged through intercom, telephonic message or through complaint register kept in BMS Room. A Complain number will be given for every complain and a Ticket would be raised for the same with the time mentioned. This mentioned time will be the reference for Response, Rectification time as detailed below and for calculation of penalty as per Para 8.9. The ticket will be got countersigned by DFCCIL representative immediately. The complaint will be closed jointly with DFCCIL representative when complaint is resolved to the satisfaction of the DFCCIL representative. The Complain register and Tickets to be preserved as per direction of DFCCIL. Detailed format of ticket shall be decided jointly by contractor and DFCCIL representative.
- d. Response Time (Max) – 30 Minutes, to reach the site of complaint.
- e. Rectification Time (Max.) -  
 03 Hrs. for minor fault and 24 hrs for major fault..  
 The minor fault after 16:00 hrs can be attended on next working day from 8:00 AM if allowed so by DFCCIL representative on request of contractor.  
 Emergency calls have to be attended as per directions of DFCCIL representative.  
 Major and Minor fault will be decided jointly within 07 days of start of work and can be modified later as per working experience. Decision of DFCCIL in this regard shall be final and binding
- f. The quantum of work involved should be decoded within 30 minutes of the complaint received and recorded jointly with the representative of the Contractor and Engineer-in-charge/DFCCIL.
- g. Status of spares shall be jointly signed on every Friday at 17.00 hrs & timeline submitted for replenishment, if required.
- h. For expeditious disposal of complaints, the contractor shall maintain following minimum spares & consumables at site. These spares shall be replenished as soon as the designated quantity gets used and it should not be beyond 07 (Seven) days. However if working of system is disrupted due to non-availability of any spare, penalty as per Para 8.9 will be imposed

SN	Description	Quantity
1	Refrigerant	4 cylinders
2	Nitrogen Gas	02 Cylinders
3	Condenser fan motor	05
4	Condenser fan blade	05

5	PCB – ODU	05
6	PCB – IDU and others	02 of each type
7	IDU Motor – Ductable	01 (each type)
8	Blower Ductable	01 set each type
9	MCCB/MCB 63A or as required	10
10	Contactor	05
11	Inverter/Digital compressor	02 each type
12	FAHU Motors of Different ratings	02 of each type
13	Water pump for IDU	02 each type
14	Water level sensor	02 each type
15	Capacitors ODU/IDU	05 each type
16	IDU motor (Cassette)	1% of the holding. 1 motor for each type
17	IDU display	02 each type
18	Terminal Block	02 nos
19	Thimbles	06 nos each type
20	EC Fans (AHU)	02 nos each type
21	Filters as required	
22	Cables as required.	

Note: The spares shall be of OEM/same make. Where the 'Make' of item is not identified/defined, it shall be of reputed make with the approval of Engineer in-charge/DFCCIL.

## 8.9 Maintenance of Records:

- The contractor shall maintain proper log sheets for recording of temperature/Relative Humidity at nominated places as decided by Engineer-in-Charge/DFCCIL.
- Separate log sheets shall be maintained for Routine/Preventive/Breakdown maintenance. Format shall be approved from Engineer-in-Charge/DFCCIL.
- Joint recording of temperature & Humidity shall be done every Monday, preferably 15.00 hrs to check performance of the system.
- Joint recording of compressor currents & refrigerant temperatures shall be done on fortnightly basis to cover entire circuits in a month.
- A record of tripping of safety devices should be maintained. The Contractor shall provide a report to the Engineer/DFCCIL at the end of every week indicating the defect of the system and target date of rectification/replacement which should not be beyond the next schedule in which the item is covered.
- Proper record of maintenance schedule to be maintained & should be available for cross-check anytime.

**8.10 Penalty for delay in Comprehensive Maintenance work:** The penalties under this clause will be imposed without prejudice to any other right available with DFCCIL under this contract.

- a. After report of failure, if maintenance personnel does not start work at site & advise the action plan to attend the failure within half hour, penalty @ Rs. 200/- per hour or part thereof shall be levied to ensure that proper cooling is maintained in the entire premise & there shall be no discomfort to the occupants.
- b. A penalty will be imposed in case any complaint remains unattended after the rectification time as per clause no. 8.7 (e) is over @ Rs. 200/- per 03 hrs or part there-of. After 09 hrs for minor fault and 72 hrs for Major fault it will be @ Rs 400/- per 03 hrs or part there-of. In case the defective HVAC systems are not rectified within a period of 7 days after expiry of rectification time mentioned in para 8.7, a penalty of @ Rs 600/- per 03 hrs or part there-of will be levied.
- c. After 7 days of non-rectification of a failure without any valid & justifiable reason, the cost of damage to HVAC system or DFCCIL property, if any due to failure of system will be sole responsibility of the contractor & the cost of damage of the same shall be borne by the contractor. In such case DFCCIL has right to carry out the work on risk & cost of contractor without further intimation. This will be over and above the penalty as per Para b.
- d. In case the spares (quantities) as mentioned at para 8,7 (a) and (j) are not maintained at site, by the Contractor, the spares may be purchased by DFCCIL and the cost of purchase plus 25% shall be deducted by DFCCIL from the bills for payment to the Contractors. Defects due to such spares will be on account of contractor only.
- e. For Para 8.6 (b), penalty for absence of Supervisor- 2000/- per day, for Technician-1000/- per day per Technician.
- f. The decision regarding penalty and imposition of penalty shall be solely at the discretion of the Officer In-charge of the DFCCIL. The total amount of liquidated damages under this condition shall not exceed 10% of the contract value.

**8.11 Maintenance Period**

All terms and conditions mentioned in Para 8 for CAMC including deployment of staff shall also apply during Maintenance Period except that the Contractor shall not get any payment during maintenance period for maintenance of HVAC system

**8.12** The contractor has to comply with all statutory guidelines and norms related with contracts and HVAC system. Also other contractors will be working on site and contractor is required to ensure coordination with them.

**8.13** In case of any confusion regarding interpretation of clauses of CAMC the decision of DFCCIL shall be final and binding.

**8.14** The contractor will be provided sitting space and Lockable space for spares.

**8.15** Obsolescence of Technology: In case of obsolescence of technology of any sub-component / sub-system or any component / system, the same shall be made good with proven design by contractor without affecting the quality of service with no financial implications to DFCCIL, other than the CAMC payments due to the contractor after fulfilment of contractual obligations. The contractor shall submit detailed proposal/design to DFCCIL for approval for using the new sub-component / sub-system or component / system in place of an obsolete sub-component / sub-system or component / system.

**TECHNICAL SPECIFICATION FOR  
LOW VOLTAGE WORKS  
(SECTION-V)**

## LOW VOLTAGE TECHNICAL SPECIFICATIONS

### I- CCTV SYSTEM

#### 1 HD Outdoor IR IP dome camera

- SITC of HD Outdoor IR IP dome camera with 1/3-inch CMOS, Sensor pixels 4 MP 2688 x 1520, Sensitivity-0.4 lx (color) 0.05 lx (mono), IR range 30 mtrs, Dynamic range 100 db, True day/night, Automatic Electronic Shutter, Video compression H.265 MP ; M-JPEG, White balance, BLC, quad-streaming, Video Analysis with minimum 4 analytics run simultaneously ( Object removal , Loitering , Enter or Exit from the Field , Object Classification etc.), Privacy Mask, Auto Varifocal Lens (zoom / focus) 2.7mm to 13.5 mm lens, Two-way, full duplex Audio, Audio compression AAC, G.711, L16 (live and recording), 5s pre-alarm recording Memory card slot support upto 512 GB , IP66 , ONVIF Profile S, CE, UL, FCC Certified. IP66 , IK 10
- Interface
- Communication Interface : 1 RJ45 10M/100M Ethernet interface
- General
- Regulatory : CE, FCC,UL
- Operating Conditions : -30 °C – 60 °C (-22 °F – 140 °F) Humidity 95% or less (non-condensing)
- Power Supply : 12 V DC  $\pm$  10% PoE (802.3af)
- Power Consumption : Max. 5W
- Ingress Protection level : IP66
- IR Range : 30 meters
- Impact Protection : IEC60068-2-75Eh, 20J; EN50102, up to IK10

#### 2 HD Outdoor IR IP Bullet camera

- SITC of HD Outdoor IR IP Bullet camera with 1/3-inch CMOS, Sensor pixels 4 MP 2688 x 1520, Sensitivity-0.4 lx (color) 0.05 lx (mono), IR range 30 mtrs, Dynamic range 100 db, True day/night, Automatic Electronic Shutter, Video compression H.265 MP ; M-JPEG, White balance, BLC, quad-streaming, Video Analysis with minimum 4 analytics run simultaneously ( Object removal , Loitering , Enter or Exit from the Field , Ob0ject Classification etc.), Privacy Mask, Auto Varifocal Lens (zoom / focus) 2.7mm to 13.5 mm lens, Two-way, full duplex Audio, Audio compression AAC, G.711, L16 (live and recording), 5s pre-alarm recording Memory card slot support upto 512 GB , IP66 , ONVIF Profile S, CE, UL, FCC Certified. IP66 , IK 10
- IR Range :Minimum 30Mtr
- Storage :On Board Micro SD/SDHC/SDXC slot, Support up to 128 GB
- Reset :yes
- DNR :3D
- Face Detection :Supported
- Region of interest :Support 1 Region of interest per stream



- Analytic :Object removal, Line crossing, intrusion, unattended baggage
- Regulatory :UL, CE, FCC
- Temperature/ Humidity :-30 °C to +60 °C / 95% or less
- Protection :IP66, IK10 Rated, Lightning Protection, Surge Protection and Voltage Transient Protection
- Power Consumption :12 VDC, 1.2A, 14.5W PoE (802.3at), 0.5A to 0.1Amax. 16.5W

3 Network Video Recorder

SITC of 4U Rack mount single chassis Network Video Recorder with dual Gb NIC, 1 DVI-I + HDMI

+ 1 Display Port, max 2 simultaneous monitors, RS-232/485 serial port, DVD, Server Operating System- Windows 10,Ubuntu Linux 16.04, Gen 4 Intel Core i7, Local Client Display Rate (FPS)Windows – 700 FPS (HD)Linux – 900 FPS (HD),High Performance, High Reliability IP Recorder. — Continuously records 400Mbps (Windows) & 800 Mbps (Linux)of video while hosting a local client, multiple remote clients and the web server on a single server, RAM-8 GB, 16 GB (Optional)solid-state operating system drive,USB-6 x USB 2.0, 2 x USB 3.0 high air flow cooling and hardware monitoring features ensure maximum uptime. keyboard and mouse, Professional Grade client and server software pre-installed and software updates. Access live and recorded video on multiple client PCs with free Windows, Mac or Linux client application. web server application is pre-installed on the server to access video through a web browser or free Mobile iPhone / iPad and Android apps. 90 days storage of camera feeds is required. Storage Capacity be catered accordingly.

NVR must support duplex audio between control room and camera location

NVR must be OEM agnostic

NVR must be configured in HA mode and NVR must be scalable to support upto 256 video inputs.

All associated racks, patch panel, patch cords, face plates and cabling requirements of all kinds will be provided from day 1.

All applicable licenses will be provided for the entire warranty duration or minimum 3 years whichever is later.

4 Outdoor IR HD PTZ Camera

- SITC of Outdoor IR HD PTZ Camera with 1/3" 4 Mega pixel progressive scan Exmor CMOS, Effective pixels 2688x1520, 30x Optical Zoom 4.5mm - 135 mm;°, Minimum Illumination- Sense up on- Color: 0.05 lux , B/W: 0.01 lux, With infrared (IR) 0 lux,

WDR 120dB, Video Analysis ( Object removal , Loitering , Enter or Exit from the Field , Object Classification etc.) Intelligent Dynamic Noise Reduction, BLC, White Balance, Mechanical switchable IR filter, Pan Range 360° continuous, Tilt Range 0°–90°, Pan/Tilt Modes - Pan: 0.1°/s - 240°/s; Tilt: 0.1°/s - 120°/s, Presets 256 , Tours, IR distance 100 mtrs, IR can be internal or external with full 360 deg PAN coverage; White Led 60m; Audio- 1/1 Channel In/Out, Memory card slot (support upto 1TB) , 24 individually configurable privacy masks, Simple single cable installation with POE+ support for Outdoor application, wiper, Defog, IP66 , ONVIF Profiles S & G, CE, UL Certified.

- Imaging:
- Sensor type : 1/3-inch CMOS
- Total sensor pixels : 2688 x 1520 (4 MP)
- Sensitivity : 0.05 lux, Mono, 0.01 lux
- High Dynamic Range : 120 db or better
- True Day/Night : Auto, Color, Monochrome
- Noise reduction : iDNR / 3DNR with separate temporal and spatial adjustments
- Shutter Speed : 1/30 s to 1/10000 s
- Intelligent defog : Intelligent Defog automatically adjusts parameters for best picture in foggy or misty scenes (switchable)
- Video resolution : 1440p, 1080P, 720P, D1
- No. of Streams : Multiple configuration streams
- Video compression : H.265 MP, H.264, M-JPEG
- Max. frame rate : 60 fps
- Optical and Digital zoom : 30x Optical 16X digital
- Lens type : 30x motorized zoom | 6.6 mm - 198 mm (F1.5 – F4.8)
- White LED : Require white LEDs to see Images in color upto 60 Mtr in no Ambient light
- IR Range : 100 Mtr or better
- Lens adjustment : Motorized zoom/focus
- Pan angle : 360 ° Continuous
- Tilt angle : -90° to 0° (Auto-flip 180°)
- Pre set Position : 256

Guard Tour : 2 ( Maximum Total duration of 15 minutes for each Tour) and 2 Pre position tour.

Sector/Blanking : 16 Independent sectors with 20 characters on each title

Pre position speed : Pan : 240 °/s , Tilt : 100 °/s

Audio communication : Two-way, full duplex

Audio Line In/Out : 1/1

Alarm In/Out : 1/2

Ethernet : 10/100 Base-T, auto-sensing, half/full duplex

Ethernet connector : RJ45

Connectivity : ONVIF Profile S, ONVIF Profile G

Analysis Type : Edge Based Analytics

Alarm rules : Rule based alarms and tracking, Line crossing, Enter / leave field, Follow route, Loitering, Idle / removed object, People counting, Crowd density estimation.

Object filters:- Colour , Speed , direction

Other functions : Sharpness, Backlight compensation, Contrast enhancement, Display stamping (Name/logo/Time), Pixel counter

Memory card slot : Min. 512 GB support

SD card health monitoring : Extreme lifetime and health monitoring support that provides early service indication

Hardware for data security : Unique Crypto-processor / TPM

Dual Power Supply for redundancy : POE+( IEEE802.3bt) and 24VAC

Operating temperature : -40 °C to +60 °C (-40 °F to +140 °F)

Humidity : 0 to 90% ( NON condensing)

Ingress protection : IP 66

IK Rating : IK10

Wiper : Require rain sensing Wiper.

Privacy Masking : 32 Individual configurable

**5 Video Management System (VMS)**

Supply, installation, testing and commissioning of Video Management System (VMS) software shall be used to view live and recorded video from capture cards and IP devices connected to local and wide area networks. The VMS software shall have a client/server-based architecture that can be configured as a standalone VMS system with the client software running on the server hardware and/or the client running on any network-connected TCP/IP workstation. Multiple client workstations shall be capable of

simultaneously viewing live and/or recorded video from one or more servers. Multiple servers shall also be able to simultaneously provide live and/or recorded video to one or more workstations. The VMS server software shall also have the ability to be installed on an IP edge device—such as an IP camera or encoder that allows for 3rd party applications—allowing the device to serve as both a server and IP video recording device. The VMS shall not charge for the number of concurrent clients (min. 50 thick clients and 16 mobile clients to be provided along with VMS)

VMS must be OEM agnostic and also support third party cameras.

All hardware including servers, storage etc and software as per latest specifications required for seamless working of the application for next 5 years will be provided as part of the solution.

The VMS shall support the following recording services:

- a. Video Recording Manager Server
- b. Support Servers connected with DAS (Direct Attached Storage)/ SAN (Storage Area Network)/ NAS (Network Attached Storage)
- c. The software components of the video management system can be deployed together on a single PC for small system applications or on separate PCs and servers to meet large systems requirements.
- d. The VMS shall support cameras compliant to ONVIF Profile S. It shall be possible to scan the network for ONVIF cameras. VMS manufacturer shall provide their SDK (or any other integration means) libraries and documentation) to ensure a seamless integration with any other system
- e. It shall be possible for operator to access live streams and to control PTZ functionality.
- f. The VMR shall be an optional package of the installation program of the VMS and should run on server of any non-camera OEM Hardware.
- g. It shall be possible to restrict access to Video Wall Displays to specified operator client workstations.
- h. The VMS shall support a video wall for an Enterprise System, i.e. an Enterprise Operator Client shall be able to call up and view cameras of the various subsystems on a central video wall.
- i. The open/close states of inputs and relays from devices connected to the system, including IP cameras and PTZ cameras, video encoders and decoders, matrix switchers shall be indicated on the VMS operator client user interface and can be queried via the VMS SDK.
- j. The VMS shall interface to the digital I/O devices.
- k. The video management system shall be capable of monitoring third-party equipment SNMP protocol.
- l. The video management system shall provide a software interface that allows third-party software to generate events in the video management system. The

software shall support any COM programming languages (e.g. Visual Basic and C++), any .Net programming language (e.g. C#) or JavaScript.

- m. It shall be possible to create and export reports of the current configuration in CSV / TEXT / PDF / HTML / or any other format -format for the purpose of documentation.
- n. An operator client user logging on to an Enterprise Management Server shall be able to simultaneously access the devices of up to 10 subsystems and a total number of 10000 encoders/cameras. If each subsystem contains less than 100 cameras, the video management system shall support up to 30 subsystems for simultaneous access to the devices.
- o. The system shall allow system control via the keyboards.
- p. Keyboard connections shall be possible to operator client Workstations.

1	Processor	Intel Xeon Hexa(12 MB Intel smart Cache, 3.4 GHz) or Better
2	RAM	16GB DDR4-2666 2Rx8 ECC UDIMM
3	Memory Protection	ECC Unbuffered
4	RAID Controller	SAS controller, RAID5, RAID6
5	System storage for OS	2 x 120 GB SSD RAID-1 configuration
6	Optical drive type	DVD double Player
7	Ethernet Port	Dual Gigabit LAN
8	Form Factor	HU Rack mounts.
9	Maximum camera	Upto 250 numbers

## 6 Workstation for CCTV system

The Item consists of workstation ( i-7 PC, with 8 GB RAM and 1 TB HDD, 10/100 Mbps Ethernet card, USB connection and internal modem, Microsoft(R) Windows(R) 7 OS Professional Enterprise, Web Server Software, DVD-ROM Drive (with RAM), 100/1000 Mbps NIC for Network connection and antivirus software with 22" colour graphics monitor as per Tender Specifications. Accessories included Optical Mouse, Key Pad.)

## II- Displays

- 1 55 Inches Display with 4K UHD LED backlight
  - Brightness : minimum 400 nits
  - Native Resolution : 4K UHD 3840 x 2160
  - Contrast Ratio : 3000:

- Bezel Width : 0.5’’ or less
- Display Depth : 2.5’’ or less
- Heat load :383 BTU per hour or less
- Power consumption : 112 watts or less
- Display Resolution : 3840 x 2160
- Aspect ratio : 16:09
- Display technology : Direct/Edge LED
- Full Viewing Angle : 178 Degree or better
- External Connectors: HDMI 2.0 x 2, DVI-D, VGA
- CEC - Display must be able to support CEC commands
- HDCP 2.2 Compliance USB playback support
- Embedded browser with scheduling capabilities
- Support for 4K @60 Hz content
- Diagnostic LED's : the display must incorporate diagnostic and status LED's that is with setup and troubleshooting.
- Scaling Capabilities : the display must be capable of accepting input resolutions of VGA (640 x 480) to UHD (3840 x 2160)
- Display Control : IR, Rs232, LAN, HDMI-CEC, Keypad
- Backlight Life - 30000 hrs or better
- Speakers: 10W x 2 built in
- Auto Setup Options: the display must be capable to detect automatically and sync to any incoming selected source within the specified operating range without user intervention.
- Operating temperature range - 0~ 40 Degree Celsius
- Operating Humidity range: 20 ~ 85% RH non condensing
- Power Supply Voltage : 100~240VAC, 50 to 60 Hz

2      65 Inches Display with 4K UHD LED backlight

- Brightness : minimum 400 nits
- Native Resolution : 4K UHD 3840 x 2160
- Contrast Ratio : 3000:1
- Bezel Width : 0.5’’ or less
- Display Depth : 2.5 ‘’ or less
- Heat load :383 BTU per hour or less
- Power consumption : 112 watts or less
- Display Resolution : 3840 x 2160
- Aspect ratio : 16:09
- Display technology : Direct/Edge LED
- Full Viewing Angle : 178 Degree or better
- External Connectors: HDMI 2.0 x 2, DVI-D, VGA,
- CEC - Display must be able to support CEC commands

- HDCP 2.2 Compliance USB playback support
- Embedded browser with scheduling capabilities
- Support for 4K @60 Hz content
- Diagnostic LED's : the display must incorporate diagnostic and status LED's that is with setup and troubleshooting.
- Scaling Capabilities : the display must be capable of accepting input resolutions of VGA (640 x 480) to UHD (3840 x 2160)
- Display Control : IR, Rs232, LAN, HDMI-CEC, Keypad
- Backlight Life - 30000 hrs or better
- Speakers: 10W x 2 built in
- Auto Setup Options: the display must be capable to detect automatically and sync to any incoming selected source within the specified operating range without user intervention.
- Operating temperature range - 0~ 40 Degree Celsius
- Operating Humidity range: 20 ~ 85% RH non condensing
- Power Supply Voltage : 100~240VAC, 50 to 60 Hz

3 85 Inches Display with 4K UHD LED backlight

- Diagonal Display Size - 85’’
- Response Time: 13 ms or better
- Contrast ratio : 1200:1 or better
- Bezel Width : 0.8’’ or less Display Depth : 2.7 ‘’ or less
- Power consumption : 350 watts or less
- Display Resolution : 3840 x 2160
- Aspect ratio : 16:09
- Display technology : Direct/Edge LED
- Brightness : minimum 350 nits
- Full Viewing Angle : 178 Degree or better
- External Connectors: HDMI 2.0 x 2, DVI-D, VGA,
- CEC - Display must be able to support CEC commands HDCP 2.2 Compliance
- USB playback support
- Embedded browser with scheduling capabilities
- Support for 4K @60 Hz content
- Diagnostic LED's : the display must incorporate diagnostic and status LED's that is with setup and troubleshooting.
- Scaling Capabilities : the display must be capable of accepting input resolutions of VGA (640 x 480) to UHD (3840 x 2160)
- Display Control : IR, Rs232, LAN, HDMI-CEC, Keypad
- Backlight Life - 30000 hrs or better
- Speakers: 10W x 2 built in

- Auto Setup Options: the display must be capable to detect automatically and sync to any incoming selected source within the specified operating range without user intervention.
- Operating temperature range - 0~ 40 Degree Celsius
- Operating Humidity range: 20 ~ 85% RH non condensing
- Power Supply Voltage : 100~240VAC, 50 to 60 Hz

#### 4 DIRECT VIEW LED WALL

Display Size (W x H)	2.44 M X 1.37 M
Pixel Pitch	1.27 mm or lower
LED Configuration	RGB 3 in 1 SMD
Pixel Density	Minimum 620,000 pixels per sqm or higher
Half Gain Horizontal / Vertical Viewing Angle	H 160 degrees / V 160 degrees or better
Refresh Rate	>3840 Hz or better
Temp Range	-10 to +45 Degrees C or better
Grey Scale Processing	14 Bit or better
Brightness (Calibrated)	600 cd/m <sup>2</sup> or better
Maximum Power Consumption	625 w/sq m or lower
Module Resolution	120 x 135 pixels
Power Input	100 ~ 240 VAC
Individual Tile/Cabinet	Each cabinet/tile shall be made of Die-cast Aluminium with depth less than 70 mm. Size of each cabinet shall be 610 mm x 343 mm
Contrast Ratio	5000:1 or better
Access for Maintenance	Front



Weight of each tile	7.5 Kg or lower
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## 5 Projector

Light Output 6000 ISO Lumens

Native Resolution WUXGA ( 1920 x 1200)

Aspect Ratio : 16:10

Light Source Laser light source with life of 20,000 hours

Technology -Single Chip DLP Projector with 1 x 0.67" DMD Darkchip

Inputs : HDMI 1.4a X 2,

HDMI 1.4a+ MHL x 1,

VGA IN X 1,

3D Sync Out x 1,

Audio IN 3.5 mm jack x 1,

Audio in Phono X 2,

Audio Out x 1,

USB Type A X1,

RS232 X 1,

LAN X 1,

HD Base-T X 1,

Standard Zoom lens with throw ratio of 1.15~1.9:1

Dynamic Contrast ratio 20,000,00 :1

Video & Graphics Processing

HDMI 1.4a for Side by Side, Frame Packing, Frame Sequential & Top Bottom 3D formats.

