# DETAILED TECHNICAL SPECIFICATIONS DOCUMENT

## PROPOSED OFFICE INTERIOR FITOUT WORKS AT 5TH FLOOR, TOWER C, WTC, NAUROJI NAGAR, NEW DELHI

## CLIENT: POWER GRID CORPORATION OF INDIA LIMITED (PGCIL)
## CONSULTANT: MASS N VOID DESIGN CONSULTANTS, NEW DELHI

# SECTION 1: GENERAL NOTES & TENDER CONDITIONS OF CONTRACT

**1.1 Scope of Work & Intent of Tender: The Scope of Work covers complete design execution, supply, installation, testing, and commissioning of Civil, Partition, Ceiling, Flooring, Millwork, Modular Furniture, Sanitary/Plumbing, HVAC, Electrical, Fire Protection, Fire Alarm, ELV/IT, Audio-Visual, Artwork and Signage works at 5th Floor, Tower C, WTC, Nauroji Nagar, New Delhi for Power Grid Corporation of India Limited (PGCIL).**

**All works shall be completed in all respects to make the premise fully operational and functional.**

**1.2 Complementary Documents:** The Bill of Quantities (BOQ), Technical Specifications, Tender Drawings, General Conditions, and Special Conditions shall be taken as mutually explanatory and complementary. In case of ambiguity, the stringent technical requirement and decision of the Engineer-in-Charge (EIC) shall prevail.

**1.3 Governing Standards & Codes:** All materials, workmanship, and execution shall strictly comply with CPWD Specifications (latest edition with correction slips), National Building Code (NBC 2026), and relevant Indian Standards (IS), British Standards (BS), European Standards (EN), DIN, ASTM, BIFMA, IGBC, and ISO standards. Where codes are silent, sound engineering practice as approved by the Consultant shall govern.

**1.4 Site Coordination & Parallel Works**: The Contractor shall manage and coordinate seamlessly with all parallel specialized subcontractors (interior, mechanical, electrical, fire, HVAC, IT, AV etc.). Immaculate planning and qualified engineering supervision on site are mandatory. The site shall be kept clean, dry, and free of dust/debris daily.

**1.5 Debris & Environmental Management Plan:** Implement strict debris management, isolate work areas to prevent contamination, provide dust masks to workers, protect installed items from moisture damage, seal duct/equipment openings, and safely exhaust toxic fumes.

**1.6 Project Schedule & Bar Chart (CPM/PERT):** The Contractor shall submit a detailed CPM/PERT Bar Chart within 7 days of contract award. The agreed bar chart signed by the Contractor, and EIC shall be binding for progressing the work to completion by the due date.

**1.7 Sample Approvals & Working Mock-Ups:** At least two weeks prior to procurement, the Contractor shall submit samples of all materials for written approval from EIC/Consultant. Working mock-ups of key areas (office cabins, workstations, toilets, ceilings, wall panelling) shall be constructed on site and approved prior to bulk execution.

**1.8 Testing & Inspection:** All materials and equipment shall be subjected to routine, type, and field acceptance tests. Factory inspection at OEM works shall be arranged for major equipment (VRF units, LT panels, UPS, Fire Alarm FACP, AV Matrix) at Contractor's cost.

**1.9 Storage & Safeguarding:** Materials delivered to site shall be stored in a flat, clean, dry, secure space protected from weather and site damage. Damaged items shall be replaced at Contractor's cost.

**1.10 As-Built Drawings & Handover Documents:** Upon completion, the Contractor shall submit 4 sets of bound As-Built Drawings, Asset Registers, Test Certificates, Technical Data Sheets, and Operation & Maintenance (O&M) Manuals in hard copy and soft copy.

**1.11 Defect Liability Period (DLP):** The Defect Liability Period shall be as per provisions laid in the contract. During DLP, the Contractor shall conduct quarterly preventive maintenance, load checking, ELCB testing, and prompt rectification of all defects without extra charge.

**1.12 Statutory Approvals:** The Contractor shall liaise with and obtain all statutory approvals from the Electrical Inspectorate, Local Municipal Authorities, Fire Department (NOC), and Power Utility at no extra cost (statutory fees shall be reimbursed against original challans).

# SECTION 2: GENERAL PRINCIPLES & RULES FOR MODE OF MEASUREMENT

**2.1 General Metric System Rules:** All measurements shall be taken in the metric system (Sqm, Rmt, Cum, Nos, Set, Kg) jointly by the Contractor and EIC representative and recorded in the Measurement Book (MB). Only actual finished visible plan/elevation area supplied and installed in position shall be measured.

**2.2 Civil & Masonry Works:** AAC block masonry measured in Cum net volume without deductions for small openings <0.1 sqm. Plastering and skim coat putty measured in Sqm of finished vertical/horizontal surface area. Anti-termite treatment measured in Litres (chemical) / Metres (injection) / Sqm (surface).

**2.3 Drywall Partitions & Wall Claddings:** Partitions measured in Sqm from finished floor level (FFL) up to false ceiling height (or true ceiling as specified). Openings for doors and glazed panels deducted from partition area and paid separately under door/glass items. Wall claddings (HPL, Sintered Stone, PET Acoustic panels, Wooden Acoustic slats, Lacquered Glass, Plywood panelling) measured in Sqm of actual cladded finished face area.

**2.4 Doors, Windows & Glazing:** Door shutters measured in Sqm or per door set as specified in BOQ. Frameless glass doors and demountable glass partitions measured clear from jamb to jamb and floor to top profile in Sqm or per set. Fire doors measured per set inclusive of frame, vision panel, intumescent seals, drop seals, and fire-rated hardware.

**2.5 False Ceilings:** Measured on horizontal finished plan area in Sqm. Vertical drops/fascias up to 450mm included in plan area measurement. Openings for light fittings, diffusers, and smoke detectors exceeding 0.5 sqm deducted; smaller cutouts included in scope without deduction.

**2.6 Flooring & Tiling:** Marble flooring, vitrified tile flooring, LVT, wooden laminate, woven vinyl, and false access flooring measured in Sqm of actual laid net plan area. Skirting measured in sqm as per BOQ item. Self-levelling underlayment measured in Sqm.

**2.7 Painting & Surface Finishes:** Measured in Sqm of actual painted ceiling/wall area. No deduction for small switch boxes or light cutouts.

**2.8 Millwork & Custom Counters:** Counters and reprographics units measured in Rmt or Sqm of finished frontal/top surface area. Storages measured in Sqm or Nos as specified. Wall pelmets and transition strips measured in Rmt.

**2.9 Modular Furniture & Workstations:** Workstations, executive tables, conference tables, pedestals, and chairs measured in Nos or Sets as per BOQ description.

**2.10 Sanitary, Plumbing & Drainage:** Sanitary fixtures, sensor taps, soap dispensers, 3-in-1 / 4-in-1 panels, WCs, basins, urinals, and valves measured in Nos. Water supply (CPVC) and drainage (UPVC