Synchronization of active 3D glasses.

DICOM simulation mode.

Mobile High-Definition Link (MHL™) connection allows mirrored content from smartphones, tablets and other portable consumer electronics devices.

Vertical & Horizontal Keystone correction (2D: Vertical  $\pm 30^\circ$ , Horizontal  $\pm 30^\circ$ ).

Four Corner adjustment.

Selectable 16:9, 4:3, Native, Letterbox and Full Screen aspect ratios.

Digital Zoom +10~-10.

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## 6 LCD Videowall

LCD Video wall comprising 55” LCD panels in a configuration of 2 ( C ) x 2 ( R ) complete with wall mounts

Individual Panel Size 55” Diagonal	
Bezel to Bezel Gap (Typical)	0.88 mm
Back Light Type	Direct LED
Resolution	Full HD 1920 x 1080, professional-grade display
Display Colors	1.07 billion
Display Mode	Direct LED Backlight / Normally Black
Brightness (Typical)	500 nits
Contrast Ratio (Typical)	Dynamic 500000:1
Inputs	2x HDMI 2.0, 1x DP 1.2
Outputs	1x Audio Out, 1 X HDMI/DP
Power Control	AC Power ON/OFF Switch
AC Power Input Range	100~240VAC, 50/60Hz
Power Consumption	Normal Mode: <250 W
Standby Mode: <0.5W	
Dimensions (W x H)	1211.4 x 682.3 mm
Operating Temperature	0°C ~ 40°C
Storage Temperature	-10°C ~ 60°C
Operating / Storage Humidity	10% ~ 90%, non-condensing
Backlight Lifetime (Typical)	100,000 hours

## 7 4K Digital Signage Media Player

4K Digital Signage Media Player Android Media Player with 8 GB Storage, LAN based. UHD 4K output digital media player that delivers enterprise performance and seamless playback of UHD 4K content.

Software to playback the content of scheduled from Meeting controller/ manager and the content assigned to each Machine

Antenna: Two 2.4 GHz / 5 GHz dual-band antenna

HDMI: Two HDMI 2.0 ports with screw lock

Audio: One 3.5 mm

USB: Two USB 3.1 Type A ports, One USB 3.0 Type A port

Enclosure: Anodized aluminum case, fanless

Dimensions: 300 x 186 x 32 mm / 11.8 x 7.3 x 1.3 in

Weight: 2145 g / 4.7 lb

Operating Temp: -10° - 45° C / 14° - 113° F

Storage Temp: -55° - 75° C / -67° - 167° F

Humidity: 5 - 95% Non-condensing"

8      **4K Digital Signage Server Software**

4K Digital Signage Server Software Signage Content creating software and scheduling

Features:

- Control and customize playlists to deliver the right content to the intended audiences at the right time.
- Stable and reliable performance 24 hours a day, 7 days a week
- Superior playback technology delivers smooth sub-pixel motion without distracting choppy stutters
- Access localized and globalized support Create and deploy content effortlessly
- Schedule and deploy content to multiple screens with ease
- Design and customize content from scratch or choose from multiple templates
- Display live feeds such as news, weather, traffic, financial data and social media, in real time
- Effective communication through the integration of different information systems
- Support a wide range of media formats for images, graphics, video, flash and sound.
- Content Manager
- Media Player

**III- Audio Visual**

**1). Video Conferencing**

**1      HDBaseT TX/RX for HDMI with USB**

System Type: HDBaseT TX/RX for HDMI with USB

Transmitter : Input Port: 1 x HDMI, Output Port :    1 x HDBT & Data Port : 1 or 2 x USB Hub, 1 x USB Host

Receiver : Input Port: 1 x HDBaseT, Output Port : 1 x HDMI & & Data Port : 1 or 2 x USB Hub

Signal & Control Extension: Extender for HDMI, power, control, and USB upto 70mtr using CAT6a/7 cable

Resolution Support with compatible receiver:

1080p or 1900 x1200

4K/UHD @ 60 Hz with 4:2:0

USB : Signal - 2.0

Maximum Data Rate - 120 Mbps

Remote powering over HDBaseT or local powering

Chroma Subsampling: 4:4:4, 4:2:2, 4:2:0

Audio Support:

Analog In: PCM 2CH

HDMI In / HDBaseT Out: LPCM 5.1, LPCM 7.1, Dolby Digital, DTS 5.1, Dolby Digital+, Dolby TrueHD, DTS-HD Master Audio

Sample Rate: upto 192kHz

Bit Rate: up to 24-bit

HDCP 2.2 & CEC pass through

Cable Link Monitoring: Integrated HDBaseT link status monitoring

Certification: CE , FCC

**2 Wallplate HDBaseT Transmitter for HDMI and USB-C with USB Hub**

HDBaseT transmitter for AV and USB

Inputs : HDMI, USB-C, USB Type-B & Type-A

USB 2.0 interfacing and extension up to 330 feet

4K capability @ 60 Hz with 4:4:4 chroma subsampling

HDCP 2.2 compliant

USB Signal 2.0 @ 120 mbps

Remote powering over HDBaseT

Certificate : CE, FCC

**3 Universal 5X2 Switcher**

Universal 5X2 Switcher with Built-in or External Wireless Presentation interface

Input Port: 2 x HDMI, 1 x USB-C, 1 x DP & Data Port : 2 x USB Hub , 2 x USB Host

Output Port: 1 x HDMI with matrix output on 1x HDBaseT,

Signal & Control Extension: Over HDBaseT extends AV, Ethernet & Control upto 100mtr using CAT6a/7 cable

Resolution Support :

4K @ 60 Hz with 4:4:4

USB : Signal - 2.0

Maximum Data Rate - 120 Mbps

Support HDR10, and Dolby® Vision™ @ 60 Hz

Provides convenient Wi-Fi connectivity for an iOS, Android, Mac, Chromebook, or Windows-based device

USB-C input for AV, data.

Auto Switching: Select Active input via Hot Plug & Video Detect Technology

Auto Display Control: Automatic Display On / Off control based on switcher.

Manual Control: Front Panel Input Selection

LED Indicator: To provide power and input selection status information

Chroma Subsampling: 4:4:4, 4:2:2, 4:2:0 with Color Depth 8-bit, 10-bit, 12-bit

Audio Support: Analog In: PCM 2CH ;Audio Out: De-Embedded Audio Output

HTTPS, SSH, IEEE 802.1x, and WebSockets with TLS, WPA2-PSK, and AES-128 encryption

Selectable 4K to 1080p downscaling

Contact closure for screen or display lift control

Control: TCP/IP & RS-232, Configuration: GUI-based configuration using integrated web server

HDCP 2.2 & CEC pass through

Certification: CE , FCC

4 6×2 Matrix Presentation Switcher with USB

System Type: 6×2 Matrix Switcher with USB

Input Port: 2 x HDBT, 3 x HDMI, 1 x USB-C & Data Port : 2 x USB Hub , 2 x USB Host

Output Port: 1 x HDMI with matrix output on 1x HDBaseT

Signal & Control Extension: Over HDBaseT extends AV, Ethernet & Control upto 100mtr using CAT6a/7 cable

Resolution Support : 4K @ 60 Hz with 4:4:4

USB : Signal 2.0 or better

Maximum Data Rate - 120 Mbps

Support HDR10 and Dolby® Vision™ @ up to 60Hz; HDMI and USB-C ports only  
USB-C input for AV, data.

Auto Switching: Select Active input via Hot Plug & Video Detect Technology

Auto Display Control: Automatic Display On / Off control based on switcher. Control signals to display are transmitted via IP, RS-232 or CEC.

Chroma Subsampling: 4:4:4, 4:2:2, 4:2:0 with Color Depth 8-bit, 10-bit, 12-bit

Audio Support: HDMI / HDBaseT Inputs support : PCM 2.0, LPCM 5.1, LPCM 7.1, Dolby® Digital, Dolby Digital Plus™, Dolby TrueHD, Dolby Atmos® DTS-HD Master Audio™, and DTS:X®

Sample Rate: upto 192kHz with Bit Rate: up to 24-bit

Audio Out: De-Embedded Audio Output

4K/UHD downscaling and upscaling for HDMI output

Control: TCP/IP & RS-232

HDCP 2.2 / 1.4 & CEC pass through

Configuration: GUI-based configuration using integrated web server

Certification: CE , FCC

5 2×1 AV Switcher cum Receiver

2×1 AV Switcher cum Receiver with Scaler and USB – HDBaseT and HDMI Inputs

System Type: HDBaseT Receiver for HDMI with USB

Input Port: 1 x HDBT, 1 x HDMI & Data Port : 2 x USB Hub

Output Port: 1 x HDMI

Signal & Control Extension: Receiver for HDMI, Ethernet, power & control, upto 100mtr using CAT6a/7 cable

Resolution Support:

4K @ 60 Hz with 4:2:0 / 4:4:4

Supplies powering over HDBaseT to a transmitter

Chroma Subsampling: 4:4:4

Color Depth: 8-bit, 10-bit, 12-bit

Audio Support:

HDMI Pass-Through Formats : PCM 2Ch, LPCM 5.1, LPCM 7.1, Dolby® Digital, DTS® 5.1, Dolby Digital Plus

Audio Out: De-Embedded Audio Output

4K downscaling and upscaling

Dual Ethernet ports and integrated network switch

Two relays provide control for motorized screen, shades, or display lift

Control : TCP/IP and RS-232

HDCP 2.2 & CEC Pass-through

Certification: CE , FCC

**6 2×1 AV Switcher cum Receiver with Scaler**

2×1 AV Switcher cum Receiver with Scaler – HDBaseT and HDMI Inputs

System Type: HDBaseT Receiver for HDMI

Input Port: 1 x HDBT & 1 x HDMI

Output Port: 1 x HDMI

Signal & Control Extension: Receiver for HDMI, Ethernet, power & control, upto 100mtr using CAT6a/7 cable

Resolution Support:

4K @ 60 Hz with 4:2:0 / 4:4:4

Supplies powering over HDBaseT to a transmitter

Chroma Subsampling: 4:4:4

Color Depth: 8-bit, 10-bit, 12-bit

Audio Support:

HDMI Pass-Through Formats : PCM 2Ch, LPCM 5.1, LPCM 7.1, Dolby® Digital, DTS® 5.1, Dolby Digital Plus, Dolby TrueHD, DTS-HD, Master Audio, DTS:X

Sample Rate: upto 192kHz

Bit Rate: up to 24-bit

Audio Out: De-Embedded Audio Output

4K downscaling and upscaling

Dual Ethernet ports and integrated network switch

Two relays provide control for motorized screen, shades, or display lift

Control : TCP/IP and RS-232

HDCP 2.2 & CEC Pass-through

Certification: CE , FCC

7 HDBaseT receiver for HDMI with USB

System Type: HDBaseT Receiver for HDMI with USB

Input Port: 1 x HDBT

Output Port: 1 x HDMI

Data Port: 2 x USB Hub

Signal & Control Extension: Receiver for HDMI, Ethernet, power, control, and USB upto 100mtr using CAT6a/7 cable

Resolution Support:

4K @ 60 Hz with 4:2:0

USB :

Signal - 2.0

Maximum Data Rate - 120 Mbps

Remote powering over HDBaseT or local powering

Chroma Subsampling: 4:4:4

Color Depth: 8-bit, 10-bit, 12-bit

‘Audio Support:

Pass-through: PCM 2Ch, LPCM 5.1, LPCM 7.1, Dolby® Digital, DTS® 5.1, Dolby Digital Plus, Dolby TrueHD, DTS-HD, Master Audio, DTS:X

Sample Rate: upto 192kHz

Bit Rate: up to 24-bit’

TMDS Clock 300 MHz

HDCP 2.2 & CEC Pass-through

Cable Link Monitoring: Integrated HDBaseT link status monitoring

Certification: CE , FCC

8 Wireless Presenter module

- Allows simultaneous present upto 4 or more screens at the same time
- Allows a user to manage on-screen presenters as well as queued presenters
- Integrated WI-FI Access Point – can be segregated from the facility LAN for security reasons
- Shall be having provision for being used as a digital signage media player (additional hardware and software may be added to achieve the same)
- Shall have functionality to support streaming like YouTube streaming for archival and viewing purpose
- Dynamic Layout Mode - automatically adapts to incoming or disconnected source content
- Wireless screen casting through native AirPlay, Google Cast, or Miracast protocols
- Supports wireless video upto 1080p/30 4:2:0
- Local storage for playback of images and video

- Shall be controllable over IP and RS-232 both
  - Shall have min. 1 x HDMI, 2x USB 2.0/3.0 port
  - Certification : CE, FCC
- 9      Centralized Management and control software  
Centralized Management and control software to control all networked AV devices, on-premises installation and Management plus Room Scheduling.  
Shall have capability to control upto 20 rooms  
Shall be accessible from a web browser for setup and management of AV assets.  
Supports industry-standard, network security features and protocols  
Should support minimum 40 room scheduling panels  
"Certification: CE, FCC
- 10     10'' Touch Panel for Room Scheduling  
Capacitive touch screen with 1280×800 resolution  
Remotely powered via PoE (Power over Ethernet) – single-cable network connection for data and power  
Fast, streamlined setup with automatic network discovery and configuration by the centralised monitoring software  
Supports multi-touch and gesture interactions  
Color Depth: 8 bit  
Electro Optical Ambient Light Sensor  
PoE 802.3af compliant  
Certification: CE, FCC
- 11     8'' Touch Panel for control  
8" touch panel for Audio & Video control  
Capacitive touch screen with 1280×800 resolution  
Remotely powered via PoE (Power over Ethernet) – single-cable network connection for data and power  
Fast, streamlined setup with automatic network discovery and configuration by the AV Control Processor  
Supports multi-touch and gesture interactions  
Color Depth: 8 bit  
Electro Optical Ambient Light Sensor  
PoE 802.3af compliant  
Complete with table top mount kit  
Certification: CE, FCC
- 12     8-Button Network wall mount control panel  
Nos. of Buttons : Eight, soft-touch, backlit buttons  
Easy to configure with either the built-in web server or downloadable templates.



- Fast installing, single cable integration  
Remotely powered via PoE
- 13 Advanced 1080p business webcam with H.264 support  
Supports 1080p (Full HD) @ 30fps  
90° diagonal fixed field of view (dFOV)  
4x digital zoom (Full HD) available  
Built-in HD autofocus ensures you're seen clearly throughout video calls.  
Supports H.264  
Audio : Dual omni-directional mics  
Connectivity : USB-A  
1/4" thread for tripod mounting
- 14 4K Video Conferencing Codec with IP Microphone and Camera  
VIDEO INPUT: 1x HDCI, 1x HDMI, 3x USB  
Video Output : 2x HDMI  
Content Resolution : Input-Upto UHD (3840 x 2160), Output -UptoUHD (3840 x 2160)  
Content frame rate : 5–60 fps  
Media Encryption (H.323, SIP): AES-128, AES-256  
H.235.6 support  
Authenticated access to admin menus, web interface and APIs  
PKI/Certificate Management:  
remote, NTSC/PAL; Cables: 2 HDMI 1.8m, 1 CAT 5E LAN 3.6m, 1 CAT 5E SHLD 25ft, 1 HDCI 6ft, 1 HDCI Mini 3m, Power: India BIS. Maintenance Contract Required. Partner Premier, One Year
- 15 Video Switching, Distribution and Extension Systems:  
4K UHD @ 60Hz 4:4:4 AV over IP via 1Gbps to 20 Gbps Fiber Based with HDMI analog audio, RS-232, IR and USB HID addons; 4K transmitter & receiver with scaling:
- Should use standard 1 to 10 Gigabit Fiber network for video over IP transmission.
  - Should use standard SFP+ optical fiber connectivity for signal extension.
  - Should support 4K 60Hz 4:4:4 resolution, and all resolutions specified under HDMI 2.0 standard.
  - Should have minimum one standard Gigabit SFP+ connections for signal extension.
  - Should support extension of minimum two simultaneous video streams
  - Should have the ability to be configured as transmitter or receiver device
  - Should support HDCP 2.2 encrypted video content.
  - Should support scaling and frame rate conversion up to 4K 60Hz 4:4:4 for at least one of the extended video stream.

- Should be able to be used with standard 10 Gigabit Ethernet switch as an endpoint in a virtual matrix configuration.
  - Should support USB KVM for KVM application
    - Under desk mounting for above, AV over IP Video System
- 16 Matrix Management Unit for the AV Over IP system.
- Should have a central management hardware unit for device control and signal management, in case of a virtual matrix configuration.
  - Central management hardware unit should support central firmware upgrade to all the endpoints in the system at the same time.
- Intuitive control software for device configuration
  - Advanced error handling and logging with time code
  - Advanced EDID Management
  - Multiple TCP/IP connections
  - Device control via Ethernet (TCP/IP)
  - Built-in website for device configuration
  - Firmware upgrade through Ethernet
- 17 96 Port 10G Fiber Network Switch, L3 Managed + LAG Support
- 10 Gbps non-blocking switch (capable of full bandwidth transmission between all ports. Supports IEEE Std. 802.3ad-2000 Link Aggregation Control Protocol, with Link Aggregation Groups for each endpoint.
- IPv4 (or Layer 2) Multicast Forwarding based on IGMP v2 snooping, with at least 16 addresses available for each endpoint, e.g. 4096 IPv4 multicast addresses for 256 endpoints
- Supports Internet Group Management Protocol version 2 (RFC 2236) snooping
- Supports IEEE Std. 802.1Q VLAN tagging: 1 VLAN reserved for control and media transmission, other(s) available for user traffic.
- IPv4 (or Layer 2) Multicast Forwarding based on IGMP v2 snooping, with at least 16 addresses available for each endpoint, e.g. 4096 IPv4 multicast addresses for 256 endpoints.
- 18 2x1 switcher
- 2x1 switcher with USB-C, HDMI 2.0 and USB 3.1 / 2.0 ports supporting 4K signal formats (4K UHD @ 60Hz RGB 4:4:4, up to 18 Gbps), secure control Ethernet interface. USB-C connectivity for 4K video, audio. Advanced automated room control features
- Should Support USB-C input connectivity for 4K Video, Audio, Data (Video, Audio, Data over a single USB-C connection)

- Should support Multiple USB 3.1 Gen 1 / USB 2.0 connectivity for any type of USB devices (Camera, speakerphone, USB-HID devices etc...)

USB 3.1 Gen 1/ USB 2.0 /USB 1.1 compliant

- Should support Dedicated secure corporate and room utility Ethernet connectivity
- Should support USB 3.1 Gen 1 / USB 2.0 / USB 1.1 compliant
- Should support Occupancy sensor connection or in-built (with 24V power supply)
- Should support Splash screen for custom corporate logo and on-screen display warning messages
- Should support Audio de-embedding
- Should Support GPIO control ports
- Should support Device control via Ethernet (TCP/IP), RS-232 and USB
- Should support Uncompressed video up to 18 Gbps data rate (600 MHz pixel clock)
- Should support Occupancy sensor connection (with 24V power supply)
  - Should support Splash screen for custom corporate logo and on-screen display warning messages
  - Should support Audio de-embedding
  - Should Support GPIO control ports
  - Should support Device control via Ethernet (TCP/IP), RS-232 and USB
  - Should support Uncompressed video up to 18 Gbps data rate (600 MHz pixel clock)

19 a. HDMI IR HDBaseT wallplate transmitter

HDMI1.4, VGA, DP1.1 + Ethernet + RS-232 + bidirectional IR HDBaseT wallplate transmitter for CATx cable. HDCP, 3D and 4K60 4:4:4 support. 100m extension distance or more. US 2-gang wall box size. Compatible with input boards and receivers. Powering not included, external PSU or The power injector from same OEM to be provided separately.

b. HDMI IR HDBaseT Receiver:

SITC of HDMI1.4 + Ethernet + RS-232 + bidirectional IR HDBaseT receiver over CATx cable. HDCP, 3D and 4K 60Hz 4:4:4 compliant. 100m extension distance or more.

20 Image Processing Systems

Fully modular and scalable 4K/8K multi-screen presentation system and videowall processor. Unrivalled ease-of-use, versatile 4K digital connectivity, unmatched real-time 10/12-bit 4:4:4 video processing power, best-in-class image quality and pure 4K60p on each input and output with ultra-low latency with 20x HDMI 2.0 inputs and 4x HDMI 2.0 output.

- Should be a modular design to allow you to easily swap in I/O cards to accommodate a variety of connectivity arrangements and your match source and display requirements.
- Should be specifically engineered to perform to the highest standards in mission-critical applications. By combining a heavy-duty modular design, the highest quality components selected for their proven reliability and features such as redundant swappable power supplies and smart thermal management, to deliver uninterrupted 24/7 performance and peace of mind!
- Should support 2 dedicated Multiviewer outputs and up to 12x 4K or 24x HD freely assignable mixing layers for preview applications
- Should offer powerful features that will allow you to handle any creative display configuration, such as a custom output formats, output rotation, AOI, bezel compensation and pixel pitch management.
- Should feature state-of-the-art real time processing features that will help you to unleash all your creative potential and produce flawless, stunning live presentations: true seamless switching, real-time SDR/HDR conversion, flying layer movement, advanced cut and fill, cutting edge keying engine... It also allows to remove external audio de-embedding boxes.
- Should support HDMI 2.0 connectors, each supporting up to 4K60p 8-bit 4:4:4 or up to 4K60p 12-bit 4:2:2 or up to 4K30p 12-bit 4:4:4 both on the Inputs and Output of the HDMI Signal
- Should support input formats such as 8192×1080@60p (aka “8k x 1k”) on a single connector both on the Input and the Output Signal.
- Should support 1000 screen memories, 50 layer memories and 500 master memories presets
- Should Support up to 120 Megapixels throughput at 10 bits 4:4:4 @60Hz on Program, without restricting Preview or Multiviewer
- Should Support Real-time SDR/HDR10/HLG conversion based on 3D-LUTs, Advanced motion compensation deinterlacing, BT.601; BT.709; BT.2020 color spaces ,Compatible with HDCP 1.4. and HDCP 2.2
- Should Support Custom output formats for non-standard display applications
- Should support Independent resolution and rate on all outputs.

- Should Support True A/B Mix, Misc. layer border effects/colors and separate shadow, Transitions: Cut, Fade, Slide, Wipe, Circle, Stretch, Depth, Flying layer movement with programmable paths

- Should Support Highly ruggedized chassis with cleanable air filter, Swappable redundant power supplies (2+1), Quiet: 49dB, average noise at 1m when ambient temperature is less than 32°C/90°F, Dedicated BNC with loop out for Framelock, blackburst and tri-level sync, EDID management on every input and output, Backup and restore functions, Tally/GPI-O for customizations.

21 Codec

Video conferencing Codec with all necessary accessories

Codec support IPv4/IPv6

Resolution 4K

Standards H.264 AVC, H.264 High Profile, H.265, H.239

Inputs: 1 x HDMI, 1 x HDCI/HDMI, 3 x USB (3.0),

Outputs: 2 x HDMI

Content Sharing: Contact App, Airplay/Miracast

Media Encryption H.323, SIP

Security: AES-128, AES-256

Interoperability: Zoom, Starleaf, GoToMeeting, Bluejeans/All cloud service providers through video made app

22 Camera

30x Optical Zoom PTZ Camera with 4K UHD @30/60Hz output

- Optical Zoom: 30x

- Digital Zoom: 12x

- Sensor 1/2.5" 8.57MP CMOS

- Video Format: 2160p: 29.97 / 25, 1080p: 59.94 / 50 / 29.97 / 25, 1080i: 59.94 / 50, 720p: 59.94 / 50 / 29.97 / 25

- Video Output: 3G-SDI / HDMI / Ethernet

- Horizontal Viewing Angle: 68° or better

- Vertical Viewing Angle: 38.3° or better

- Panning Angle: +170° ~ -170°

- Tilting Angle: +90° ~ -30°

- Aperture: F1.6 ~ F3.4 or better

- Focal Length 4.6mm ~ 135mm or better

- Shutter Speed 1/1 ~ 1/10,000 sec

- Should support Image Flip

- Preset: 256 or more

- Control Interface: RS-232 / RS-422 / Ethernet

- Control Protocol: VISCA / PELCO D / ONVIF /FreeD
- Video Stream: RTSP / RTMP / RTMPS / MPEG-TS / SRT
- Video Compression: HEVC(H.265) / H.264
- Audio Input: 1 x Line In / MIC In
- Audio Output: Ethernet / SDI / HDMI
- Power: PoE+ (IEEE802.3at) or DC In 12V +/- 20%

23 Software VC AV Bridge to convert the 4K HDMI to USB 3.0

- Should enable software-based video conferencing with Pro AV peripherals
- Capture and stream directly to PC (USB) or network (IP)
- Should support HD encoding of audio/video sources
- Video Input: HDMI up to 3840x2160
- Outputs simultaneous USB 3.0 and IP streaming with up to 1080p quality
- Audio Inputs: 2 or more x phoenix connector Mic/Line level inputs
- Bi-Directional USB Audio
- Control: RS232/Telnet
- IP streaming: Up to 1080p/30 over RTSP or RTMP
- Power: PoE (Builtin/External)
- Certifications: CE/FCC/TAA

24 Control Systems

Control System: Rack-mountable control system with expandable memory

- Integrated control ports and optional control card expansion slots.
- Bidirectional 6 x RS-232/422/485 or more
- IR/Serial: Minimum 8 or more
- Relay: Minimum 8 or more, 4 or more LAN
- Expandable slots x 3 or more
- Support RS-232/IR or I/O with SDRAM 2GB, Flash 8GB

Should support External USB mass storage devices up to 1 TB, as per site requirement

A rack-mountable control system processor with expandable memory, integrated control ports and optional control card expansion slots

Bidirectional 6 x RS-232/422/485, 8 x IR/Serial, 8 x Relay, 4 or more x LAN/Ethernet Port, 3 x Expandable slots supporting RS-232/IR or I/O with SDRAM 2GB and Flash 8GB

Should support External USB mass storage devices up to 1 TB, as per site requirement

Shall be accessible from a web browser for setup and management

Supports industry-standard, secure data communications through HTTP/2, HTTPS, SSH, SFTP, and WebSocket's with TLS and AES-128 encryption

3 interface device license each for i-Pad and Android touch interface license

iPhone, iPad, and Android control app support

Flexible scalability for integrating one or several AV systems over a network

25 15.6''HD Capacitive Touch Screen, Tabletop Tilt, Black Smooth

- Display Type: TFT active matrix color LCD
  - Aspect Ratio: 16:9 Full HD
  - Resolution: 1920 x 1080 pixels
  - Brightness: 400 nits (cd/m<sup>2</sup>)
  - Contrast: 800:1
  - Color Depth: 24-bit, 16.7M colors
  - Viewing Angle:  $\pm 80^\circ$  horizontal,  $+80^\circ/-65^\circ$  vertical"
- "10.1'' Touch Screen, Black Smooth (Side Table)
- Display Type: TFT active matrix color LCD
  - Aspect Ratio: 16:10 WUXGA
  - Resolution: 1920 x 1080 pixels
  - Brightness: 400 nits (cd/m<sup>2</sup>)
  - Contrast: 1000:1
  - Color Depth: 24-bit, 16.7M colors
  - Viewing Angle:  $\pm 80^\circ$  horizontal,  $+80^\circ/-65^\circ$  vertical"

26 **Audio System**

26.1 DSP Processor

10 input & 6 Line output. DANTE Audio Interface

AEC Mic / Line Input: min 10 No's and support 24 AEC channel processing with network audio sources connected to DSP

Line Output: min 6 No's

USB Audio Interface 24Bit, 48Khz

GPIO Contacts: 6 No's

Built in Digital Audio DANTE Network with 64 x 64 Channel

Frequency Response: 20Hz to 20KHz

Ethernet Port: Yes

RS232 connector for interfacing with 3rd party control systems

Crosstalk (inter-channel @ 1 kHz): < -75 dB

Common mode rejection: Typically, -60 dB at 1 kHz

Latency: <1.8ms

Maximum output level: -31 dBu to +24 dBu

THD+N : <0.005%,

Dynamic range: > 105 dB

Certification: CE , FCC etc. complete required as per specification

26.2 Dual Channel Power amplifier 2\*120W

- Class D
- Nos. of Channel : 2

- Signal To Noise Ratio: >97 dBA or better
- Channel separation (Crosstalk) >85 dBA
- Power Handling : 2 x 120W @ 4/8ohm & 70V/100V
- High-pass filter 80 Hz HPF
- Frequency Response : 20 Hz to 20 kHz
- Input impedance 10 k $\Omega$  unbalanced and RCA, 20 k $\Omega$  balanced
- GPI remote volume control using standard RJ-45 connector and Ethernet cable
- Energy Star Rated
- Amplifier protection Thermal protection, over current protection, DC protection, high frequency protection
- Cooling Convection-cooled, fanless etc. complete required as per specifications

26.3 Dual Channel Power amplifier 2 \* 240W

- Class D
- Nos. of Channel : 2
- Signal To Noise Ratio: >97 dBA or better
- Channel separation (Crosstalk) >85 dBA
- Power Handling : 2 x 240W @ 4/8ohm & 70V/100V
- High-pass filter 80 Hz HPF
- Frequency Response : 20 Hz to 20 kHz
- Input impedance 10 k $\Omega$  unbalanced and RCA, 20 k $\Omega$  balanced
- GPI remote volume control using standard RJ-45 connector and Ethernet cable
- Energy Star Rated
- Amplifier protection Thermal protection, over current protection, DC protection, high frequency protection
- Cooling Convection-cooled, fanless etc. complete required as per specifications

26.4 4'' Ceiling speaker

- Speaker Type: Two-Way / Coaxial Ceiling Speaker
  - Driver Size : 1 x 4'' LF & 0.75'' HF Driver
  - Nominal impedance: 8Ohm
  - Sensitivity: 84dB or better
  - RMS Power : 30 W
  - In-built transformer Tap : 100V / 70V upto 25W
  - Maximum SPL : RMS - 99dB , Peak - 105dB
  - Dispersion: 110 Degree Conical @ 1kHz
  - Frequency Range (-10 dB) : 70 Hz-20 kHz
  - Certification: UL 94V-0, EN54-24:2008 certified Type A, UL 1480/UL 2043
  - Enclosure: Steel Backcan
  - Aluminum, powder coated grill
- Included Accessories: Metal grille, cable gland, flex conduit, C-ring, tile-bridge kit, paint mask, cutout template, should have option of Black and white colour to choose



- 26.5 Passive Column Array Loudspeaker  
7 Full Range Drivers and Dispersion Control  
Speaker Type: Passive Column Array speaker  
Driver Size : 7 x 3.5'‘ Full range Driver  
RMS Power : 150 W  
Built-in transformer Tap : 100V / 70V upto 150W  
Maximum SPL : Peak - 118dB  
Sensitivity : 90dB  
Dispersion: 130 (H)  
Frequency Range : 110 Hz – 14 KHz  
Rating : IP65, EN 54-24 Certified  
Enclosure : Aluminium extrusion  
Powder coated perforated steel grill  
Included Accessories: Flying bracket, wall mount bracket, input panel cover plate and gland
- 26.6 Central Conference Controller with Recording facility  
Conference Controller with built-in Digital Signal Processing  
Control upto minimum 50 Discussion Unit and expandable upto 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  
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
- 26.7 Flush Mount Chairman Discussion Unit  
Chairman Discussion Unit with Gooseneck Microphone of minimum Length 400mm 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

Loop-through, daisy-chain cabling

Different LED Signaling for Mic On/Off OR Request-to-Speak Push Button

Audio Quality 16Bit digital

Frequency Response: 30Hz-15kHz

Microphone with 400 Gooseneck Length

Polar Pattern: Unidirectional, Cardioid

Max SPL @ 1kHz: 110dB SPL

S/N Ratio: 67dB-A

Connection: Screw Lock

Material: Brass

Certification: CE

**26.8 Flush Mount Delegate Discussion Unit**

Delegate Discussion Unit with Gooseneck Microphone of minimum Length 400mm 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 Signaling for Mic On/Off OR Request-to-Speak Push Button

Audio Quality 16Bit digital

Frequency Response: 30Hz-15kHz

Microphone with 400 Gooseneck Length with

Polar Pattern: Unidirectional, Cardioid

Max SPL @ 1kHz: 110dB SPL

S/N Ratio: 67dB-A

Connection: Screw Lock

Material: Brass

Certification: CE

**26.9 Wired Omnidirectional Condenser Boundary Microphone with USB**

- ELEMENT: Condenser
- Pick up Pattern: Omnidirectional
- Frequency Response: 50 – 15,000 Hz
- Open Circuit Sensitivity : -46 dB

- Cable: terminated with USB connector
- 26.10 UHF Wireless Handheld Cardioid Dynamic microphone system  
Receiving System : True Diversity  
Modulation mode : FM  
Frequency Response : 100 Hz to 15000 Hz  
RF Sensitivity: 20 dBuV at 60 dB S/N ratio (50 ohms termination)  
Total Harmonic Distortion: 1.0 % or less (at 1 kHz,  $\pm 17.5$  kHz deviation)  
Dynamic Range 110 dB or higher (A-weighted), typical  
switch function : Mute/unmute & On/OFF  
Automatic frequency scanning to find open channel  
Operating range: 100 m  
RF Power Output High: 30 mW, Low: 10 mW (switchable)  
No. of Channel : 10 channels per band  
Built-in Tone Lock™ digital identification system  
Antenna Input : BNC type, 50 $\Omega$  - BIAS voltage 12V DC 60mA each for powering an antenna booster, active splitters, an antenna combiner or any other active component.  
Maximum Output level XLR / Balanced: +9 dBV & 6.3 mm (¼”) / Unbalanced: +4 dBV  
Balanced and unbalanced outputs  
Balanced audio output attenuator : Two position switch: 0/-12 dB  
Accessories Included: detachable Antennas, Rack mount kit
- 26.11 UHF Wireless Lavalier Cardioid Condenser Microphone system  
Receiving System : True Diversity  
Modulation mode : FM with beltpack transmitter  
Frequency Response : 100 Hz to 15000 Hz  
RF Sensitivity: 20 dBuV at 60 dB S/N ratio (50 ohms termination)  
Total Harmonic Distortion: 1.0 % or less (at 1 kHz,  $\pm 17.5$  kHz deviation)  
Dynamic Range 110 dB or higher (A-weighted), typical switch function: Mute/unmute & On/OFF  
Automatic frequency scanning to find open channel  
Operating range: 100 m  
RF Power Output High: 30 mW, Low: 10 mW (switchable)  
No. of Channel : 10 channels per band  
Built-in Tone Lock™ digital identification system  
Lavalier Terminated with locking 4-pin connector  
Antenna Input : BNC type, 50 $\Omega$  - BIAS voltage 12V DC 60mA each for powering an antenna booster, active splitters, an antenna combiner or any other active component.  
Maximum Output level XLR / Balanced: +9 dBV & 6.3 mm (¼”) / Unbalanced: +4 dBV  
Balanced and unbalanced outputs

Balanced audio output attenuator : Two position switch: 0/-12 dB

Accessories Included: detachable Antennas, Rack mount kit

#### 26.12 Ceiling microphone tile

Ceiling microphone tile with 24 or more microphones, with 5 or more static beams and 1 or more dynamic beam, Built-in Smart Mix, AEC, AGC and EQ, Built-in Analog input and output, DANTE Interface, Built-In LED indicator port, Shall be able to Can be used as flush mount, surface mount or hanging type depending on requirements as per site condition, IP control port. etc. and complete as required

#### 26.13 6 Channel Digital Processor Mixer

Inputs : 4 balanced mic, 2 balanced Mic/Line, 1 stereo unbalanced input

Inputs equipped with Low-cut filter, phase inversion and 4-band EQ

Onboard 6 channel AEC processing

1 stereo and 2 mono outputs

Each output channel equipped with adjustable output level, 12-band fully parametric EQ with notch filtering, compressor, limiter, and 8-band feedback suppressor.

2-channel USB audio interface

8 x 3 audio routing matrix

Maximum Gain : 64 dB

Dynamic Range : 110 dB or better

Signal-to-noise ratio: 90 dB or better

Microphone Phantom Power : +48V DC

Front panel Monitoring, Controls and LED indicators

Web Remote functionality

IP control for third-party CCS administration

Cascadable upto 6 units

Euroblock connectors

Accessories Included : Rack-mount adapters

#### 26.14 DUAL Wireless Lapel Microphone system in UHF band.

- IR synchronism between receiver and microphones.
- LCD display with AF, RF, gain and frequency information.
- Individual and Mix outputs of two channel
- RECEIVER Frequency band - True Diversity
- Frequency response - 20 Hz - 20kHz
- S/N Ratio >104dB (A)
- Dynamic range >99.5dB
- LAPEL MICROPHONE -
- Polar Pattern - Cardioid
- RF output power - 30 mW

- S/N Ratio >104dB (A)
- 26.15 DUAL Wireless Handheld Microphone system in UHF band.
- IR synchronism between receiver and microphones.
  - LCD display with AF, RF, gain and frequency information.
  - Individual and Mix outputs of two channel
  - RECEIVER Frequency band - True Diversity
  - Frequency response - 20 Hz - 20kHz
  - S/N Ratio >104dB (A)
  - Dynamic range >99.5dB
- HANDHELD MICROPHONE -
- Polar Pattern - Cardioid
  - RF output power - 30 mW
  - S/N Ratio >104dB (A)
- 26.16 11" Electret condenser gooseneck microphone-
- Cardioid polar pattern and slimline profile design.
  - The microphone is constructed from high quality brass construction semi-rigid shaft with 8mm gooseneck.
  - Frequency Response 50 Hz - 18 KHz.
  - Sensitivity -40dB
  - A Reed switch is fitted to allow pop / click free muting of a microphone.
  - The microphone is fitted with a phantom power adaptor accepting 9 to 48 volts DC
  - Including Shock Absorbing Through Table Microphone Mount.
- 26.17 Boundary Microphone:
- Retractable Through Table Cardioid Condenser Boundary Layer Microphone.
  - Cardioid polar pattern.
  - The Microphone is push activated for both UP and Down positions
  - Built-in mechanism that will allow the user to make the microphone disappear without having to physically remove it from the table
  - The Microphone is engineered in high quality brass for long life and smooth act.
  - Impedance 200 Ohms
  - Frequency 50Hz - 18HZ
  - Sensitivity  $-37 \pm 3\text{dB @ 1 KHz}$  (0db = 1V/Pa)
- 26.18 Audio DSP:
- Audio Format 24 bits, 48 kHz sampling rates
  - System Latency < 6 ms
  - Analog I/O Channels 12×8

- Supports adaptive echo cancellation (AEC), adaptive feedback control (AFC), automatic gain control (AGC), automatic mixture control (AMC), automatic noise suppression (ANS),
- Built-in USB interface,
- GPI/O Port - 8 GPI/O

**26.19 6" ceiling speaker 50W RMS**

The Item consists of Compact Full Range 6" ceiling speaker 50W RMS Power @8Ohm.

**26.20 Audio Amplifier:**

- Class D Multichannel Amplifier - Output Power (100V & 70V line) 2x 115W
- Input sensitivity 1V ( $\pm 0.1$ V)
- Frequency response : 102 Hz - 14.5 kHz
- Voltage gain (100V) : 39 dB
- THD+N <0.1%
- S/N rate >94 dB
- Crosstalk >69dB

**IV- Access Control System**

The system should support seamless integration with CCTV & Fire Alarm Systems.

- Communication Speed - 9600, 19200, 57600, and 115200 bps
- It is possible to issue maximum 15 cards per user under single user id to create uniformity in data base.
- DB format SQL Express Server 2012, password protected.
- DB Backup, Backup now option or clear all now option Complete DB export configuration or by event (selectable backup and restore) for easy set up and configuration.
- The system is intended to ensure situational awareness by displaying relevant information like events or devices in a Map.
- The access control system application software shall be client server architecture.

**1 2 Reader 2 Door Controller**

The Item consists of Surface mounted 2 Reader 2 Door Controller capable of controlling multiple readers(IN/OUT) along with TCP/IP Connectivity complete as per specification control panel housed in MS Powder coated cabinet with tamper switch complete with power supply unit for controller & magnetic locks.

**2 Smart Card Readers**

The Item consists of smart card readers as per specifications suitable for mounting on metal surface/metal frames or wooden frames wall or as required based on site conditions including all accessories

3 Digital Lock without cut-out.

Digital door lock to be stand-alone systems with an electronic control mechanism. The lock to be enable to be operated with all three modes with fingerprint + password + IC card from the list of specified make with necessary accessories. Should have a capacity of 10 administrators and more than 300 ordinary users. Should have minimum 2 cards. Cost of two cards included. Locks to operate either on alkaline batteries or rechargeable lithium-ion cell ones. In both cases, an alert or indicator should be there to indicate the level of battery level when batteries need to be replaced. Lock to have Speedy and accurate access with the optical finger print authentication. The fingerprint recognition to be robust against any dust or foreign materials.

3 Panic bar with electric latch retraction.

Constructed from heavy gauge rolled steel section with heavy duty touch bar mechanism that has been used successfully in all architectural grade touch bar devices. The panic bar exit device for all types of single and double doors with mullion and the hardware. Panic Bar should be is for panic exit hardware. It should be specifically designed for use in areas where frequent usage can be expected.

4 Workstation for ACS

The Item consists of workstation ( i-7 PC, with 8 GB RAM and 1 TB HDD, 10/100 Mbps Ethernet card, USB connection and internal modem, Microsoft(R) Windows(R) 7 OS Professional Enterprise, Web Server Software, DVD-ROM Drive (with RAM), 100/1000 Mbps NIC for Network connection and antivirus software with 22" colour graphics monitor as per Tender Specifications. Accessories included Optical Mouse, Key Pad.)

5 Access Control Software

The Item consists of Access Control Software, Software shall be based on a standard Client-Server architecture, Capacity for 128 reader capacity and 20,000 card holder capacity Basic GUI ,TA Module, Alarm Module 5Nos client Module for usion SQL DB and multi site Module. The server connects to the database the clients draw the information from the server: Clients connect to the server using a LAN remote communication

- User-friendly PC software with intuitive layout reduces the complexity of access control
- Manages user data, photo and information fields, access rights, alarms, strike time, and door mode, all from one central location
- Produces reports from acquired data, such as entry and exit times, as well as alarm types initiated by user, location, and time events

- Available in multiple languages and date formats
- Compatible with additional video management software modules
- Password controlled login in which it is possible to grant individually based restricted. Security rights for different operators, with access to only specified elements of the system or with read-only access.
- The Software graphic user interface (GUI) shall allow users to configure, monitor, and control every aspect of a facility's access control network.
- When a user selects an element from the Tree View, its contents are shown in the main display area, and the toolbar icons change to suit the selected element.

## 6 BOOM BARRIERS

The Item consists of K4 crash rated boom barrier 5 & 2.5 meter hydraulic barrier with opening/Closing time Between 5 to 6 seconds/100% duty cycle.

Hydraulics' Drive Mechanisms with internal locking feature circuit controller for Auto off in fully raised & lowered position with limit switches and manual operation in case of Power failure. PCB Electronic to automatically switch off motor in case of fault.

Technical Parameters:

- Blocking height - 110 cm
- Blocking dimensions - 125 mm x 75 mm
- Opening /Closing time - 5-8 sec
- Steel Structure – Complied - K4, K8 & K12
- Corrosion Protection - Galvanized
- Ingress Protection - IP 54
- Duty Cycle - 100%
- Operating temperature - 15 + 55 deg C
- Operating Humidity - 98%
- Power Consumption - 1300 W
- Power Supply - 3 Phase, 400-440 V, AC 50-60 Hz
- Absorbed Current - 3-5 A

## 7 BAGGAGE SCANNER

Baggage X-Ray Scanner (Medium 550 mm X 350 mm Tunnel Size or Equivalent),

- a) Tunnel Sizes :- 530 mm X 320 mm, 530 mm X 350 mm and 550 mm X 350 mm
- b) Penetration :- Greater Than or Equal to 10 mm
- c) Resolution Wire Detectability :- Standard / Guaranteed :- Greater Than or Equal to 38 AWG Typical :- Greater Than or Equal to 39 AWG.
- d) Generator :- Greater Than or Equal to 90 kV
- e) Beam Direction :- Vertically Upward / Diagonal / Dual



- f) Duty Cycle :- 100%
- g) Operating Temperature :- 0 Degree to 50 Degree
- h) Operating Humidity :- Up to 95% Non-Condensing
- i) Entry and Exit Rollers Tables :- Yes Required in 0.5 meter or 1 meter or 1.5 meter length as per space requirement.
- j) Barriers for Rollers :- Yes Required
- k) Certifications :- US, CE and AERB (India)
- l) Standards Features :- All Required as Stated in the Data Sheets
- m) Tropical Kit/Power Conditioner etc. :- Required
- n) Mandatory Features Required along with Standard Features :- X-ACT / Screener Assist Threat Detection / Target, Threat Image Projection / HI-TIP, OTP / X-TRAIN, Density Threat Alert (DTA) / High Density Alert (HAD), Advance Image Archiving 100, 000 Images

## **V- IT Network**

### **1 PASSIVE NETWORKING COMPONENTS**

#### **1.1 UTP 4 pair 23 AWG CAT 6A LSZH Cable**

The Item consists of UTP 4 pair 23 AWG CAT 6A LSZH Cable in the existing surface/ recessed steel/ PVC conduit as required conforming to the following standards like ANSI/TIA 568 C.2, IEC 60332-1, IEC 60754-1. Cable Dia 8.0 mm with bending radius -4 X Cable Diameter Operates at frequency of 500 Mhz

##### **Construction**

- Conductor 23 AWG solid bare copper
- Insulation High Density Polyethylene
- Pairs 2 insulated conductors twisted together
- Sheath LSZH
- Cable Diameter 8.0 mm Nominal
- Electrical Properties
- Conductor Resistance  $\leq 9.3 \text{ Ohm}/100\text{m}$
- Mutual Capacitance  $< 5.6\text{nF}/100\text{m}$
- Resistance Unbalance 5% Max
- Capacitance Unbalance 330pF/100m
- Delay Skew  $< 45\text{nS}$

##### **Mechanical Properties**

- Bending Radius 4 x Cable Diameter at  $-20^{\circ}\text{C} \pm 1^{\circ}\text{C}$
- Pulling Force 11.5 Kg

- Temperature Range -20°C to +70° C

#### Flame Properties

- Flammability Test IEC 60332-1
- Acid Gas Emission Test IEC 60754-1
- Smoke Density Test ASTM 2843

#### 1.2 24 Port Patch panels

The Item consists of 24 Port Patch panels CAT6A (1U with rear wire manager) 24°silver-plated IDCs (insulation displacement connection) for secure, reliable gas-tight connections

#### 1.3 Dual port Face Plate

The Item consists of Dual port Face Plate : Polycarbonate Hi-Grade Plastic FR Grade & UV Resistant 850 degree C/ Glow Wire Test. The face plate should be compatible for Cat5e, Cat6 & Cat6A range of RJ45 .The face plate Size should be of minimum 86x86mm

#### 1.4 Quad port Face Plate

The Item consists of Quad port Face Plate : Polycarbonate Hi-Grade Plastic FR Grade & UV Resistant 850 degree C/ Glow Wire Test. The face plate should be compatible for Cat5e, Cat6 & Cat6A range of RJ45 .The face plate Size should be of minimum 86x86mm

#### 1.5 CAT6A RJ45 tool less I/O

The Item consists of CAT6A RJ45 tool less I/O with a separator to eliminate crosstalk, on concealed wall mounted boxes, impacting of I/O's (CAT6 RJ45 I/O) & installation /impacting of surface mount boxes (includes labelling)

Should Accept RJ11 (4 contacts), RJ12 (6 contacts), RJ45 (9 contacts).Double colour code EIA – TIA 568 A and B on terminals:- STP 9 contacts 360° screen Double-wire: 0.5 to 0.65 mm, AWG 22 to 25

Multiple-wire: AWG 26

Polyethylene conductor insulation: max Ø with insulation 1.58 mm

Information outlet should have transparent shutter for protection against dust when not used.

The information outlet termination should be of built in self crimping type without use of 110 punching tool requirement

Contacts : gold/nickel, minimum thickness of gold > 0.8 µm

Metal parts : bronze, nickel, platinum, gold

The information outlet shall be made of high impact PBT Polycarbonate plastic material

Greater than or equal to 1000V

Less than or equal to 20mOhms

Greater than or equal to 500 M Ohm at 100 V DC

Connector should be tested and guaranteed under PoE restrictions, IEEE 802.3af standard and PoE+, standard 802.3at, up to 2500 on-load connections / disconnections.

Tested with 2 simultaneous PoE+ circuits for a minimum total power of 50W

- 2500 mating cycles (plug insertion/withdrawal). IK03
- ISO 11801 Second edition
- EN 50173 Second edition
- EIA/TIA-568-C.2
- NF C 20730
- Standard 8877 - 603.7
- 3P, UL, ETL and RoHS
- 25 years warranty
- -40 Deg C to +70 Deg C"
- Terminates 8 conductors at the same time reducing installation time
- 45° silver-plated IDCs provide secure, reliable gas-tight connections

#### **1.6 CAT6A UTP 24 AWG Patch Cord - 1 mtr**

The Item consists of CAT6A UTP 24 AWG Patch Cord - 1 mtr with cross separator, Manufactured from stranded wires for longer flex-life , Minimum length of 1m, and maximum length of 5m Conforming to the following standards like EN 50173, ISO/IEC 60603-7 & 11801/IEC 60332-1, UL VW-1

Performance at 500 MHz IEC 61935-2 - Ed. 3.0 / ISO/IEC 11801

Usage Temperature – 20 to + 60°C

Jacket PVC / LSZH

Technical and Mechanical Features

- Diameter over Insulation (mm): 1.03
- Operating temperature range: -10°C to +60° C
- Cable Diameter (mm): 6.5
- No of Twists: 500
- No of insertions: 750
- AWG gauge: 26
- Tensile Strength of the cord:  $\geq 50$  N

#### Electrical Features

- Contact Resistance: Less than 20 m Ohm
- Total Resistance of the cord: Less than 5 Ohms
- Resistance per 100m of cable with cord: Less than 14 Ohm
- DC Dielectric Strength: 1 KV/ 1 min"

Over-molded boot at each end provide strain relief and maintains minimum bend radius of the cable. Assembled with RJ45 50 $\mu$ " gold plated contacts according to IEC 603.7/class A.

### 1.7 CAT6A UTP 24 AWG Patch Cord - 2 mtr

The Item consists of CAT6A UTP 24 AWG Patch Cord - 2 mtr with cross separator, Manufactured from stranded wires for longer flex-life , Minimum length of 1m, and maximum length of 5m Conforming to the following standards like EN 50173, ISO/IEC 60603-7 & 11801/IEC 60332-1, UL VW-1

Performance at 500 MHz IEC 61935-2 - Ed. 3.0 / ISO/IEC 11801

Usage Temperature – 20 to + 60°C

Jacket PVC / LSZH

#### Technical and Mechanical Features

- Diameter over Insulation (mm): 1.03
- Operating temperature range: -10°C to +60° C
- Cable Diameter (mm): 6.5
- No of Twists: 500
- No of insertions: 750
- AWG gauge: 26

- Tensile Strength of the cord:  $\geq 50$  N

#### Electrical Features

- Contact Resistance: Less than 20 m Ohm
- Total Resistance of the cord: Less than 5 Ohms
- Resistance per 100m of cable with cord: Less than 14 Ohm
- DC Dielectric Strength: 1 KV/ 1 min

#### 1.8 Fiber Cable Multimode

6 core OM3 indoor/outdoor rated, with waterblocked fiber elements and U/V stabilized sheath Loose tube construction, Permanent tensile strength minimum 350N, Maximum installation tensile strength 1000N, Impact resistance 25Nm, Low Smoke Zero halogen jacket, fire rated for IEC 60332-1-2, IEC 60754-1, IEC 60754-2, IEC 61034-2 and confirming to (TIA/EIA 492 AAAD) through existing GI/HDPE/ Hume pipe or on cable trays inside the cable duct including all necessary fixing accessories e.g. cable ties, hardware etc.

#### 1.9 12 Port LIU

The Item consists of 12 Port LIU (fiber optic interconnecting unit) Rack Mount 19" housing with front modules/ Couplers with blank adapter panel & Fully loaded with 24 Pigtailes, Splice tray & Cable Management accessories

#### 1.10 24 Port LIU

The Item consists of 24 Port LIU (fiber optic interconnecting unit) Rack Mount 19" housing with front modules/ Couplers with blank adapter panel & Fully loaded with 24 Pigtailes, Splice tray & Cable Management accessories

#### 1.11 Duplex Fiber optic patch cords

The Item consists of Duplex Fiber optic patch cords Multimode (LC to LC) - OM3 50/125

Factor SFP Connector

SC - Standard Connector ("Shove & Click")

SC stands for Subscriber Connector- a general purpose push/pull style connector.

#### 1.12 OM3 50/125μ Type Pigtailes

The Item consists of OM3 50/125μ Type Pigtailes of ISO/IEC-11801-OM3 Pigtailes with LC Type Connectors, pigtailes for terminating fibers on the FOPP complete in all respect.

## 2 NETWORK RACKS

### 2.1 Network Rack - 24U

The Item consists of Floor Standing Network Rack - 24U / 600w / 600d, with Heavy Duty Extruded Aluminium Frame for rigidity. Top cover with FHU provision. Top & Bottom cover with cable entry gland plates. Two pairs of 19" mounting angles with 'U' marking. Depth support channels - 3 pairs. With a Overall Weight Carrying Capacity of 500Kgs. Side Panels - 24U/600d Front Glass Door p 24U/600w Rear MS Door (Fully Perforated - Mesh) 22U/600w Fan 90CFM 230V AC, 4" dia Castors with Brake (set of 4) Cable manager 1U MS with Loops Shelf, Stationery 475mm N/W PDU 7Sockets 5Amps with MCB Mounting Hardware (Pkt. Of 20) Vertical Cable Channel 50mmW 22U complete in all respect.

Front Door S12C 19" / 24U

AC Distribution Box + H/W (02 Nos. of 6 Points of 5/15 AMP sockets - (Horizontal)

19" 1U Cable Manager PVC with duct fingers x 2

Fan housing unit 4 Fan POSN

Fans 90 CFM 230 VAC

Mounting Hardware (Pack of 10) x 5

### 2.2 Network Rack - 42U

The Item consists of Floor Standing Network Rack - 42U / 800w / 1000d, with Heavy Duty Extruded Aluminium Frame for rigidity. Top cover with FHU provision. Top & Bottom cover with cable entry gland plates. Two pairs of 19" mounting angles with 'U' marking. Depth support channels - 3 pairs. With a Overall Weight Carrying Capacity of 500Kgs. Side Panels - 42U/1000d Front Glass Door 36U/800w Rear MS Door Split Perforated honeycomb 42U/800w Fan 90CFM 230V AC, 4" dia Castors with Brake (set of 4) Vertical Cable manager 80mmW 42U Shelf, Stationery 700mm N/W PDU 12Sockets 5/15Amps with MCB Mounting Hardware (Pkt. Of 20) earthing Kit 150mmH Cable manager 1U MS with Loops complete in all respect.

Enclosure Type: 42 U Floor Standing Rack

Compliance with standards: UL, IEC

Degree of Protection: The unit should have a minimum of IP 20

Earthing: All cabinet components (doors, side panels, top panels, 19" rails, pdu brackets) shall be grounded directly to the frame using Dual Copper plated earth stud of suitable rating on main Metal parts for better electrical continuity.

Weight Capacity: Load Capacity of minimum 1200 Kg

Coating: Powder coated black with fine texture – 60 to 80 uM

Material & Features:

- a) Enclosure: Modular Construction of the rack made of 4 vertical, 4 horizontal & 4 depth aluminum/MS bolted and joined together with Links . and Corner Block. Enough support channel to equate the load evenly and castor provision at bottom side.
- b) Top and Bottom: Top cover consist of Fire Retardant Brushes and Fire retardant ABS plastic / MS frame for cable and fiber entry to rack from fiber runner and copper cable pathway system. This consists of Brush with 2 line of brush system UL Certified Fire Retardant Brushes and Fire.
- c) Mounting Angle: 19" Upright adjustable in depth, equipment mounting angles with square slots to accommodate M6 cage nuts, powder coated texture finish. It contains U printing pattern which can be read from down to up and vice versa."

Dimensions should be minimum of 800mm (W) x 1000mm (D), All mounting / cable management accessories & Castors). - Not exceeding 2200mm in height (For Server room - Servers, Voice & IP Surveillance)

2 Nos. of 1U power distribution box, with 10 x IEC - C13 sockets & with 32Amp MCB-terminating on a IP56 power sockets - Vertical in each rack

1 No. Horizontal PDU with 5/15Amp Universal Sockets with 32Amp MCB Grounding / Bonding kit 42U in each rack

Mounting Hardware (Pack of 10) x 10

Cantilever tray & Keyboard Tray

Stationary Shelf - full depth (2Nos.)

### 2.3 Network Rack 36U

The Item consists of Closed Network Rack 36U- with Side panel, Perforated Doors,

Dimensions should be minimum of 800mm (W) x 800mm (D), All mounting /

cable management accessories & Castors). - Not exceeding 2200mm in height (For Server room - Servers, Voice & IP Surveillance)

2 Nos. of 1U power distribution box, with 10 x IEC - C13 sockets & with 32Amp MCB-terminating on a IP56 power sockets - Vertical in each rack

1 No. Horizontal PDU with 5/15Amp Universal Sockets with 32Amp MCB Grounding / Bonding kit 42U in each rack

Mounting Hardware (Pack of 10) x 10

Cantilever tray & Keyboard Tray

Stationary Shelf - full depth (2Nos.)

**2.4 9U (W 600mm / D 600mm) Close rack**

The Item consists of 9U (W 600mm / D 600mm) Close rack 19" Floor mount :

AC Distribution Box + H/W (5 Points of 5/15 AMP sockets - (Horizontal)

19" 1U Cable Manager PVC with duct fingers x 5

Fan housing unit 4 Fan POSN

Fans 90 CFM 230 VAC

Castor Set Normal/ Brake

Bar, Earthing 9U

Mounting Hardware (Pack of 10) x 5

**2.5 15U (W 600mm / D 600mm) Close rack**

The Item consists of 15U (W 600mm / D 600mm) Close rack 19" Wall mount :

Front Door S12C 19" / 15U

AC Distribution Box + H/W (5 Points of 5/15 AMP sockets - (Horizontal)

19" 1U Cable Manager PVC with duct fingers x 5

Fan housing unit 4 Fan POSN

Fans 90 CFM 230 VAC

Mounting Hardware (Pack of 10) x 5



2.6 27U (W 600mm / D 650mm) Close rack

The Item consists of 27U (W 600mm / D 650mm) Close rack 19" Floor mount :

Front Door S12C 19" / 24U

Rear Door S12C 19" / 24U

Side Panels S12C 24U / 800mmD

AC Mains Channel (10 Points of 5/15 AMP sockets - (Vertical)

AC Distribution Box + H/W (5 Points of 5/15 AMP sockets - (Horizontal)

19" 1U Cable Manager PVC with duct fingers x 5

Fan housing unit 4 Fan POSN

Fans 90 CFM 230 VAC

Castor Set Normal/ Brake

Bar, Earthing 36U

Mounting Hardware (Pack of 10) x 5

a) Accessories:

a. Castor: Set of 4 castors with levelling feet, 2 brakes on front side and 2 without brakes.

b) b. Mounting Hardware: Mounting Hardware Packets with set of M 6 screw, Cage Nuts and Washer set of 10 or 20

c) c. Characteristics value Indicated (Hx W x D):

3 **ACTIVE NETWORKING COMPONENTS**

3.1(a) Router

Supply, installation, testing & commissioning of Router: complete in all respect 5 Year OEM NBD warranty and 24x7 TAC support.

Router should be modular in architecture with 4 x 1G interfaces plus 2x 10G interface. Minimum 1 slot should be free for future expansion.

The router should support minimum of 10 Gbps of SD-WAN IPsec throughput

Should have redundant Internal hotswappable power supplies.

Should support minimum 6000 IPsec tunnels

Should support min 8GB DRAM (upgradable to 16GB or higher) and 8 GB flash/SSD memory

Router should be provided with SD-WAN features from day 1

Shall support Routing protocols like RIP ver1 & 2 OSPF ver2.

Multicast routing protocols support: IGMPv1, v2, PIM-SM and PIM-DM.

Shall support IPv6 features: DHCPv6, IPv6 QoS, and OSPFv3 for IPv6.

Shall support IP Accounting features

Shall support QoS, Class-based Weighted Fair Queuing, Weighted Random Early Detection, PBR, FEC, CoS Marking

Shall support the following

AAA support using Radius and/or TACACS

GRE

IPSec

Multiple privilege level authentication for console and telnet access

The device should work in SD-WAN Mode managed by controller. However if required it should work as standalone routing platform without controller.

Shall have support for management thru Telnet, SSH, Secure Web based management thru HTTPS and SNMPv3 and Out of band management through Console and external modem for remote management

Should provide a provision to analyse IP service levels for IP applications and services by using active traffic monitoring (the generation of traffic in a continuous, reliable, and predictable manner) for measuring network performance.

Should support flow-based traffic analysis of applications, hosts, performance-based measurements on application and network latency, quality of experience metrics for network-based services such as voice over IP (VoIP) / video.

Should have the ability to monitor events and take informational, corrective, action when the monitored events occur or when a threshold is reached.

The router shall conform to UL 60950 or IEC 60950 or CSA 60950 or EN 60950 Standards for Safety requirements of Information Technology Equipment.

The router shall conform to EN 55022/32 Class A/B or CISPR22/32 Class A/B or CE Class A/B or FCC Class A/B Standards for EMC (Electro Magnetic Compatibility) requirements.

All associated racks, patch panel, patch cords, face plates and cabling requirements of all kinds will be provided from day 1.

All applicable licenses will be provided for the entire warranty duration or minimum 3 years whichever is later.

### **3.1 (b) Core Switch**

The Item consists of Core Switch: Supply, installation, testing & commissioning of Core Switch: 32-port 40G/100G QSFP28 Ports. With advanced L3 features including dual field replaceable Power supplies. 40 Gig connectivity between Core switches and

Distribution Switch and 100G Connectivity between Core Switches thru QSFP+ cable for HA mode complete in all respect 3 Year OEM On site NBD warranty. For detailed technical specification, please refer tender.

Switch should be 1U and rack mountable in standard 19" rack.

Switch should support Line rate architecture, non-blocking Layer2 switching and layer 3 routing feature from day one. Should have advanced L3 features supporting all required L3 Protocols from day 1..

Switch should support dynamic routing and Layer 3 features etc. for IPv4 and IPv6 from day 1.

Switch shall scalable and modular architecture to provide the enhance performance. Switch should have USB/Ethernet management interfaces. It should support 64K mac address from day one.

100 Gig connectivity between Core switches thru QSFP+ cable for HA mode complete in all respect.

It should have minimum 8 GB RAM and 8 GB Flash Memory and support 9K MTU

It should have minimum switching capacity of 6400 Gbps and throughput performance of 2000 Mpps

Minimum No of VLAN and VLAN Id supported should be 4000

It should have Console port; Internal, Redundant Power supply; Redundant fan; it should have Operating System.

It should support Policy based routing from day one.

Should support L3 routing protocol Static Routing, RIPv1, RIPv2, BGP, OSPFv2, OSPFv3, RIPng,PBR, QoS from day one. It should support protocols OSPFv2, OSPFv3, PBR, BGP, BGP4, IS-IS,PIM-SM,PIM-SSM from day one.

Should support protocol MPLS, BGP, BGP4, IS-IS, PIM-SM,PIM-SSM,VRF Lite from day one

Switch should support 802.1x authentication and accounting, IPv4 and IPv6 ACLs and Dynamic VLAN assignment and minimum MACSec (AES-128) in all ports. Switch should support Access control lists (ACLs) provide IP Layer 3 filtering based on source/ destination IP address/subnet and source/ destination TCP /UDP port number.

Switch should support Simple Network Management Protocol (SNMPv2 and SNMPv3).

Switch should Support for authentication, authorization, and accounting (AAA) using RADIUS and TACACS+.

Switches must be able to deliver 100% of functionalities - licenses and Subscription model must be defined from day1.

Switch should support VLAN s support.

Switch shall conform to UL 60950 or IEC 60950 or CSA 60950 or EN 60950 Standards for Safety requirements of Information Technology Equipment.

Switch shall conform to EN 55022 Class A/B or CISPR22 Class A/B or CE Class A/B or FCC Class A/B Standards for EMC (Electro Magnetic Compatibility) requirements.

Switch should be tested for EAL3/NDPP or above under Common Criteria Certification.

All associated racks, patch panel, patch cords, face plates and cabling requirements of all kinds will be provided from day 1.

### **3.2 24 port 10/100/1000BASE-T POE+**

Supplying Installation testing and Commissioning of 24 port 10/100/1000BASE-T PoE ports and four GbE/10GbE SFP/SFP+ uplink ports,

Switch should have Management port to manage switch.

Switch must support minimum 8 no of stacking with minimum 160 Gbps of stacking bandwidth from day-1.

Switch should support Line rate architecture from day one. Proposed switch must be L2 and L3 capable switch.

Switch shall scalable and modular architecture to provide the enhance performance

Switch should support dynamic routing and features etc. for IPv4 and IPv6 from day 1.

Switch shall scalable and modular architecture to provide the enhance performance . Switch should have USB/Ethernet management interfaces. It should support 32K mac address and 4GB DRAM and 4GB Flash from day one.

It should have minimum switching capacity of 128 Gbps and throughput/forwarding rate performance of 95 MPPS

Minimum No of VLAN and VLAN Id supported should be 1000 from day one.

It should have Console port; Internal, Redundant Power supply ; Redundant fan; it should have Operating System.

It should support Policy based segmentation from day one.

Should support IEEE Standards of Ethernet: IEEE 802.1D, 802.1s, 802.1w, 802.1x, 802.3ad, 802.3x, 802.1p, 802.1Q, 802.3, 802.3u, 802.3ab, minimum MACSec -128 in all ports.

For QoS, shall have 802.1p class of service, IP differentiated service code point (DSCP) and IP precedence. Switch should support marking, classification, policing and shaping. Should support strict priority queuing. Switch should support port security. DHCP snooping to allow administrator to ensure consistent mapping of IP to MAC address. Switch should support IPv4 and IPv6 ACLs, VLAN, Port and Time based access list with time ranges

Switch should support Simple Network Management Protocol (SNMPv2 and SNMPv3), SSHv2, Configuration and management through CLI, GUI, console, telnet, SSH. Switch should support NTP. Should support LACP within and across switch, DHCP server & client and DHCP relay Should have LLDP support.

Switch should Support for authentication, authorization, and accounting (AAA) using RADIUS and TACACS+.

Switches must be able to deliver 100% of functionalities - licenses and Subscription model must be defined from day1.

Switch should support VLAN s support.

Switch shall conform to UL 60950 or IEC 60950 or CSA 60950 or EN 60950 Standards for Safety requirements of Information Technology Equipment.

Switch shall conform to EN 55022/55032 Class A/B or CISPR22 Class A/B or CE Class A/B or FCC Class A/B Standards for EMC (Electro Magnetic Compatibility) requirements.

Switch should be tested for EAL3/NDPP or above under Common Criteria Certification.

All associated racks, patch panel, patch cords, face plates and cabling requirements of all kinds will be provided from day 1.

All applicable licenses will be provided for the entire warranty duration or minimum 3 years whichever is later.

**3.3 24 port 1/10GbE SFP+ Distribution Switch**

Supply, installation, testing & commissioning of Distribution Switch: 24 1/10GbE SFP+ multi mode ports, 2 nos 40/100GbE QSFP+ fully loaded ports. With advanced L3 features including dual Power supplies. 40 Gig connectivity between Core switches thru QSFP+ cable for HA mode complete in all respect 3 Year OEM On site NBD warranty. For detailed technical specification, please refer tender.

Switch should be 1U and rack mountable in standard 19" rack.

Switch should support Line rate architecture, non-blocking Layer2 switching and layer 3 routing feature from day one. Should support advanced L3 features supporting all required L3 Protocols from day 1.

Switch should support dynamic routing and Layer 3 features etc. for IPv4 and IPv6 from day 1.

Switch shall scalable and modular architecture to provide the enhance performance. Switch should have USB/Ethernet management interfaces. It should support minimum 32K mac address from day one.

Switch should have 24 no 1/10GbE SFP+ multi- mode ports, 2 no 40/100 GbE QSFP+ ports fully populated from day one.

40 Gig connectivity between Distribution switches thru QSFP+ cable for HA mode complete in all respect.

It should have minimum 8 GB RAM and 8 GB Flash Memory and support 9K MTU

It should have minimum switching capacity of 800 Gbps and throughput performance of 550 Mpps

Minimum No of VLAN and VLAN Id supported should be 4000

It should have Console port; Internal, Redundant Power supply; Redundant fan; it should have Operating System.

It should support Policy based routing from day one.

Should support L3 routing protocol Static Routing, RIPv1, RIPv2, BGP, OSPFv2, OSPFv3, RIPv3, PBR, QoS from day one. It should support protocols OSPFv2, OSPFv3, PBR, BGP, BGP4, IS-IS, PIM-SM, PIM-SSM from day one.

Should support protocol MPLS, BGP, BGP4, IS-IS, PIM-SM, PIM-SSM, VRF Lite from day one

Switch should support 802.1x authentication and accounting, IPv4 and IPv6 ACLs and Dynamic VLAN assignment and minimum MACSec-128 in all ports. Switch should support Access control lists (ACLs) provide IP Layer 3 filtering based on source/destination IP address/subnet and source/ destination TCP /UDP port number.

Switch should support Simple Network Management Protocol (SNMPv2 and SNMPv3).

Switch should Support for authentication, authorization, and accounting (AAA) using RADIUS and TACACS+.

Switches must be able to deliver 100% of functionalities - licenses and Subscription model must be defined from day1.

Switch should support VLAN s support.

Switch shall conform to UL 60950 or IEC 60950 or CSA 60950 or EN 60950 Standards for Safety requirements of Information Technology Equipment.

Switch shall conform to EN 55022 Class A/B or CISPR22 Class A/B or CE Class A/B or FCC Class A/B Standards for EMC (Electro Magnetic Compatibility) requirements.

Switch should be tested for EAL3/NDPP or above under Common Criteria Certification.

### **3.4 Edge Switch: 24 RJ-45 10/100/1G BaseT**

SITC Edge Switch: Supplying Installation testing and Commissioning of 24 port 10/100/1000BASE-T ports and four GbE/10GbE SFP/SFP+ uplink ports,

Switch should have Management port to manage switch.

Switch must support minimum 8 no of stacking with minimum 160 Gbps of stacking bandwidth from day-1.

Switch should support Line rate architecture from day one. Proposed switch must be L2 and L3 capable switch.

Switch shall scalable and modular architecture to provide the enhance performance

Switch should support dynamic routing and features etc. for IPv4 and IPv6 from day 1.

Switch shall scalable and modular architecture to provide the enhance performance . Switch should have USB/Ethernet management interfaces. It should support 32K mac address and 4GB DRAM and 4GB Flash from day one.

It should have minimum switching capacity of 128 Gbps and throughput/forwarding rate performance of 95 MPPS

Minimum No of VLAN and VLAN Id supported should be 1000 from day one.

It should have Console port; Internal, Redundant Power supply ; Redundant fan; it should have Operating System.

It should support Policy based segmentation from day one.

Should support IEEE Standards of Ethernet: IEEE 802.1D, 802.1s, 802.1w, 802.1x, 802.3ad, 802.3x, 802.1p, 802.1Q, 802.3, 802.3u, 802.3ab, minimum MACSec -128 in all ports.

For QoS, shall have 802.1p class of service, IP differentiated service code point (DSCP) and IP precedence. Switch should support marking, classification, policing and shaping. Should support strict priority queuing. Switch should support port security. DHCP snooping to allow administrator to ensure consistent mapping of IP to MAC address. Switch should support IPv4 and IPv6 ACLs, VLAN, Port and Time based access list with time ranges.

Switch should support Simple Network Management Protocol (SNMPv2 and SNMPv3), SSHv2, Configuration and management through CLI, GUI, console, telnet, SSH. Switch should support NTP. Should support LACP within and across switch, DHCP server & client and DHCP relay Should have LLDP support.

Switch should Support for authentication, authorization, and accounting (AAA) using RADIUS and TACACS+.

Switches must be able to deliver 100% of functionalities - licenses and Subscription model must be defined from day1.

Switch should support VLAN s support.

Switch shall conform to UL 60950 or IEC 60950 or CSA 60950 or EN 60950 Standards for Safety requirements of Information Technology Equipment.

Switch shall conform to EN 55022/55032 Class A/B or CISPR22 Class A/B or CE Class A/B or FCC Class A/B Standards for EMC (Electro Magnetic Compatibility) requirements.

Switch should be tested for EAL3/NDPP or above under Common Criteria Certification.

All associated racks, patch panel, patch cords, face plates and cabling requirements of all kinds will be provided from day 1.

All applicable licenses will be provided for the entire warranty duration or minimum 3 years whichever is later.



### 3.5 Edge Switch: 48 RJ-45 PoE+

Supplying Installation testing and Commissioning of 48 port 10/100/1000BASE-T ports and four GbE/10GbE SFP/SFP+ uplink ports,

Switch should have Management port to manage switch.

Switch must support minimum 8 no of stacking with minimum 160 Gbps of stacking bandwidth from day-1.

Switch should support Line rate architecture from day one. Proposed switch must be L2 and L3 capable switch.

Switch shall scalable and modular architecture to provide the enhance performance

Switch should support dynamic routing and features etc. for IPv4 and IPv6 from day 1.

Switch shall scalable and modular architecture to provide the enhance performance . Switch should have USB/Ethernet management interfaces. It should support 32K mac address and 4GB DRAM and 4GB Flash from day one.

It should have minimum switching capacity of 128 Gbps and throughput/forwarding rate performance of 95 MPPS

Minimum No of VLAN and VLAN Id supported should be 1000 from day one.

It should have Console port; Internal, Redundant Power supply ; Redundant fan; it should have Operating System.

It should support Policy based segmentation from day one.

Should support IEEE Standards of Ethernet: IEEE 802.1D, 802.1s, 802.1w, 802.1x, 802.3ad, 802.3x, 802.1p, 802.1Q, 802.3, 802.3u, 802.3ab, minumum MACSec -128 in all ports.

For QoS, shall have 802.1p class of service, IP differentiated service code point (DSCP) and IP precedence. Switch should support marking, classification, policing and shaping. Should support strict priority queuing. Switch should support port security. DHCP snooping to allow administrator to ensure consistent mapping of IP to MAC address. Switch should support IPv4 and IPv6 ACLs, VLAN, Port and Time based access list with time ranges

Switch should support Simple Network Management Protocol (SNMPv2 and SNMPv3), SSHv2, Configuration and management through CLI, GUI, console, telnet, SSH. Switch should support NTP. Should support LACP within and across switch, DHCP server & client and DHCP relay Should have LLDP support.

Switch should Support for authentication, authorization, and accounting (AAA) using RADIUS and TACACS+.

Switches must be able to deliver 100% of functionalities - licenses and Subscription model must be defined from day1.

Switch should support VLAN s support.

Switch shall conform to UL 60950 or IEC 60950 or CSA 60950 or EN 60950 Standards for Safety requirements of Information Technology Equipment.

Switch shall conform to EN 55022/55032 Class A/B or CISPR22 Class A/B or CE Class A/B or FCC Class A/B Standards for EMC (Electro Magnetic Compatibility) requirements.

Switch should be tested for EAL3/NDPP or above under Common Criteria Certification.

All associated racks, patch panel, patch cords, face plates and cabling requirements of all kinds will be provided from day 1.

All applicable licenses will be provided for the entire warranty duration or minimum 5 years whichever is later.

### 3.6 Edge Switch: 48 RJ-45 10/100/1G BaseT

Supplying Installation testing and Commissioning of 48 port 10/100/1000BASE-T ports and four GbE/10GbE SFP/SFP+ uplink ports,

Switch should have Management port to manage switch.

Switch must support minimum 8 no of stacking with minimum 160 Gbps of stacking bandwidth from day-1.

Switch should support Line rate architecture from day one. Proposed switch must be L2 and L3 capable switch.

Switch shall scalable and modular architecture to provide the enhance performance

Switch should support dynamic routing and features etc. for IPv4 and IPv6 from day 1.

Switch shall scalable and modular architecture to provide the enhance performance . Switch should have USB/Ethernet management interfaces. It should support 32K mac address and 4GB DRAM and 4GB Flash from day one.

It should have minimum switching capacity of 128 Gbps and throughput/forwarding rate performance of 95 MPPS

Minimum No of VLAN and VLAN Id supported should be 1000 from day one.

It should have Console port; Internal, Redundant Power supply ; Redundant fan; it should have Operating System.

It should support Policy based segmentation from day one.

Should support IEEE Standards of Ethernet: IEEE 802.1D, 802.1s, 802.1w, 802.1x, 802.3ad, 802.3x, 802.1p, 802.1Q, 802.3, 802.3u, 802.3ab, minimum MACSec -128 in all ports.

For QoS, shall have 802.1p class of service, IP differentiated service code point (DSCP) and IP precedence. Switch should support marking, classification, policing and shaping. Should support strict priority queuing. Switch should support port security. DHCP snooping to allow administrator to ensure consistent mapping of IP to MAC address. Switch should support IPv4 and IPv6 ACLs, VLAN, Port and Time based access list with time ranges.

Switch should support Simple Network Management Protocol (SNMPv2 and SNMPv3), SSHv2, Configuration and management through CLI, GUI, console, telnet, SSH. Switch should support NTP. Should support LACP within and across switch, DHCP server & client and DHCP relay Should have LLDP support.

Switch should Support for authentication, authorization, and accounting (AAA) using RADIUS and TACACS+.

Switches must be able to deliver 100% of functionalities - licenses and Subscription model must be defined from day1.

Switch should support VLAN s support.

Switch shall conform to UL 60950 or IEC 60950 or CSA 60950 or EN 60950 Standards for Safety requirements of Information Technology Equipment.

Switch shall conform to EN 55022/55032 Class A/B or CISPR22 Class A/B or CE Class A/B or FCC Class A/B Standards for EMC (Electro Magnetic Compatibility) requirements.

Switch should be tested for EAL3/NDPP or above under Common Criteria Certification.

All associated racks, patch panel, patch cords, face plates and cabling requirements of all kinds will be provided from day 1.

All applicable licenses will be provided for the entire warranty duration or minimum 5 years whichever is later.

### **3.7 Multi-Gig Switch**

24 RJ-45 ports (8 mGig ports up to 10G, 16 ports up to 1G), 4x10G Ports, POE/POE+/UPOE Power budget 1440 Watt

Includes a country specific power cord, 19" rack mount hardware. Field replaceable internal Redundant Power Supply from day 1, 8 number of stacking for upto 320 Gbps with IEEE 802.1AE MACSEC.

### **3.8 Fiber Transceivers**

A. Supply, Installation, Testing & Commissioning of Modules 10G Network Modules, 10GBASE-SR SFP, MMF, OM4 Cable upto 400 Meter distance, LC connector.

B. Supply, Installation, Testing & Commissioning of Modules 40G Network Modules, 40GBASE-SR SFP, OM4 Cable upto 400 Meter distance

### **3.9 Wireless Controller**

2 x 10G SFP+ Ports, USB and Rj-45 Console Ports. It should support upto 250 Access Points, 5 Gbps Throughput, 2000 Clients with scalability of supporting of 500APs, 10 Gbps Throughput, 8000 Clients on the same hardware.

### **3.10 Indoor Access Point**

The Item consists of Indoor Access Point: Dual band radio 4x4 on both 2.4GHz and 5GHz 802.11a/b/g/n, .11ac, .11ax MU-MIMO with four spatial stream, WiFi6 AP, integrated antenna, 1 x2.5GbE, 1x USB, BLE radio, 1x Console with mounting Kit

### **3.11 Outdoor Access Point**

The Item consists of outdoor Access Point: Dual band radio 4x4 on both 2.4GHz and 5GHz 802.11a/b/g/n, .11ac, .11ax MU-MIMO with four spatial stream, WiFi6 AP, integrated antenna, 1 x2.5GbE, 1x SFP port, 1x USB, BLE radio, 1x Console with mounting Kit

### **3.12 Network Management System**

- SITC of NMS: Network Management System for managing both wired and wireless devices as per the quantity of AP and Switches asked in the RFP
- \*The proposed solution should be premise based and not cloud based. This should be based on standard server
- \*Redundant solution shall be proposed. The centralized management function shall allow to display the physical topology of the network.
- \*The centralized management function shall be able to handle wired equipment (switches) and wireless (Access Point) management for a “unified management” approach.
- \*The solution shall be able to automatically discover new Switch or APs added to the network.
- \*The solution shall be able to blacklist a client, either manually or automatically after a client attack has been detected.
- \*The centralized management function shall allow per equipment configuration and software backup and restore, and bulk backup and restore.
- \*The centralized management function shall allow access to all wIPS/wIDS features.
- \*The centralized management function shall offer, on the basis of an application signature file, insight at application layer (e.g. facebook.com, youtube.com, salesforce.com...) even if the applications run on top of the HTTP or HTTPS protocols. It shall also allow control of those applications.
- \*The solution should allow the admin to easily provision, manage and maintain a network infrastructure with alarms, unified access security policies
- \*The solution should provide full visibility into wireless, devices and applications, as well as predictive analysis for forward planning
- \*Should support third party network devices for basic SNMP and report
- \*Provides threat mitigation through a secure perimeter against intrusion and malware attacks

### 3.13 Workstation for NMS

SITC of Appliance for NMS: 4 Core Intel Xeon-S 4110 @ 2.10 Ghz , Memory: 32GB, Storage: 6 TB Hardisk minimum, Licensed Operating Server (Latest).

### 3.14(A) EXTERNAL FIREWALL

Supply, Installation, Testing & Commissioning of External firewall with the with 5 years of subscription / support .

The Firewall should be Hardware based, Reliable, purpose-built security appliance with hardened operating system that eliminates the security risks associated with general-purpose operating systems.

The proposed vendor must have "AAA" rating with min 97% of block rate for evasions as per CyberRatings Enterprise Firewall Test Report 2021

Firewall appliance should have at least 4 x 1/10Gig TX ports ,14 x 1/10Gig SFP/SFP+ ports with required transceivers , 4X 40 Gig Ports with required transceivers from Day one.

Minimum NG Threat prevention throughput in real world/production environment (by enabling and measured with Application-ID/AVC, User-ID/Agent-ID, NGIPS, Anti-Virus, Anti-Spyware, Anti Malware and logging security threat prevention features enabled – 6 GBPS real world/production environment/Application Mix . The bidder shall submit the performance test report reference from public documents or from Global Product Engineering department / Global Testing Department/ Global POC team of OEM certifying the mentioned performance .

IPsec VPN throughput – 9 Gbps.

New sessions per second – Min 160 K

Concurrent sessions – Min 4 Million

The NGFW must have GUI based packet capture utility within its management console with capability of creating packet capture filters for IPv4 and IPv6 traffic and ability to define the packet and byte count. It should also support protocols like LLDP, DHCPv6. NAT 64 etc.

The Firewall should support virtual System and should be provided with 3 from day-1. The virtual system should have all the features as of physical device.

The proposed firewall shall delineate different parts of the application such as allowing Facebook chat but blocking its file-transfer capability inside the chat application base on the content. It should have atleast 3500 application and content based signatures and atleast 16000 IPS signatures.

The firewall must have the capability to create DOS prevention policy to prevent against DOS attacks on per zone basis (outbound to inbound, inbound to inbound and inbound to outbound) and ability to create and define DOS policy based on attacks like UDP Flood, ICMP Flood, SYN Flood(Random Early Drop and SYN cookie), IP Address Sweeps, IP Address Spoofs, port scan, Ping of Death, Teardrop attacks, unknown protocol protection etc

All the proposed threat functions like IPS/vulnerability protection, Antivirus, C&C protection etc should work in isolated airgapped environment without any need to connect with Internet.

The proposed firewall shall have on box Anti-Virus/Malware, Anti Spyware signatures and should have minimum signatures update window of every one hour.

Should be able to perform Anti-virus scans for HTTP,https, smtp, smtps,imap,impas, pop3, pop3s, ftp,, ftps, SMB traffic with configurable AV action such as allow, deny, reset, alert etc

Vendor should automatically push dynamic block list with latest threat intelligence data base on malicious IPs, URLs and Domains to the firewall policy as an additional protection service.

The NGFW should have native protection against credential theft attacks(without the need of endpoint agents) with ability to prevent the theft and abuse of stolen credentials and the folowing :

Automatically identify and block phishing sites

Prevent users from submitting credentials to phising sites

Prevent the use of stolen credential

HA : Active/Active and Active/Passive

Logs and Report

Logs will be storedfor 180 days. Storage will be catered accordingly.

The Logs and Reporting platform must be a dedicated same OEM appliance and VM/software running on server will not be accepted.

The Logs and Reporting platform support running on-demand and scheduled reports

Should have f Hard Drive Capacity in RAID-1 for logging and reporting if not please quote separate appliance

Real-time display of information allows you to follow real-time trends in network usage such as the source IP address and the destination URL for HTTP traffic or IM message traffic.

All log files and messages are searchable and can be filtered to drill down and locate specific information.

All associated racks, patch panel, patch cords, face plates and cabling requirements of all kinds will be provided from day 1.

All applicable licenses will be provided for the entire warranty duration or minimum 5 years whichever is later.

The make model and OEM of the external Firewall will be different from that of the Internal firewall.

### 3.14(B) INTERNAL FIREWALL

The Item consists of firewall with the following salient features from day one with 3 years of subscription / support and flexibility to scale up to 10000 users, having 99.9% uptime with each level redundancy, single pane of glass for reporting and includes following features as per detailed specification

- a) Full SSL Inspection
- b) Next Generation Firewall
- c) Sandboxing
- d) Bandwidth Control
- e) Mobility

#### Firewall

- a) The Firewall should be Hardware based, Reliable, purpose-built security appliance with hardened operating system that eliminates the security risks associated with general-purpose operating systems
- b) The Proposed Firewall Vendor should be in the Leader's in Quadrant of Gartner Magic Quadrant for Enterprise Network Firewall.
- c) Firewall appliance should have at least 20x 1GE interface, 6x 10G SFP+ interfaces and 2 GE RJ45 Management ports
- d) The solution should support minimum 9 Gbps of NGFW (FW + IPS + AVC) throughput for Mix / production traffic
- e) The solution should support minimum 5 Gbps of Threat Prevention (FW + IPS + AVC + AV) throughput for Mix / production traffic
- f) Firewall should support minimum 30 Gbps of VPN throughput
- g) Firewall should support 20000 site-to-site & client to site VPN Tunnels.
- h) Firewall should support minimum 5,000 concurrent SSL VPN users and should be scalable in future
- i) Firewall should support 480,000 new sessions per second
- j) Firewall should support 20 Million concurrent sessions
- k) The Firewall solution should support NAT64, DNS64 & DHCPv6
- l) The proposed system shall be able to operate on either Transparent (bridge) mode to minimize interruption to existing network infrastructure or NAT/Route mode. Both modes can also be available concurrently using



#### Virtual Contexts.

- a) The proposed system should have integrated Traffic Shaping functionality.
- b) The Firewall & IPSEC VPN module shall belong to product family which minimally attain Internet Computer Security Association (ICSA) Certification.
- c) The proposed system should support
  - i. IPSEC VPN
  - ii. PPTP VPN
  - iii. L2TP VPN
- d) The device shall utilize inbuilt hardware VPN acceleration:
  - i. IPSEC (DES, 3DES, AES) encryption/decryption
  - ii. SSL encryption/decryption
- e) The system shall support the following IPSEC VPN capabilities:
  - i. Multi-zone VPN supports.
  - ii. IPSec, ESP security.
  - iii. Supports NAT traversal
  - iv. Supports Hub and Spoke architecture
  - v. Supports Redundant gateway architecture
- f) The system shall support 2 forms of site-to-site VPN configurations:
  - i. Route based IPSec tunnel
  - ii. Policy based IPSec tunnel
- g) The system shall support IPSEC site-to-site VPN and remote user VPN in transparent mode.
- h) The system shall provide IPv6 IPSec feature to support for secure IPv6 traffic in an IPSec VPN.

#### Virtualization

The proposed solution should support Virtualization (Virtual Firewall, Security zones and VLAN). Minimum 5 Virtual Firewall license should be provided.

#### Intrusion Prevention System

- a) The IPS capability shall minimally attain NSS Certification
- b) IPS throughput should be minimum 11 Gbps for Mix / Production traffic
- c) The IPS detection methodologies shall consist of:
  - a. Signature based detection using real time updated database
  - b. Anomaly based detection that is based on thresholds

The IPS system shall have at least 7,000 signatures

- a) IPS Signatures can be updated in three different ways: manually, via pull technology or push technology. Administrator can schedule to check for new updates or if the device has a public IP address, updates can be pushed to the device each time an update is available

- b) In event if IPS should cease to function, it will fail open by default and is configurable. This means that crucial network traffic will not be blocked and the Firewall will continue to operate while the problem is resolved
- c) IPS solution should have capability to protect against Denial of Service (DOS) and DDOS attacks. Should have flexibility to configure threshold values for each of the Anomaly. DOS and DDOS protection should be applied and attacks stopped before firewall policy look-ups.
- d) IPS signatures should have a configurable actions like terminate a TCP session by issuing TCP Reset packets to each end of the connection, or silently drop traffic in addition to sending a alert and logging the incident
- e) Signatures should a severity level defined to it so that it helps the administrator to understand and decide which signatures to enable for what traffic (e.g. for severity level: high medium low)

#### Antivirus

- a) Firewall should have integrated Antivirus solution
- b) Firewall antivirus should have minimally attain Internet Computer Security Association (ICSA) Certification.
- c) The proposed system should be able to block, allow or monitor only using AV signatures and file blocking based on per firewall policy based or based on firewall authenticated user groups with configurable selection of the following services:
  - a) HTTP, HTTPS
  - b) SMTP, SMTPS
  - c) POP3, POP3S
  - d) IMAP, IMAPS
  - e) FTP, FTPS
- d) The proposed system should be able to block or allow oversize file based on configurable thresholds for each protocol types and per firewall policy.

#### Web Content Filtering

- a) The proposed system should have integrated Web Content Filtering solution without external solution, devices or hardware modules.
- b) The proposed solution should be able to enable or disable Web Filtering per firewall policy or based on firewall authenticated user groups for both HTTP and HTTPS traffic.
- c) The proposed system shall provide web content filtering features:
  - a. which blocks web plug-ins such as ActiveX, Java Applet, and Cookies.
  - b. Shall include Web URL block
  - c. Shall include score based web keyword block
  - d. Shall include Web Exempt List
- d) The proposed system shall be able to queries a real time database of over 110 million + rated websites categorized into 70+ unique content categories.

#### Application Control

- a) The proposed system shall have the ability to detect, log and take action against network traffic based on over 3000 application signatures
- b) The application signatures shall be manual or automatically updated
- c) The administrator shall be able to define application control list based on selectable application group and/or list and its corresponding actions

#### High Availability

- a) The proposed system shall have built-in high availability (HA) features without extra cost/license or hardware component
- b) The device shall support stateful session maintenance in the event of a fail-over to a standby unit.
- c) High Availability Configurations should support Active/Active or Active/Passive

#### Logs and Report

- a) The Logs and Reporting platform must be a dedicated same OEM appliance and VM/software running on server will not be accepted.
- b) The Logs and Reporting platform support running on-demand and scheduled reports
- c) Should have 4 TB of Hard Drive Capacity for logging and reporting if not please quote separate appliance
- d) Real-time display of information allows you to follow real-time trends in network usage such as the source IP address and the destination URL for HTTP traffic or IM message traffic.
- e) All log files and messages are searchable and can be filtered to drill down and locate specific information.

### 3.15(A) Network Access Control

#### SITC of Network Access Control

The Solution should provide a highly powerful and flexible attribute-based access control solution that combines authentication, authorization, and accounting (AAA); posture; profiling; and guest management services on a single platform.

Provides complete guest lifecycle management by empowering sponsors to on-board guests.

Solution should be scalable enough to support 1500 endpoints in the network from day 1 and scalable to support 5000 endpoints on the same appliance.

Solution should be scalable enough to support 1500 Network devices from day 1 and scalable to support 5000 network devices on the same appliance in future.

The solution should support guest users onboarding through social media login to simplify the registration process

The solution should support sponsor approval for guest users connecting into the network and the approval request should have control from multiple sponsor to avoid single point of failure

The solution should support flexible guest account approval even in absence of sponsor

Enforces security policies by blocking, isolating, and repairing noncompliant machines in a quarantine area without requiring administrator attention

The NAC solution should be able to block unauthenticated/rogue machine without giving any access to the network.

The NAC solution should be able to control the user even before IP address is assigned. It should act as a pre-admission solution

The NAC solution should be able to integrate with APT, NBAD and SIEM solution

The solution should provide full TACACS+ capability including enable password, configuration present for different NAD types, TACACS+ proxy etc.

Utilizes standard RADIUS protocol for authentication, authorization, and accounting (AAA).

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).

Provides a wide range of access control mechanisms, including downloadable access control lists (dACLs), VLAN assignments, URL redirect, and Security Group Access (SGA) tagging.

It should allow Administrators to create their own device templates. These templates can be used to automatically detect, classify, and associate administrative-defined identities when endpoints connect to the network. Administrators can also associate endpoint-specific authorization policies based on device type.

Solution must allow administrator to add exception for certain device properties in the device templates/ device profiles available in the solution to filter unintentionally picked parameters of endpoints.

The Solution should have capability to see endpoints attribute data via passive network telemetry or alternatively from the infrastructure via device sensors on switches at Core, Distribution and Access Layer.

Solution should allow end users to interact with a self-service portal for device onboarding, providing a registration vehicle for all types of devices as well as automatic supplicant provisioning and certificate enrolment for standard PC and mobile computing platforms.

Verifies endpoint posture assessment for PCs connecting to the network. Works via either a persistent client-based agent or a temporal web agent to validate that an endpoint is conforming to a company's posture policies. Provides the ability to create powerful policies that include but are not limited to checks for the latest OS patches, antivirus and antispymware software packages with current definition file variables (version, date, etc.), registries (key, value, etc), and applications. Solution should support auto-remediation of PC clients as well as periodic reassessment to make sure the endpoint is not in violation of company policies.

Allows administrators to quickly take corrective action (Quarantine, Un-Quarantine, or Shutdown) on risk-compromised endpoints within the network. This helps to reduce risk and increase security in the network.

Includes a built-in web console for monitoring, reporting, and troubleshooting to assist help-desk and network operators in quickly identifying and resolving issues. Offers comprehensive historical and real-time reporting for all services, logging of all activities, and real-time dashboard metrics of all users and endpoints connecting to the network.

Solution should have capability which allows users to add a device on a portal, where the device goes through a registration process for network access. Should allow users to mark as lost any device that you have registered in the network, and blacklist the device on the network, which prevents others from unauthorized network access when using the blacklisted device. Should have capability to reinstate a blacklisted device to its previous status in Device Portal, and regain network access without having to register the device again in the Devices Portal. Should also support removing any device in the enterprise network temporarily, then register the device for network access again later.

Should provide a Registered Endpoints Report which provides information about a list of endpoints that are registered through the device registration portal by a specific user for a selected period of time. The report should provide the following details

- Logged in Date and Time
- Portal User (who registered the device)
- MAC Address
- Identity Group
- Endpoint Policy
- Static Assignment
- Static Group Assignment
- Endpoint Policy ID
- NMAP Subnet Scan ID
- Device Registration Status

Solution should support automatic provisioning of NAC agents

The NAC solution should support any SAML v2 compliant solution.

Should support native supplicant profiles to enable users to bring their own devices into network. When the user logs in, based on the profile that you associate with that user's authorization requirements, solution should provide the necessary supplicant provisioning wizard needed to set up the user's personal device to access the network. This should be supported over Microsoft windows, Apple Mac and iOS and Android devices.

When endpoints are discovered on the network, they can be profiled dynamically based on the configured endpoint profiling policies, and assigned to the matching endpoint identity groups depending on their profiles.

Must be able to differentiate policy based on device type + authentication

The solution should support BYOD workflow for Partner/Contractor or Employees for BYOD scenario by automatically provisioning the supplicant such that Owner & the device are authenticated based on certificate.

The NAC solution should be standard RADIUS server with built-in certificate authority

The CA server should be able to provision certificate for multiple use cases like BYOD, EAP authentication and Third Party Client and Server side authentication.

The solution must have internal CA server functionality with flexibility to create certificate template to be used by other network services

Solution must support Non 802.1x technology on assigned ports and 802.1x technology on open use ports

The NAC solution should integrate with vulnerability scanner like Rapid7, Tenable etc. Should be a listed vendor and officially supported integration and should allow use of threat intelligence to build authorization permissions based on the vulnerability scores received from these tools to enforce permissions.

Should support session termination with port shutdown option to block an infected host that sends a lot of traffic over the network.

Should support TCP dump utility & also support saving a TCP dump file.

The solution must have internal CA server functionality to provision certificate for multiple use cases like BYOD, Contractor, Employee Asset etc.

The Solution should support complete guest lifecycle where Sponsor should be able to Extend, Suspend and reinstate guest accounts with reasons.

The solution should support centralized and distributed deployment options with clustering of nodes or cross-site failover for disaster recovery scenarios

Any third party product required to achieve the functionality should be provided with the necessary enterprise version license of software/appliance and necessary hardware, database and other relevant software or hardware etc should be provided with the solution

NAC Solution should support phased deployment for more flexibility during deployment and simplifies the transition from See/monitor phase to Control/closed mode but without allowing non-compliant endpoint on network or without waiting for endpoint to receive IP address on the network;

When Network device connectivity to NAC is lost or authentication service outage occurs the Endpoint should be retained in unauthenticated VLAN and should be automatically subjected to Reauthentication when server is marked alive to ensure that the Endpoint does not join the network without authentication.

Solution must support identifying the profile of endpoint joining the network as early as possible without granting Endpoint access to the network and there by speed up the Endpoint discovery without compromising security.

Solution should be able to enforce Layer 4 controls right from Access to distribution to core to edge to data centre to servers without the need of mirroring the traffic and maintaining end to end segmentation even when two endpoints are in same broadcast domain.

Solution should consume license only based on active devices on the network where Devices include user endpoints (such as laptops, tablets and smartphones), non-user devices (such as printers, IP phones, security equipment, medical devices, manufacturing equipment), virtual machines, Network infrastructure devices (such as switches, routers and access points) should not consume license and If so vendor should consider these licenses exclusively and should be counted along with User/Endpoints.

Solution should support 3rd party integration for sharing Contextual awareness and other endpoint related data such that it can Publish, subscribe and work as broker as well.

The solution must have capability to hide agent to prevent the user from exiting the agent.

Open seating environments where the MAC addressee is not persistence, solution should be to authorize managed endpoint

Solution must have single unified agent for VPN, Posture assessment & 802.1x authentication

Solution must support integration with firewall and must be able to share usergroup information with firewall so that user traffic can be controlled based on user group at firewall.

Solution must support integration with existing EDR solution and must be able to quarantine endpoint based on EDR alerts.

All associated racks, patch panel, patch cords, face plates and cabling requirements of all kinds will be provided from day 1.



SITC of IP Communication Servers – 02 Nos. (On redundant mode with hot standby) as per the specifications in the RFP. Distributed Architecture, should include Rack Mountable with duplicated controls

Proposed system shall be in compliance with ITU-T (International Telecommunication Union Telecommunication) standards and technical recommendation. Any subject matter not governed herein shall be in line with the applicable recommendations of ITU-T (CCITT).

IP Users: 870 Nos.

PRI: 04 Nos.

Deskphone Based Operator Console with 12 Key DSS: 02 Nos.

PC Based Operator Consoles with Busy lamp Field, Multi-Media Keyboard & associated IP Phones: 01 No. Inclusive of PC with latest configurations

Network Management Software for Managing, Maintaining and Collection of Call Detailed records with associated PC of latest configuration: 01 No.

DISA & Integrated Multi-Level Automated Attendant

28 Party Meet-Me Conferencing Bridges-03Nos.

28 Party Blast Dial Conference Bridge-03 No.

Unlimited 3 Party Conference

The proposed system shall support IPv6 from day one. It shall be possible to assign IPv6 addresses to the system, as well as IPv4 addresses. The system shall be capable of directly responding to IPv6 requests (establishing a call over IPv6, IPv6 supported IP telephone operation etc.) without requiring any converters. The system shall also support hybrid IP networks in which both IPv6 and IPv4 protocols are used. The system shall be able to communicate over IPv4 and IPv6 networks, simultaneously.

System architecture should be of Server gateway based with external industry standard server to facilitate a distributed architecture with centralized call control over the IP backbone. It should support geographical redundancy.

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The communication server should be deployed in a distributed architecture over IP infrastructure (LAN/WAN). Both the active and standby processors should not be in

the same unit/cabinet sharing the same active backplane so as to prevent total system failure on failure of the motherboard/backplane.

It should work in hot-standby operation mode, during changeover from active server to standby server, any active/on-going calls across the entire network/location should not be interrupted or affected. There should be no restriction on number of endpoints being backed up in case of one server failure.

It shall be possible to distribute the system into sub-systems to be installed in different locations. However, these sub-systems shall work as a unified (single) system with a unified numbering plan, centralized operation and management. In case, connection between server and sub-systems fail, it shall be possible for the remotely located sub-systems to continue operation in self-survival mode. When the connection gets restored, sub-systems shall resume its normal operation as a part of main system.

The system should have support built in subscriber page, The Subscriber Page can be accessed from all platforms such as computers with Windows or Linux operating systems or as mobile devices with IOS, Android or Windows Phone operating systems entering the IP address of the application via web interface.

The system should support SNMP (Simple Network Management Protocol). It shall be possible to have access to systems from remote locations to monitor the status and to update software or to take system backup.

The system shall capable of operating with the following units:

1. IP telephone devices
2. Wi-Fi telephone devices
3. IP Video Phone
4. Softphone (software based telephone) applications
5. Other Telephone Exchanges (PABX)
6. ISDN 4 PRI 2 Mbps (E1) Network
7. Facsimile devices
8. Data extensions
9. Voice Mail System
10. Smart mobile phones

#### 11. Tablets and computers

The system should have these security features:

1. Transport Layer Security(TLS)
2. Secure Real-time Transport Protocol (sRTP)
3. Certification of IP endpoints

#### Integration with Firewall

4. Protection against DOS attacks
6. Password aging
7. Admin accounts with different authority levels
8. Log reports

The IP PBX system should have my subscribe page. By using My Subscriber Page;

1. A call can be made.
2. Missed calls can be seen.
3. Reminders can be set.
4. By using the directory special memory, shared memory and all internal numbers can be accessed and
5. A private speed dial directory can be created.
6. Forwarding can be made in Night and Day Time modes. Extension may check the access and usage settings.
7. 24 Port Voice gateway for interfacing with Analog and Digital Exchanges with 5 years warranty all supporting hardware, software and licenses

### **System Architecture**

The telephony system should be designed with IP at the core Server & Gateway type communications system, allowing fully distributed IP solutions across data networks. The system will be call servers based and it should support traditional TDM or mixed IP-TDM or full 100% IP configurations, telephony , gateway , end points & all telephony

application should be from same OEM & PRI card should not be installed in any PC / Server

It should support the following devices :-

- (i) IP Communication Devices e.g. IP Phones, Video Phones, Multimedia PCs, SIP phones, Softphones or H.323 terminal devices etc.
- (ii) Legacy TDM communication devices (Digital and analog 2 Wire telephone instruments with Caller-ID)

The call control servers should be fully redundant solution The solution must provide geographical redundancy by separating the servers over LAN/WAN. I.e. if the server in the main data center fails, the other server, which is installed at geographically different location over LAN/WAN should take over the entire communication network load.

The proposed system should support both industry standard OEM servers (HP, Dell, Lenovo) and Proprietary hardware as Call control server

The system should be capable of supporting analog and IP Telephones. System should support up to 5000 users on the same hardware that is supplied as part of this RFP. The system should manage CAC (Call Admission Control) mechanisms to optimize the usage of the bandwidth in the WAN for multi-site configurations.

The system should be capable of supporting a very high traffic and should support a Busy Hour Completion (BHCC) of 3, 00,000 per hour.

The IP PBX should be day one ready with full telephony Feature/Functionality, all necessary hardware should be provisioned from day one for this. Full SIP (able to connect 3rd Party SIP Phone & SIP Trunk Public & Private) capability. The main functions of SIP capability should provide SIP networking (Public & private) and support SIP endpoints in a converged communications network.

The system should be able to operate with H.323/SIP compliant device and it should be able to support internal gatekeeper for the same.

The SIP proxy, SIP registrar should be inbuilt in the system and should support open SIP stack compliant hard phones or soft phones also.

IPv6 support from day one & The quoted model should be TEC approved. Vendor to submit TEC approval certificate along with the bid

The system should support for voice encoding using following standards:-

- (i) G.711

(ii) G.729A

(iii) G.722

Call Switching. Internal calls : Based on the G.711 uncompressed PCM standard.

The System should support Network Time Protocol V4.1.2 (RFC 1305) to synchronize the system date/time of network devices.

The system should be suitable to accommodate both Decadic Pulse (DP) and DTMF telephones. The system should support outgoing DTMF transmission even from Digital phones.

The system should have non blocking architecture at all levels like System processing, Switching fabric, power supplies, other resources like DTMF receivers, R2 Receivers, unlimited 3 or more party conference circuits.

VoIP Support. System should support VoIP solutions as an integral part of the system.

(i) The system should be fully compliant to VoIP standards like H.323 and SIP (Session Initiation Protocol). Vendor to give clear compliance for the requested standards.

(ii) The system should be able to operate with any H.323/SIP compliant device and it should be able to support internal gatekeeper for the same. If required, it should be able to inter operate with H.323 standard based external gatekeepers.

(iii) The SIP proxy, SIP registrar should be inbuilt in the system and should support any open SIP stack compliant hard phones or soft phones.

(iv) System should support the QOS features for the VOIP implementation. It should be compliant with both QOS standards (Layer 2 – 802.1 p/q) and Layer 3- Diffserv/TOS).

The proposed system should Support Automatic Route Selection (ARS) and Least Cost Routing (LCR) features to route the calls based on priorities related to user profile and network availability, along the most cost effective path. This service should be transparent for users and irrespective of the physical carrier connection.

Should provide a cloud-based, enterprise-grade, Communication Platform thus delivering a free collaborative business application extending features viz. Instant Messaging/Telephony Presence, click to call (dial by name, answer, release), Call Log, P2P Audio/Screen Sharing

The system must support an IP Softphone application that allows the users to manage their calls from a PC or MAC/iPhone/iPAD/Android . This user must have access to the

full set of telephony services without any degradation. The voice should be managed by the multimedia resources of the PC.

### **System Security**

The System must support Syslog services for both internal and external command and configuration control accounting with a minimum of 30 day history.

The Call Server must be provided adequate protection from possible virus, worm and Trojan infestation

The Call Server must be provided adequate protection from possible virus, worm and Trojan infestation points such as internal e-mail servers and they must be updated every month. In case customized hardened linux distributions are being provided this clause will not be applicable.

The password and access control must include at least :-

- (i) Management console access to be provided by dual role based authentication (one of user rep and one of administrator rep).
- (ii) Management console access must allow only access to level of viewing of running configuration and status of current configurations and sys logs.
- (iii) For any configuration changes again a dual role based authentication system for write access fully integrated with the management console application for carrying out the authorized configuration changes must be provided.
- (iv) Logs of all activities to include configuration change, housekeeping activities and any other action on the system grouped user wise and specifying the time of activity must be available for each day.
- (v) Account access authentication/ restriction using external RADIUS/ LDAP/ AD resources.

Media Gateways should not host services such as proxy, FTP or local dynamic routing except those required for software Up-gradation /backup etc. to prevent exploitation in Distributed Denial of Service attacks.

IP Phones should not support direct, external initiated, connections via HTTP, telnet, FTP, TFTP or any other protocol as means to prevent distributed Denial of Service attack exploitation, except those required for software Up gradation/backup etc.

The system should have the capability to, based on standard mechanism (such as 802.1Q and DHCP), assign automatically the corresponding voice VLAN number to the IP

station clients during IP station initialization, allowing for the separation of voice and data traffic at IP station.

Commercial grade optional encryption security with minimum 128 bit key security for both signaling and voice with in a node for all IP subscribers – IP subscriber communications.

System should use randomly generated keys derived from base keys for every voice and signaling session established by the system.

### **System Management**

The system should provide a dedicated management server/platform that will be based on the latest technologies. This server should support a minimum of five or more clients having different access rights to the applications.

The management platform should provide to provide a single graphical client (Graphical User Interface (GUI)) as well as a web based interface for all network elements used in the IP PBX network.

The Management platform should provide web access allowing the administrator to manage the system to use any PC with an internet browser.

The management platform should provide the following tasks, as per the ask :-

#### **(i) Configuration and programming**

(aa) Services, users, categories and all system parameters and features.

(ab) Provide centralized management in local or remote environments of a single system or a network.

(ac) The network manager will be able to quickly and easily edit, create or delete any subscriber profile/network object by the use of import/export functions and multiple operations.

#### **(ii) Faults and Alarms management**

(aa) All the incidents and fail reports generated by the system itself informing date, hour and severity.

(ab) This module must be able to centralize the alarms and Events of the System and give colors according to the severity level of the alarm.

(ac) Notify an alarm depending on the severity level sending an e-mail or activating a script performing a specific action.

- (ad) Register and generate statistics for the alarms and events in the network on a daily basis.
- (iii) Fault diagnosis Generate reports and graphics about the statistics of the alarms.
- (iv) Accounting of all external calls generated by the users including cost, date, hour. Must provide different options to group the monitoring of the calls (cost center, extension number, trunk, user, city/area associated to dialed numbers). IP PBX system should have buffer of last 2500 tickets of call details in case of Call billing system/management system failing
- (v) Directory module should support to manage the telephone directory. This must be LDAP compatible and the exchange directory should be available on web. The LDAP server and web server application should be integral to the exchange synchronized with other directory applications, must also allow web access and provide information on all desktops allowing click to call features to the users.
- (vi) Web Interface to Directory Should support exchange directory available on web. The LDAP server and web server application should be integral to the exchange. This feature should be available for all type of users extensions
- (vii) Integrated Directory. It shall be possible to provide display equipped voice terminals with access to system directory on digital and IP phones. Also System should support internal and external LDAP directory. Any internal user can use it by browsing the URL link from his laptop/PC to see the directory and dial the required no by selecting under LDAP directory.
- viii) Call Metering and Accounting The log of local to local call should be supported. The log of local to trunk call in both directions (incoming as well as outgoing) should be maintained in the exchange in the hard disk. Should support Malicious Call Trace.
- (ix) Performance of Trunk operators The system should support to report clearance of calls by operators and evaluate performance index of each operator.
- (x) Reports The management platform must allow the administrator to generate reports and graphics of the activity per period of time in terms of traffic, accounting and alarms and giving the possibility to generate statistic of all this analysis. Those reports must be predefined but the option to personalize the reports must be also available. These reports should be exportable in HTML, pdf, excel and LDAP (.ldif) formats.

### **System Survivability**

The system should offer maximum availability, with the switchover of call control processing functions to an alternate or redundant processor in the event of significant



fault. The redundancy scheme should conform to the model used in most computer systems: the complete "mirroring" of the information (both static and dynamic data.) The switch over between 2 call servers in LAN or WAN location over L2 or L3 Network should not interrupt existing and established communications to include all analog, digital, hard, soft and Video IP Phones. The complete set of programs and software modules must be duplicated in real time. In case of failure of the main Server (hardware or software), the standby Server (emergency mirror) must take over the control of communications instantaneously.

All critical resource elements (call server, hard disks, data bases, IP interfaces, DSP resources, clocking sources, Processor, RAM, Tone generators, All the IO ports – serial and Ethernet TCP/IP ports, Ring generators, resources like DTMF receivers, Tone detectors etc.) must be redundant and in a hot standby configuration

Remote Media Gateway should support survival mechanism that allows them to maintain 100% of the telephony services for their users, in case of failure in the WAN links where the signalling with the call server drops.

The management platform must provide a backup mechanism for all critical system information in a both manual and an automatic/schedule archival and a Disaster Recovery Mechanism.

Replacement of cards without switching off exchange (hot swappable) including the control cards and peripheral/interface cards.

All the tone generation and tone detection should be local to the gateway.

The system should be able to restart automatically without human intervention when the external ac power supply is resumed after complete power failure i.e even after batteries are discharged.

The call server should support the two or more different geographically locations more than 10 Kms in the network

### **System Features**

**Numbering Scheme** The IP PBX should be suitable for up to 8 digit extension numbering scheme. This numbering scheme should be flexible. System should also allow mixed numbering scheme

The system should provide distinctive ringing for internal calls, junction calls, auto call backs, back up service and emergency reporting service

The system should support the attribution of an external number DDI or individual line or a bundle head to a trunk, a bundle, an attendant, a group of attendants, a subscriber, a group of subscriber or virtual equipment. The unanswered DDI communication can overflow, to Attendant or attendant group, Local subscriber, Network subscriber, Voice mailbox, automated attendant, abbreviated number, External number

The proposed system should support automatic route selection (ARS) and least cost routing (LCR) features to route the calls based on priorities related to user profile, tariff, and network availability, along the most cost-effective path. This service will be transparent for users and irrespective of the physical carrier connection

Voice guidance for Telephone features to be offered as standard.

DTMF and Busy Tone Resources As many busy tone detectors are to be offered as the number of trunks.

#### **4A IP Phone type I -**

128x64 pixels, black and white LCD with backlit, 6 soft keys, 2 fast Ethernet ports, HD Audio

The Phone should be hands free, full duplex.

The Phone should support 3-way conference.

The Phone should support for using in integration with Net Console computer telephony integration (CTI) application.

The Phone should have to show Incoming, outgoing, missed and answered calls list.

Fast Ethernet 10/100 connectivity for LAN

and PC

802.3AF Power over Ethernet (PoE) - Class 0/1/2/3

minimum 1 SIP account keys

- Conference key
- Redial key

- Transfer key
- Hold key
- 4-way navigation and OK key

**QoS**

- 802.1p (SIP and RTP QoS)
- DSCP

**Phonebook**

- Individual phonebook (300 entries)
- LDAP/XML directory service

**4B IP Phone type II -**

2 X 10/100 MBPS ports, 132X64 graphical display with minimum 2 simultaneous lines with backlit or better, RJ9 and 3.5 mm Jack for headsets, Dual SIP accounts, minimum 100 individual phone entries

- i. The Phone should have 132x64-pixel graphical LCD with backlight.
- ii. The Phone should have minimum two 10/100 ethernet ports.
- iii. The Phone shall support IPv4 & IPv6.
- iv. The phone shall support PoE and external power adaptor.
- v. The phone should support HD Voice
- vi. The phone should have Full-duplex hands-free speakerphone
- vii. The phone should support headset.
- viii. The phone support minimum 2 SIP accounts.
- ix. Wall mountable
- x. The Phone shall have 6 Feature keys, minimum 4 navigation keys & volume control keys.
- xi. The Phone shall support auto provision via FTP / TFTP / HTTP/ HTTPS for easy configuration & fast deployment.

xii. The Phone shall support sRTP for voice, TLS, IEEE 802.1X and AES encryption for configuration file.

**4C Type- III IP Phones**

- i Display: minimum 3.5 inch color,  
240 x 320 pixels, LED Backlight, Ambient light sensor
- ii. The Phone shall have LED for call and message waiting indication.
- iii. The phone should have dual Gigabit (10/100/1000 Mbps) ethernet ports.
- iv. The Phone shall support IPv4 & IPv6.
- v. The phone shall support PoE(802.3af) and external power adaptor
- vi. The phone shall support up to minimum 5 SIP accounts.
- vii. The phone should have full duplex speakerphone.
- viii. The phone should have HD voice, Headset
- ix. The phone Supports expansion modules.
- x. The phone should have built-in a USB port, support Bluetooth headset
- xi. The phone shall having mounting stand with 2 adjustable angles
- xii. The phone shall have 5 line keys with LED and line keys can be programmed up to 24 various features (minimum 2-page view).
- xiii. The phone shall have 4 contextual soft key buttons, 7 feature key, minimum 4 navigation keys.
- xiv. Wall mountable
- xv. Simple, flexible and secure provisioning options.
- xvi. The Phone shall support auto provision via FTP / TFTP / HTTP/ HTTPS for easy configuration & fast deployment.
- xvii. The Phone shall support sRTP for voice, TLS, IEEE 802.1X and AES encryption for configuration file

**VII - Various Video Patch Cables, USB-C, HDMI, USB 2.0, Audio Connectors, Speaker Cable, Microphone cable, Control Cable, etc. for all Low Voltage Services-**

1 **Patch cables**

USB-C, HDMI, USB 2.0, Audio Connectors, Speaker Cable, Microphone cable, Control Cable, etc. for all Low Voltage Services High-Speed HDMI Cable 6' 1.80(M) 4K@60Hz (4:4:4).

- All patch cords shall exceed the performance requirements in EIA/TIA and ISO/IEC Category 6A /Class specifications or equivalent; and the copper patch cords shall be used to crossconnect the Category 5 and Category 6 cables in the racks/frames within the IT Rooms and the Central Server Room.
- The patch cords shall provide air-tight connections and shall comply with ISO/IEC 11801 Class Ea and EIA/TIA 568-C-2 Category 6A requirement and PowerSUM NEXT requirement.
- Patch cords shall be available in 1.0, 2.0, 3.0, and 5.0 metres, excluding modular plugs at both ends; The RJ45 plugs are shielded with brass alloy. The assembly boot ensures excellent strain relief and together with the insert, ensures that performance is stable when using the Patch Cord.

2 **Face Plates**

The Item consists of **Face Plates** which shall have HDMI, USB and RJ-45 Connectivity. It shall be supplied along with double side female connectors for easy installation complete in all respect.

- Shall be Single Port or Dual port (RJ45) square plate, dimension as per commercially available modular office furniture.
- Shall have spring shuttered front access for preventing ingress of dust.
- Shall have Screw hole covers along with the plate

3 **3 meters HDMI Type A to Type A**

The Item consists of 3 meters HDMI Type A to Type A which shall support data rate of up to 18 Gbps. It shall support resolutions of up to 3820x2160@60 Hz or better. It shall have Gold Plated Contacts for Signal Integrity.

It shall have a dynamic bend radius of 90mm or better.

It shall have an insulation resistance of 100 ohms or better. It shall have a Dielectric Strength of 500V/minute or better. It shall be HDMI 2.0 or better.

It shall have up to 1536 KHz or better Audio Sample Frequency for highest audio fidelity. It shall be highly resistant with RF and EMI interference.

It shall work without the use of External Power Supplies.

4        24 RJ-45 10/100/1G BaseT, 2 fixed SFP+

24 RJ-45 10/100/1G BaseT, 2 fixed SFP+ (1/10G)+ 4 fixed SFP+ (1G/10G) uplink/stacking ports. 1RU size, internal AC power supply. Includes a country specific power cord, guides, 19" rack mount hardware and 10 Gigabit direct attached cable (DAC, uplink/stacking) 1m, SFP+

## VIII- IBS

### 1.1 Concept:

- 1.1.1 Proposed solution should be Modular in Design with respect to addition of Operators/bands
- 1.1.2 Modular POI should have the flexibility to take SISO or MIMO card in the same sub rack to minimize space and sub-rack requirement
- 1.1.3 All Passive components should have at least -150dBC PIM@2x20W Carrier
- 1.1.4 Proposed solution should support 2x2 MIMO for all LTE bands including LTE850/ LTE1800/ LTE2300/ LTE2500
- 1.1.5 RSL/RSRP/RSCP to be shared for all supported technologies so as to justify the number of Remote Units and Antennas considered in the design
- 1.1.6 BOM should be offered at each card/module/component to have ordering flexibility as per requirement
- 1.1.7 Remote Network Monitoring System should be proposed for all Active Elements in the Active DAS network
- 1.1.8 All cables used in the project should be Fire Retardant Low Smoke Zero Halogen type
- 1.1.9 The proposed system design should generate minimum Uplink noise in 3G/4G Uplink paths

## 2. DISTRIBUTED ANTENNA SYSTEM: (Technical Specifications)

### 2.1 SISO POI

- 2.1.1 Supported Technologies: LTE850/ GSM900/ GSM1800/ LTE1800/ UMTS2100/ LTE2300/ LTE2600
- 2.1.2 RF Input to POI: Max 30dBm
- 2.1.3 RF input Per Modular Card: >4`
- 2.1.4 Power consumption: <75Watt
- 2.1.5 Weight: < 10Kg
- 2.1.6 Temperature Range: - 10deg C to +55 deg. C

## 2.2 MIMO POI

2.2.1 Supported Technologies: LTE850/LTE1800/LTE2300/LTE2600

2.2.2 RF Input to POI: Max 30dBm

2.2.3 RF input Per Modular Card: 2 to 4

2.2.4 Power consumption:<75Watt

2.2.5 Weight:< 10Kg

2.2.6 Operating Temperature Range:- 10deg C to +55 deg. C

## 2.3 Master Unit SISO

2.3.1 Supported Technologies: LTE850/ GSM900/ GSM1800 LTE1800/ UMTS2100/  
LTE2300/ LTE2600

2.3.2 Optical Power:+5dBm

2.3.3 Supported Fiber type: Single Mode Fiber

2.3.4 Optical Interfaces:4

2.3.5 Optical Connectors: SC/APC

2.3.6 Max RF Input Power:+10dBm

2.3.7 RF interfaces:2

2.3.8 Power consumption:<25Watt

2.3.9 Weight<25Kg

2.3.10 Operating Temperature range :-10degC to +55degC

## 2.4 Master Unit MIMO

2.4.1 Supported Technologies:LTE850/LTE1800/LTE2300/LTE2600

2.4.2 Optical Power:+5dBm

2.4.3 Supported Fiber type: Single Mode Fiber

2.4.4 Optical Interfaces:4

2.4.5 Optical Connectors: SC/APC

2.4.6 Max RF Input Power:+10dBm

2.4.7 RF interfaces:2



2.4.8 Power consumption:<25Watt

2.4.9 Weight<25Kg

2.4.10 Operating Temperature range :-10degC to +55degC

## **2.5 Remote Unit SISO+MIMO**

### **2.5.1 Supported**

Technologies:LTE850/GSM900/GSM1800/LTE1800/UMTS2100/LTE2300/LTE  
2600

2.5.2 Optical Power:+5dBm

2.5.3 Supported Fiber type: Single Mode Fiber

2.5.4 Optical Interfaces:2(1 for SISO and 1 for MIMO)

2.5.5 Optical Connectors: SC/APC

2.5.6 RF Output power:43 dB m Max.

2.5.7 RF interfaces:2(1 for SISO and 1 for MIMO)

2.5.8 Power consumption:<550Watt

2.5.9 Weight<50Kg

2.5.10 Operating Temperature range :-10degC to +55degC

## **2.6 Omni Antenna MIMO**

2.6.1 Frequency Range:698-2690MHz

2.6.2 Gain:2dBi(698-960MHz) & 4dBi(1710-2690MHz)

2.6.3 Polarization:+/-45 deg.

2.6.4 Horizontal Beamwidth:360deg

2.6.5 Vertical Beamwidth:65deg

2.6.6 PIM :Lower than -150dBC for 2x20W carrier

2.6.7 Connectors/Type:2/ N(F)

2.6.8 Pigtail length:300mm

2.7 Panel Antenna MIMO

- 2.7.1 Frequency Range:698-2690MHz
- 2.7.2 Gain:7dBi(698-960MHz) & 9dBi(1710-2690MHz)
- 2.7.3 Polarization:+/-45 deg.
- 2.7.4 Horizontal Beamwidth:90deg
- 2.7.5 Vertical Beamwidth:65deg
- 2.7.6 PIM :Lower than -150dBC for 2x20W carrier
- 2.7.7 Connectors/Type:2/ N(F)
- 2.7.8 Pigtail length:300mm

2.8 Attenuator 20dB

- 2.8.1 Frequency Range:DC-3000MHz
- 2.8.2 VSWR:  $\leq 1.3$
- 2.8.3 Attenuation:20dB
- 2.8.4 PIM :Lower than -150dBC for 2x20W carrier
- 2.8.5 Maximum Input Power:100Watt
- 2.8.6 Operating Temperature range :-10degC to +55degC
- 2.8.7 Connectors/Type: N(M)/ N(F)

2.9 Couplers

- 2.9.1 Frequency Range:698-2700MHz
- 2.9.2 VSWR:  $\leq 1.3$
- 2.9.3 Coupling loss:7dB/10dB/15dB/20dB/30dB
- 2.9.4 PIM :Lower than -150dBC for 2x20W carrier
- 2.9.5 Maximum Input Power:100Watt
- 2.9.6 Operating Temperature range :-10degC to +55degC
- 2.9.7 Connectors/Type: N(F)

2.10 Splitters

- 2.10.1 Type: 2Way/3Way/4way
- 2.10.2 Frequency Range: 698-2700MHz
- 2.10.3 VSWR:  $\leq 1.3$
- 2.10.4 Splitting loss: 3dB/4.75dB/6dB
- 2.10.5 PIM : Lower than -150dBC for 2x20W carrier
- 2.10.6 Maximum Input Power: 100Watt
- 2.10.7 Operating Temperature range : -10degC to +55degC
- 2.10.8 Connectors/Type: N(F)

2.11 7/8" Low loss RF Cable (FRLSZH)

- 2.11.1 Inner conductor: Smooth copper tube
- 2.11.2 Outer conductor: Ring Corrugated Copper
- 2.11.3 Jacket: Fire Retardant Low Smoke Zero Halogen(FRLSZH) PE

2.12 1/2" Low loss RF Cable (FRLSZH)

- 2.12.1 Inner conductor: Copper clad Aluminium
- 2.12.2 Outer conductor: Ring Corrugated Copper
- 2.12.3 Jacket: Fire Retardant Low Smoke Zero Halogen(FRLSZH) PE

2.13 Optical Fiber cable 6/12/24 or 48 core LSZH

- 2.13.1 Single Mode Fiber
- 2.13.2 Outer Sheath: LSZH black
- 2.13.3 Armoring: Corrugated Steel Tape

2.14 Fiber Management System FMS 6/12/24/48 port

- 2.14.1 Fully Loaded 19" Rack mountable Fiber management system 11.2 Ports: 6/12/24/48/
- 2.14.2 Height: 44.45mm(1u) Max
- 2.14.3 Key Technical Requirements (to be complied)

- 2.14.4 Proposed Active DAS should be State of Art design to meet the requirement of Client and should be scalable for Coverage and Capacity needs inside all important buildings (existing and proposed)
- 2.14.5 Proposed solution should be Modular in Design with respect to addition of Operators/bands
- 2.14.6 Modular POI should have the flexibility to take SISO or MIMO card in the same sub rack to minimize space and sub-rack requirement
- 2.14.7 All Passive components should have at least -150dBC PIM@2x20W Carrier
- 2.14.8 Proposed solution should support 2x2 MIMO for all LTE bands including LTE850/ LTE1800/ LTE2300/ LTE2500
- 2.14.9 Budget and RSL/RSRP/RSCP to be shared for all supported technologies so as to justify the number of Remote Units and Antennas considered in the design
- 2.14.10 BOM should be offered at L3 level describing each card/module/component to have ordering flexibility as per requirement
- 2.14.11 Remote Network Monitoring System should be proposed for all Active Elements in the Active DAS network
- 2.14.12 All cables used in the project should be Fire Retardant Low Smoke Zero Halogen type
- 2.14.13 The proposed system design should generate minimum Uplink noise in 3G/4G Uplink paths

## **LIST OF APPROVED MAKES**

**LIST OF APPROVED MAKES  
INTERIOR & FURNISHING WORK**

SL. No.	Description of Material	Approved Make /Manufacturers
1	Reinforcement Steel (HDSD TMT)	TATA / SAIL / RINL
2	Cement OPC /Cement PPC	Ultratech / Ambuja / J K
3	White Cement	JK / Birla
4	Structural steel-MS Plates	TATA / SAIL / JINDAL/RINL
5	Structural steel-Tubular sections/RHS/SHS/CHS	TATA/SAIL / JINDAL / RINL
6	Stainless steel	SAIL / JINDAL / TATA
7	Ply Board/Veneer/MDF	Duro /Century/ Green Ply
8	Flush doors	Duro / Century /Green Ply
9	Glass	Asahi / Saint Gobain/Pilkington
10	Mirror	Asahi / Saint Gobain/ Pilkington
11	Fire rated glass	Asahi / Saint Gobain/Glaverbal/ Pilkington
12	Hardware for glass Patch Fittings	Dorma / Assaabloy/ Blum/Stronel
13	Hardware fitting for Flush doors	Dorma / Assaabloy/ Blum/Stronel
14	Canopy / skylight Patch fittings / spider fittings	Dorma / Assaabloy/Blum/Ozone
15	Wooden / Metal Fire rated doors	Navair International Pvt. Limited / Shakti Horman /Kutty/ASES Security
16	Fire Door Hardware	Becker FS/Dorma/Hettich
17	Modular Glass Partition / Doors	Candorview / Jeb/ Dorma/Bene
18	Modular Glass Sliding Partition	Candorview / Jeb/ Dorma/Bene
19	Water proofing	Ceco /Impermo /Pedelite/Dr. Fixit
20	Wooden laminated flooring	Pergo / Shephard Million/Scheit
21	Vitrified Tiles (Double Charge)	HR Johnson/ Kajaria /Nitco/Somany
22	Ceramic glazed tiles	HR Johnson / Kajaria /Nitco/Somany
23	Vinyl flooring	Gerflor / Vito/ LG hausys
24	Carpet	Milliken / Sumione/ Shaw/Mohawk
25	Plastic emulsion Paint	Oikos/ Acro/Berger /Asian / Dulux/ Johnson & Nicholson
26	Texture paint	Oikos/ Acro/Berger /Asian / Dulux/ Johnson & Nicholson
27	Fire Rated Paint	Hilti / Promat / Navair International/ Viper
28	Gypsum board/ Moisture resistance board for False ceiling	Saint Gobian Gyproc / USG Boral
29	Metallic ceiling	Durlum / Armstrong/ Hunter Douglas/ Harsons Green / SAS

30	Acoustic Ceiling/ Panellings	Anutone / Topakustik / Ideacoustic
31	Acoustic Strand	Anutone / Heradesign / Knauf
32	Stretch Fabric	Barisol/ Farrel/ Anutone
33	Acoustic Materials	Anutone / Heradesign / Knauf
34	Magnesia Board	Promate, Weiran Build, Anutone
35	Acoustic Polyfibre	Anutone / Heradesign / Knauf
36	Acoustic Glass Fibre	Armstrong / Anutone / Accoustical i surface inc
37	Strand /Synth ceiling	Anutone / Ecophon / Ftiange
38	Solid acrylic surface	Durlax / Novo / Dupont Corian
39	Zinc Paneling	VMZinc / HALCOR / IEQSA
40	Window Blinds	Livin / Vista / HunterDouglas / Rosselle
41	Window blinds motor	Livin / HunterDouglas / Somfy / Rosselle
42	Silicon Sealant	Dow corning /Sikka / Wacker / McCoy
43	Lacquered Glass	Saint Gobain/ Asahi
44	Lacquered Glass Processor	Art N Glass/ Bharat Glass Co./ Shiv Shakti Glasses
45	Automatic Sliding Doors	Dorma / Autoingress/Stronel/Geze
46	Digital Lock	Stronel/Yale/ August/Schlage
47	Cam Action Door Closer	Stanum/Dorma/Assa abloy
48	G.I Partition System	Saint Gobain / USG Boral
49	Acoustic Insulation	UP Twiga / Rockwool
50	Resin panels	Lumicor India /3 Form Hunter Douglas/ Dècora
51	Signages	Egromax/ Rosselle/ ASES
52	Entry Mat	3M/ Vito
53	Graphic film	3M / Avery
54	Acoustic Sliding Folding Partition	Dorma/Ozone/ Assa Abloy
55	Paver Blocks	Nitco/ Kajaria/ Johnson/ Super
56	Aluminium Composite Panels	Alpolic/ Alucobond/ Reynobond/ Eurobond/ Alstrong
57	SS-304 Grade Railing	Ozone/Dorma/Assa Abloy
58	PU Paint	Jotun/Berger/Asian Paints/Nerolac
59	Hanging Mural/ Stained Glass/Copper Mural	As approved by Architect/Engineer/DFCCIL

**LIST OF APPROVED MAKES  
FURNITURE WORKS**

SL. No.	Description of Material	Approved Make /Manufacturers
1	Corporate Building Furniture (including Tables, Credenza, Storage Units, Compactors, Sofas & workstations etc.)	Rockworth / Haworth / Steelcase
2	VVIP, VVIP Visitor, ED, GGM, GM, AGM, JGM, DGM, Manager, Asst. Manager Chairs	Herman Miller / Human Scale/ Vitra
3	Work Station & other Chairs	Rockworth / Haworth / Steelcase

**PLUMBING WORK  
LIST OF APPROVED MAKE**

SL.No.	Description of Material	Approved Make /Manufacturers
1	Vitreous China Sanitaryware (1st class quality)	Hindware/Parryware/Cera
2	C.P fittings & Accessories	Hindware/Parryware/Cera/Jaques
3	Stainless Steel Sink	Cera/ Neelkanth / Jayna/ Nirali
4	Health Faucet (With SS)	Hindware/Parryware/Cera/Jaques
5	G.I. pipes (Up to 150 mm dia)	Jindal Hissar / APL Apollo / TATA/ Astral
6	UPVC pipes & Fittings	Supreme/ Finolex/ Prince/ AKG
7	CPVC pipes & Fittings	Rallison/ Aashirwad/ SFMC/ Astral
8	RCC pipes	Pragati/ Super wire
9	Poly propylene pipes	SFMC/ Supreme/ Fusion
10	CI Pipes and fittings	Neco/ SKF/ SRIF
11	Stoneware Pipes	Anand / Perfect
12	P TRAP	McALPINE / Cera/ Supreme/ Finolex
13	G.I.Fittings (Malleable)	UNIK / DRP / TATA/ Zoloto M
14	Gully Trap	Supreme/Anand / Perfect
15	Horizontal Soil/Waste hanging supports	Chilly / Lovely / Camery
16	Ball valve/ Butterfly Valve/ Sluice Valve	LP / Zoloto/AIP/ Leader
17	Motorised valve	LP / Lehry
18	FRP Manhole cover	Thermodrain / Techno sales corporation
19	Grating for Floor Trap & Floor Drain	Chilly / Camry/Jayna
20	Paints & Primer	J&N / Berger/ICI/Asian
21	Nut & Bolts	GKW/Fischer/Hilti
22	Pumps	Kirloskar/ ABB/ Grundfos



23	HDPE/MDPE pipe	WL Plastics/ Noble/ Apollo
24	SFRC Manhole Covers and frames	SFMC/ Jindal/ Supreme
25	FRP Manhole covers and frames	Products Unlimited/ Supreme/ Jain
26	Water Meter	C&R/ Lahri
27	Gun Metal/ Forged Brass Ball Valves	Zoloto/ AIP/ LEader

**ELECTRICAL WORKS**  
**LIST OF APPROVED MAKES**

SL.No.	Description of Material	Approved Make/Manufacturers
(A)	(B)	(C)
<b>CONDUITS, CABLES &amp; WIRES</b>		
1	MS black enameled, Galvanized ERW conduits	AKG, BEC, Steelkraft
2	GI pipes	Tata, Jindal, SAIL
3	PVC Conduit	Precision, BEC, AKG
4	PVC Conduit Accessories	Precision, BEC, AKG
5	MS Conduit accessories	AKG, BEC, Steelkraft
6	1100 volts grade XLPE cables	Finolex, KEI, RR, Havells
7	1100 volts grade PVC control cables	Finolex, KEI, RR, Havells
8	FRLS copper conductor wires	Finolex, KEI, RR, Havells
9	LT Fire survival Cables	Finolex, KEI, RR, Havells
10	Cable lugs	Dowell's, Raychem, Comet
11	Cable compression glands	Dowell's, Raychem, Comet
<b>LIGHTING &amp; SWITCHES</b>		
1	LED Type Internal Light Fixtures (Linear, Recessed, Downlighter, etc.)	Signify, LT, Regent, Bajaj, CG, Halonix
2	Lighting Management System (LMS)	Philips Dynalite, Regent, Helvar
3	External, Outdoor Landscape & Façade	Signify (CK), LT, Regent, Bajaj, CG, Halonix
4	Modular switches, socket outlets and wiring accessories with moulded cover plate	ABB(Ivie), Schneider (Zencelo), Legrand (Arteor), MK Honeywell (Blenze plus)
<b>PANELS, DB &amp; SWITCHGEARS</b>		
1	Power Distribution Panels (TTA of OEM of item No. 4)	Neptune, Advance Power, Ambit, Adlec Systems Pvt. Ltd., Tricolite or any other agency authorised by OEM of item No. 4.
2	MV, LV Switchboards	Schneider, Legrand, Siemens, ABB
3	Rising mains (powder coated, Sandwich type)	Schneider, Legrand, Siemens, ABB
4	Moulded Case Circuit Breakers (with rotary handle) (variable settings)	Siemens – 3VA, ABB (T-Max), Schneider (NSX), Legrand DPX3
5	Protective Relays (Microprocessor)	Alstom, Siemens, ABB, Schneider
6	MV Contactors, Timers (Solid state)	Siemens, ABB, Schneider, Legrand
7	Miniature Circuit Breaker	Siemens-Betagard, ABB-SB series, Schneider-Acti9, Legrand DX3
8	Earth Leakage Circuit Breaker	Siemens-Betagard, ABB-SB series, Schneider-Acti9, Legrand DX3
9	Measuring Meters	Siemens, ABB, Schneider (Conserv)

10	Cast resin Current Transformers	Automatic Electric , Kappa , Gilbert Maxwell , Precise
11	Selector Switches	Kaycee ,Siemens
12	Indication lamps (LED type) and Push Buttons	Siemens, ABB, Schneider, Legrand
13	MCB Distribution Boards in sheet steel housing (double door)	Siemens-Betagard, ABB-ITUS, Legrand-Ekinoxe3, Schneider-Acti9
14	Timers	Siemens, ABB, Schneider, Legrand(DX3)
15	Single phase preventer (current base)	Minilec , Siemens , Legrand
16	Cable tray	Indiana (Vadodara), MEM, Profab (PUK), Legrand
17	Raceway	Indiana (Vadodara), MEM, Profab (PUK), Legrand
<b>EARTHING &amp; LIGHTNING PROTECTION</b>		
1	MF Earthing with GEM	Alkemee, Karytron, Taelman, Shubhra
2	Lightning Protection System as per IEC-62305	Dehn, OBO, ABB, Altec
<b>UPS</b>		
1	True Online Double Conversion UPS System	ABB, Schneider (APC), Numeric (Legrand)
2	Sealed Maintenance Free Batteries	Exide, Amar Raja, Hitachi, Panasonic
<b>LIFTS</b>		
1	Lifts	Schindler, Mitsubishi, Otis

**LIST OF APPROVED MAKES (HVAC)**

Sl.No.	Description Of Material	Approved Make (New Tender)
1	VRF Units	Daikin, Mitsubishi Electric, Hitachi
2	Enthalpy Recovery Wheel (HRW, ERU)	DRI, Zeco, Munters
3	Air Filter	Thermadyne , Camfil , Airtech
4	Heavy Duty Drain Piping	Polypack , Supreme , Prince, Finolex
5	GI Sheets	Tata, SAIL, Jindal (Hissar)
6	AHU, TFA	Zeco, Stulz, Systemair
7	Factory Fabricated Duct-Rectangular	Zeco , Ductofab , Projtech , Eco Duct
8	Extruded Aluminum Powder Coated Grilles , Diffusers , Slot Dampers , Volume Control Dampers , Factory Fabricated Diffuser Outlet Boxes With Diffusion Plate	Systemair, Carryaire , Green Air , Airflow, Pineair
9	Stick Pin	Airflow , Prima Seal
10	Fire Dampers	Systemair , Servex , Airflow , Belimo , Seimens
11	Fire Dampers Actuator	Belimo , Honeywell , Seimens , Airflow
12	Inline Fans, Propeller Fan	Systemair , Green Heck , Kruger , Carryaire, Air Flow
13	Axial Fans	Systemair , Kruger , Green Heck , Humidin, Air Flow
14	Centrifugal Fans	Systemair , Kruger , Green Heck , Humidin, Air Flow
15	Fan Section, Cabinet Fan	Systemair, Kruger, Green Heck, Humidin, Air Flow
16	Air-Washer	Symphony, Systemair, Zeco
17	Scrubber	Trion, Rydair, Zeco
18	Accosound Insulation For: Accoustic Lining Of Ducts, Ahu Room Accoustic Lining	Paramount, Armacell , K-Flex, Supreme
19	Cross Linked Closed Cell Oxide Acetate Foam Insulation For: Ducts Thermal Insulation and Underdeck insulation of slabs	Paramount, Armacell, K-Flex, Supreme
20	Refrigerant Copper Piping	Rajco, Mandev, Maxflow, Daikin-Jobu
21	Polysiloxane Coating	Oxycoats, Jemkon , Technocrats Polycoats
22	Adhesive	Foster, Paramount Polytrete , Fevicol
23	Cushy Foot Mounts	Dunlop, Resistoflex , Easyflex
24	Brazing Rods	Diamond, Totaline, Harries
25	Paints	Dulex-ICI, Berger, Asian
26	VI Pads	Resistoflex , Easyflex
27	Air-Curtain	Mitzvah, VTS, Almonard
28	Variable Speed Drives	Danfoss, ABB, Schneider, Seimens
29	Hybrid UVGI Air Purifier	Zeco, Aeroshield, Alfaa, Honeywell

30	Air Difrential Pressure Swtich	Anergy, Siemens, Honeywell
31	Temperature And Rh Sensor And Adjuster Package	Anergy, Siemens, Honeywell
32	Air Differential Pressure Sensor And Adjuster Package	Anergy , Siemens, Honeywell
33	Precision Air-Conditioners (PAC)	Vertiv-Emerson, Stulz, Bluebox, Schneider

**LIST OF APPROVED MAKES FOR BMS**

<b>Sr.No</b>	<b>Equipment/Material</b>	<b>Approved Manufacturer</b>
<b>A</b>	<b>Controller/Software</b>	
1	Central Control BMS Server	HP/DELL/Lenovo
2	Printer	Epson/Brother/Canon
3	Video Wall	Delta/LG/Samsung
4	Building management System	Siemens/Carrier ALC/Honeywell EBI
5	Building Management Web Based Server Software	Siemens/ Carrier ALC/Honeywell EBI
6	Programmable & Application Specifier Controller (DDC)	Siemens/ Carrier ALC/Honeywell Comfort Point
7	System Intergration Units for 3RD Party software Integration	Siemens/ Carrier ALC/Honeywell Comfort Point
8	Enclosure for DDC Controller	Rittal/Siemens/BCH
<b>B</b>	<b>Sensor &amp; Field Devices</b>	
1	Immersion type temperature sensors	As per OEM Standard supply
2	Ultrasonic BTU Meter/Flow Meter	As per OEM Standard supply
3	Outside T+RH Sensor	As per OEM Standard supply
4	Differential pressure Switch Air	As per OEM Standard supply
5	Differential pressure Switch Water	As per OEM Standard supply
6	Differential Pressure Sensor-Air/Water	As per OEM Standard supply
7	Room/Duct Type Temp Sensor	As per OEM Standard supply
8	Room/Duct Type Temp + RH Sensor	As per OEM Standard supply
9	Pressure Sensor Water	As per OEM Standard supply
10	CO2 Sensor/VOC Sensor/PM2.5&10	As per OEM Standard supply
11	Water Level Switches	As per OEM Standard supply
12	Flame Proof Level Transmitter	As per OEM Standard supply
13	DC Voltage /Current/Power Factor Transducer	As per OEM Standard supply
14	Current Relay	As per OEM Standard supply
15	PH Anayser/ TDS Analyser	As per OEM Standard supply
16	Valves and Actuators	As per OEM Standard supply
17	Thermostat	As per OEM Standard supply
18	VFD Drives	As per OEM Standard supply
<b>C</b>	<b>Wiring &amp; Conduiting</b>	
1	Signal Cable , PVC Insulated , tinned Copper	RR/KEI/Bonton/Skyton
2	Lan Cable	D-Link/Skyton/Bonton/Finolex
3	PVC Conduit of 20 & 25 mm dia	BEC/AKG/RMCON
4	MS/GI Conduit of 20 & 25 mm dia	BEC/AKG/RMCON
5	Hot dipped GI Cable Tray/Race way	Profab/Advance Power/Indiana/MEM
6	Network Passive (BMS)	PENDUIT/AVAYA/LEGRAND/DLINK/HP
7	Network Active (BMS)	CISCO/HP/JUNIPER

**LIST OF APPROVED MAKES  
MISCELLANEOUS E&M ITEMS**

SL. No.	Description of Material	Approved Make, Manufacturers
(A)	(B)	(C)
<b>FIRE ALARM/PA SYSTEM</b>		
1	Addressable fire alarm control panel	Siemens (Cerberus), Bosch, Notifier
2	Active Repeater Panel	Siemens (Cerberus), Bosch, Notifier
3	Intelligent addressable Multicriteria detector (Smoke + Thermal).	Siemens (Cerberus), Bosch, Notifier
4	Intelligent addressable Smoke detector	Siemens (Cerberus), Bosch, Notifier
5	Intelligent addressable Heat detector	Siemens (Cerberus), Bosch, Notifier
6	Addressable Control Relay Module	Siemens (Cerberus), Bosch, Notifier
7	Addressable Module with one input & one output contacts,	Siemens (Cerberus), Bosch, Notifier
8	Response Indicator with matching screws	Siemens (Cerberus), Bosch, Notifier
9	Addressable manual break glass unit (Double action)	Siemens (Cerberus), Bosch, Notifier
10	Standalone Loop Powered sounder	Siemens (Cerberus), Bosch, Notifier
11	Standalone Loop Powered Strobe with inbuilt isolators	Siemens (Cerberus), Bosch, Notifier
12	Addressable Duct detector	Siemens (Cerberus), Bosch, Notifier
13	Beam Detector	Siemens (Cerberus), Bosch, Notifier
14	Fire Survival Armoured cable	Finolux, KEI, RR
15	PA controller	Bosch, Biamp, Altas IED, Notifier
16	Router monitoring.	Bosch, Biamp, Altas IED, Notifier
17	Amplifier.	Bosch, Biamp, Altas IED, Notifier
18	Call Station	Bosch, Biamp, Altas IED, Notifier
19	wall mount speaker	Bosch, Biamp, Altas IED, Notifier
20	ceiling mount certified speaker	Bosch, Biamp, Altas IED, Notifier
21	CD/DVD Player	Sony / Samsung
22	Volume control units 12,36,100W	Bosch / Notifier / Biamp
23	Equipment Rack	MTS / Rittal / APW/ Valrack
24	Workstation ( i-7 PC, with 8 GB RAM and 1 TB HDD, 10/100 Mbps Ethernet card	HP / DELL / Lenovo
25	Fire Rated Speaker Cable	Crestron, Extron, Belden
26	Graphics Software	Siemens (Cerberus), Bosch, Notifier
27	Router monitoring.	Bosch / Notifier / JBL

28	Amplifier.	Bosch, Biamp, Altas IED, Notifier, JBL
29	Call Station	Bosch, Biamp, Altas IED, Notifier, JBL
30	wall mount speaker	Bosch, Biamp, Altas IED, Notifier, JBL
31	ceiling mount certified speaker	Bosch, Biamp, Altas IED, Notifier, JBL
32	CD/DVD Player	Sony / Samsung
33	Volume control units 12,36,100W	Bosch / Notifier / JBL
34	Equipment Rack	MTS / Rittal / APW/ Valrack
35	Fire Rated Speaker Cable	Crestron, Extron, Belden
36	Graphics Software	Siemens (Cerberus), Bosch, Notifier
<b>FIRE EXTINGUISHERS</b>		
1	Composite Fire Extinguishers	Aska, Orbit, Stitchwell, Daasnav
2	Cylinder less Fire Suppression Tubes	Aska, Orbit, Stitchwell, Daasnav
<b>FIRE FIGHTING</b>		
1	MS Pipes	Jindal Hisar, Tata, SAIL
2	Expansion Joint	Easyflex, Dunlop, Vimpe
3	Butterfly Valves	Zoloto, Advance, Kartar, G-Tech
4	Hydrant Valve	Newage, Omax, Kalpex, G-Tech
5	Check Valve/ NRV/Ball Valve	Zoloto, Advance, Kartar, G-Tech
6	Hose Pipe/Branch Pipes	Newage, Omax, Kalpex, G-Tech
7	Firemen's Axe	Safeguard, Safex, Newage
8	Fire Brigade connection/ draw out connection	Newage, Omax, Kalpex, G-Tech
9	Strainer	Kartar, Sant, Honeywell
10	Flow Detectors	System Sensor, Honeywell, Switzer
11	Sprinklers	HD, Newage, G-Tech
12	FHC	ASES, Sehgal Door, G-Tech
13	Pumps	KSB, ABB, Grundfos
<b>VESDA</b>		
1	VESDA	Honeywell, Xtralis
<b>RODENT REPELLANT</b>		
1	Rodent Repellant	Maser, CWT
<b>WATER LEAK DETECTION</b>		
1	Water Leak Detection	Agni, Sontay
<b>GAS SUPPRESSION SYSTEM</b>		
1	Seamless Cylinder (PESO/CCoE Approved)	Rama, EKC
2	Valve Assembly (Brass).	UTC, Siemens, Tyco
3	Pressure Gauge cum Switch	UTC, Siemens, Tyco
4	HFC 227ea Gas (1,1,1,2,3,3,3 Hepta fluoro propane), Zero ODP, Stored Pressure 25BAR	3M
5	Electric Control Head (Solenoid actuator)	UTC, Siemens, Tyco
6	Manual (Mechanically Operated) Control Head (Brass)	UTC, Siemens, Tyco
7	Manual Activation Mechanical box	UTC, Siemens, Tyco
8	Pneumatic Actuator	Ansul, Siemens, Sevo
9	Discharge Nozzles	UTC, Siemens, Tyco
10	Master Cylinder Adapter Kit	UTC, Siemens, Tyco
11	Manifold Check Valve	Ansul, Siemens, Sevo



12	Discharge Pressure Switch	UTC, Siemens, Tyco
13	Flexible discharge Hose	Ansul, Siemens, Sevo
14	Flexible Actuation Hose	Ansul, Siemens, Sevo
15	M.S. Container strap	UTC, Siemens, Tyco
16	Brass Elbow	UTC, Siemens, Tyco
17	Gas Release Panel with battery & battery charger	Siemens, Ravel, Agni
18	Manual Release Switch	Siemens, Ravel, Agni
19	Manual Abort Switch	Siemens, Ravel, System Sensor
20	Warning Sign Board.	Siemens, Ravel, Agni
21	Commissioning of Detectors	Siemens, Ravel, Agni
22	1.5sqmm 2 Core Cable	UTC, Siemens, Tyco
23	Manifold fabricated from seamless pipe	UTC, Siemens, Tyco
24	Clean Agent Gas (NOVEC 1230)	3M
25	Multi Sensor Smoke Detector	System Sensor, Siemens
26	Seamless Pipe	BHEL, Tata, Jindal
<b>EV CHARGERS</b>		
1	Slow Chargers (AC Chargers)	Schneider, MyPowerExperts, Tricare, Tata Power, Siemens
2	Fast Chargers (DC Chargers)	Schneider, MyPowerExperts, Tricare, Tata Power, Siemens

**LOW VOLTAGE WORKS**  
**LIST OF APPROVED MAKE**

SL.No.	Description of Material	Approved Make /Manufacturers
<b>CCTV SYSTEM</b>		
1	Dome camera	Bosch, Axis, Honeywell-Equip
2	Bullet Camera	Bosch, Axis, Honeywell-Equip
3	Two-way Audio Input	Bosch, Axis, Honeywell-Equip
4	PTZ Camera	Bosch, Axis, Honeywell-Equip
5	NVR	Bosch, Axis, Honeywell-Equip
6	Hard Drives	WD / Seagate
7	LED Display	Refer S.No 1 of Displays
<b>DISPLAYS</b>		
1.	LED Display	NEC/LG/SAMSUNG
2	LCD Video Wall (2x2 video wall)	Barco/Delta/NEC
3	Projector	Barco/Digital Projection/NEC
4	Direct View LED	Delta/NEC/Samsung
5	4K Digital Signage Media Player	Trunknox / One-Lan /Vivitek
6	4K Digital Signage server software	Trunknox / One-Lan /Vivitek
7	Touch Interactive Display	Samsung / LG/NEC
<b>AudioVisual</b>		
1	Wall mount loudspeaker	BOSE/ AtlasIED / Martin Audio / Tannoy
2	Digital channel power amplifier	BOSE/ AtlasIED / Tannoy/ Lapgruppen / Powersoft
3	Professional Media Player	BOSE/ AtlasIED / Tannoy/ Apartaudio
4	Dual channel power amplifier	BOSE/ AtlasIED / Tannoy/ Lapgruppen / Powersoft
5	Sound Bar	BOSE/ Focal / Yamaha / Origin Accoustic
6	Passive Column Array Loudspeaker	BOSE/ d&b Audiotechnik / AtlasIED / Tannoy
7	Dual Channel 400watt power amplifier with 2 x 200W on each channel	BOSE/ AtlasIED / Tannoy/ Lapgruppen / Powersoft
8	Compact Powered Bass Reflex Cabinet	BOSE/ AtlasIED / Martin Audio / Tannoy
9	Ceiling Speakers	BOSE/ AtlasIED / Martin Audio / Tannoy
10	Central Control Unit Audio Conferencing	BOSE/ Marconi Technologies / Audio Technica / Televic
11	Channel Digital Processor Mixer	BOSE/ Klarktechnik / Biamp / AtlasIED / Symetrix / Audio Technica
12	Digital Chairman Unit	Marconi Technologies / Audio Technica / Televic
13	Delegate Unit Discussion Devices	Marconi Technologies / Audio Technica / Televic
14	Central Conference Controller with recording facility	Marconi Technologies / Audio Technica / Televic

15	Various Patch Cords	Crestron / Marconi Technologies / Audio Technica / Televic
16	Wireless handheld / lapel / headworn microphone	Sennheiser /Shure/ Beyerdyanamics/ Audio Technica
17	Wireless Handheld Cardioid Dynamic microphone System	Sennheiser /Shure/ Beyerdyanamics/ Audio Technica
18	Wireless Handheld Cardioid Condenser microphone System	Sennheiser /Shure/ Beyerdyanamics/ Audio Technica
19	Wired Omnidirectional Condenser boundary System	Sennheiser /Shure/ Beyerdyanamics/ Audio Technica
20	Wireless Lapel Mic	Sennheiser /Shure/ Beyerdyanamics/ Audio Technica
21	UHF wireless Cardioid Condenser lavalier microphone	Sennheiser /Shure/ Beyerdyanamics/ Audio Technica
22	UHF wireless Cardioid Dynamic handheld microphone	Sennheiser /Shure/ Beyerdyanamics/ Audio Technica
23	Wireless Presenter module	Crestron/Barco/Extron/Atlona
24	Ceiling Tile Microphone	Sennheiser / Shure/ Beyerdyanamics/ Audio Technica
25	Digital Signal Processor	BOSE/ Audio Technica / Biamp / AtlasIED/ Klarktechnik
26	Antenna distribution System	Senheiser / Shure/ Beyerdyanamics/ Audio Technica
27	UHF wide band directional LPDA	Senheiser / Shure/ Beyerdyanamics/ Audio Technica
28	Digital Control unit for minimum 50 nos tabletop conference units	Televic / Marconi Technology / Audio Technica
29	Integrated Flush Mount Chairman Discussion unit compete with 400mm Gooseneck microphone	Televic / Marconi Technology / Audio Technica
30	Integrated Flush Mount Delegate Discussion unit compete with 400mm Gooseneck microphone	Televic / Marconi Technology / Audio Technica
31	Shielded copper cable, category 6A F/UTP	Siemon, Belden, Panduit
32	Cardioid Condenser Quick Mount Gooseneck Microphone with RFI shielding	Senheiser / Shure/ Beyerdyanamics/ Audio Technica
33	FoH Digital Steerable Line Array Loudspeaker with minium 24No's of full range driver	BOSE/ Renkus Heinz / Tannoy / MeyerSound/ Fohnn Audio
34	3-way point source In-Ceiling loudspeaker with assyemtric dispersion angle	BOSE/ Tannoy / B&W / MartinLogan
35	Flush Mount Boundary Microphone with Touch Sensitive Switch & LED Indicator	Audio Technica / Marcony / Clockaudio
36	Networked Digital Audio Processor	BOSE/ Klark Teknik / Biamp / Symmetrix
37	Compact Full Range 6" ceiling speaker	BOSE/ Tannoy / Martin Audio / Atlas IED

<b>Unified Communication</b>		
1	HD Video communication desktop system	Cisco/Polycom/ Lifesize/Crestron
2	AI powered video conferencing system	Cisco/Polycom/ Lifesize/Crestron
3	4K Video Conferencing codec	Cisco/Polycom/ Lifesize/Crestron
4	Ultra High Definition Video Conferencing system	Cisco/Polycom/ Lifesize/Crestron
5	premise conference call unit (MCU)	Cisco/Polycom/ Lifesize/Crestron
6	Conference Call Unit (MCU)	Cisco/Polycom/ Lifesize/Crestron
<b>Image Processing Systems</b>		
1	4K/8K multi-screen presentation system and videowall processor	Barco/ Christie/Planar/NEC/Analog Way
2	Codec	Cisco/Polycom/ Lifesize
3	30x Optical Zoom PTZ Camera with 4K UHD @30/60Hz output	Sony/ Vaddio (by Legrand)/ Atlona
4	Software VC AV Bridge	Crestron/AMX/Extron/ Vaddio (by Legrand)
<b>Miscellaneous items</b>		
1	USB Extender System	Crestron / Extron /AMX(USA)
2	Wireless Keyboard and Mouse	Logitech / Dell / HP
3	Wireless Presenter with Green Laser Pointer	Logitech / Kensington / HP
4	Twisted Pair Extender	Crestron / Extron /AMX(USA)
5	Wireless Touch Panel	Apple
6	Docking station	iPort Luxeport
7	IPAD	Apple
8	Wireless Router - Dual Band	Cisco / Juniper/ Arista
9	16 Port Network Giga Byte Switch	Cisco / Juniper/ Arista
10	AV Rack	Rittal / APW/ Valrack
11	Semi armored -OM3/OM4 fiber optical cable	Belden, Siemon, Schneider, Panduit
12	LC Connectors	Belden, Siemon, Schneider, Panduit
13	SFP+ 10G Module	Cisco / Juniper/ Arista
14	Flexible High Speed HDMI, Display Port, Mini Dp, Male etc. Cables	Crestron/AMX/Barco/Extron
15	Shielded Digital Twisted Pair Cat6 Cable	Belden, Siemon, Schneider, Panduit
16	Shielded RJ-45 Crimp connector	Belden, Siemon, Schneider, Panduit
<b>Video Switching, Distribution and Extension Systems</b>		
1	AV over IP Video System	Lightware / Barco/ Christie/Crestron/Extron
2	Under desk mounting for above, AV over IP Video System	Lightware / Barco/ Christie/Crestron/Extron

3	Matrix Management Unit for the AV Over IP system.	Lightware / Barco/ Christie/Crestron/Extron
4	Fiber Network Switch	Cisco / Juniper/ Arista
5	2x1 switcher with USB-C	Extron / Lightware/ AMX
6	Under Desk Mounting for above 2x1 switcher	Extron / Lightware/ AMX
7	Wall plate transmitter	Extron n / Lightware/ AMX
8	Single port standalone power injector	Extron n / Lightware/ AMX
9	HDMI1.4 + Ethernet + RS-232 + bidirectional IR HD Base T receiver	Extron n / Lightware/ AMX
10	USB	Extron n / Lightware/ AMX
11	Network based Control processor	Extron n / Lightware/ AMX
12	AV Control monitoring System	Extron n / Lightware/ AMX
<b>Accessories/Cables</b>		
1	AV Connectivity Face Plate	Extron n / Lightware/ AMX
2	Pro Grade 2 Core Shielded Audio Cables – In Mtr	Extron n / Lightware/ AMX
3	Pro Grade 4 Core Control Cable - In Mtr	Extron n / Lightware/ AMX
4	Pro Grade 16 AWG Speaker Cable - In Mtr	Extron n / Lightware/ AMX
5	Rack 12 U	Rittal / APW/ Valrack
6	Rack 24 U	Rittal / APW/ Valrack
7	Patch Cord HDMI 2.0 - 2Mtr	Extron n / Lightware/ AMX
8	Patch Cord Audio - 2Mtr	Extron n / Lightware/ AMX
9	PDU	Extron n / Lightware/ AMX
10	HD Base T TX/RX for HDMI	Extron n / Lightware/ AMX
11	Wall plate HD Base T Transmitter	Extron n / Lightware/ AMX
12	Universal 5X2 Switcher	Extron n / Lightware/ AMX
13	6x2 Matrix Presentation Switcher with USB	Extron n / Lightware/ AMX
14	2x1 AV Switcher cum Receiver	Extron n / Lightware/ AMX
15	2x1 AV Switcher cum Receiver with Scaler	Extron n / Lightware/ AMX
16	HD Base T receiver for HDMI with USB	Extron n / Lightware/ AMX
17	Network based Control Processor	Extron n / Lightware/ AMX
18	Touch Panel	Extron n / Lightware/ AMX
19	8-Button Network wall mount control panel	Extron n / Lightware/ AMX
20	1080p business webcam	Sony/ Vaddio (by Legrand)/ Atlona
21	Cable cubby	Crestron / Extron, Lightware, AMX
<b>ACCESS CONTROL SYSTEM/PANIC BAR</b>		
1	I.P Controller	Bosch, Prowatch-Honeywell, Lenel
2	Card Readers	Bosch, Prowatch-Honeywell, Lenel

3	Relay Boards	Bosch, Prowatch-Honeywell, Lenel
4	Biometric reader	Bosch, Prowatch-Honeywell, Lenel
5	Bluetooth smart card readers	Bosch, Prowatch-Honeywell, Lenel
6	electromagnetic locks/ electric lockset /Digital locks	Assa Abloy, Bel, Defikas, Kaba, Stronel
7	exit buttons	Bosch, Prowatch-Honeywell, Lenel, Stronel
8	smart cards	Bosch, Prowatch-Honeywell, Lenel, Stronel
9	Magnetic Door Contact	CWT, Security Exchange, Kaba
10	Buzzer	CWT, Security Exchange, Kaba, Stronel
11	Emergency door open break glass unit	CWT, Security Exchange, Kaba, Stronel
12	DFMD	Rapiscan, Astrophysics, Smiths, Safe-gate, Samarth Security
13	Panic bar with electric latch retraction.	Dafikas / Dorma /Stronel
14	Hand held metal detector	Rapiscan, Astrophysics, Smiths, Safe-gate, Samarth Security
15	Access Control Software	Bosch, Prowatch-Honeywell, Lenel
16	Bollards	Came, Speedgatz/Neptune
17	Boom barrier	Came, Speedgatz/Neptune
18	Baggage X-Ray Scanner	Vehant/Smith/Rapiscan
19	Cables for ACS	Excel / Bonton/ KEI
20	PVC conduit	Precision, BEC, AKG, RMG
<b>PASSIVE NETWORKING COMPONENTS</b>		
1	Unshielded Twisted Pair	Belden, Schneider, Panduit
2	24 Port Patch panels	Belden, Schneider, Panduit
3	Face Plate	Belden, Schneider, Panduit
4	CAT6A/ CAT6 /RJ45 Cable	Siemon, Belden, Panduit
5	CAT 6A UTP 24 AWG Patch Coard-1 Mtr/ 2Mtr	Siemon, Belden, Panduit
6	6 Core OM 3 indoor/outdoor rated	Siemon, Belden, Panduit
7	12/24 Port LIU (Fiber optic interconnecting unit)	Siemon, Belden, Panduit
8	Duplex Fiber optic patch cords Multimode (LC to LC) 3m- OM3 50/125	Siemon, Belden, Panduit
9	OM3 50/125 Type pigtails	Siemon, Belden, Panduit
10	1U wire manager	Siemon, Belden, Panduit
11	Telephone Tag Blocks	Krone/ Pouyet/ TVS
12	Cable TV Wire	Siemon, Belden, Cisco, Commscope
13	Telephone Wire/ Co-Axial	Havells, Finolex, LAPP
<b>NETWORK</b>		
1	Network Rack	Rittal / APW/ Valrack
2	Chasis Based Core Switch	Cisco / Juniper/ Arista
3	Core switch	Cisco / Juniper/ Arista

4	Edge switch	Cisco / Juniper/ Arista
5	Modules 10GBASE-SX SFP, MMF 220 & 550 meters,	Cisco / Juniper/ Arista
6	Wireless Controller	Cisco / Juniper/ Arista
7	Dual radio 2x2, 4x4 802.	Cisco / Juniper/ Arista
8	Network Management System	Cisco / Juniper/ Arista
9	Server for NMS+Controller	HP / Dell /Cisco
10	1U RACK Server	HP / Dell /Cisco
11	Fire Wall, Unified Protection (UTM)	Fortinet, Cisco, Palo Alto
<b>Voice Solution</b>		
1	IPPBX	Cisco, NEC, Tadiran
2	IP Phones	Cisco, NEC, Tadiran
<b>In Building Solution (IBS)</b>		
1	6dB Coupler	Rosenberger, Kathrein (Ericsson), RFS (Nokia)
2	10dB Coupler	Rosenberger, Kathrein (Ericsson), RFS (Nokia)
3	2 way Splitter	Rosenberger, Kathrein (Ericsson), RFS (Nokia)
4	3 way Splitter	Rosenberger, Kathrein (Ericsson), RFS (Nokia)
5	RF Coaxial Feeder, Cable 7/8 inch	Rosenberger, Kathrein (Ericsson), RFS (Nokia)
6	RF Coaxial Feeder Cable 1/2 inch	Rosenberger, Kathrein (Ericsson), RFS (Nokia)
7	1/2" N(F) Connector	Rosenberger, Kathrein (Ericsson), RFS (Nokia)
8	7/8" N(M) Connector	Rosenberger, Kathrein (Ericsson), RFS (Nokia)
9	Combiner,4:4	Rosenberger, Kathrein (Ericsson), RFS (Nokia)
10	1/2" Super Flex Jumper	Rosenberger, Kathrein (Ericsson), RFS (Nokia)

**Notes:**

- 1 The brands/makes of the items would be executed as per the “List of Approved Makes” provided in the Tender Document.
- 2 **In case of non-availability of the brand/make specified in the approved list, the agency shall be allowed to use alternate equivalent brands of the material subject to approval of the same from Engineer/DFCCIL and decision of Engineer/DFCCIL in this regard shall be final and binding.**
- 3 The agency has to submit requisite catalogues and samples of the material to DFCCIL before approval and ensure that the supply would only be taken by agency after the materials are duly approved by

DFCCIL.

- 4 The agency has to produce Manufacturer Test Certificates (MTC), Warranty Certificates/Invoices for material/equipment supplied for certification and approval.
- 5 Submittals and samples before supply must be approved from Architect/Engineer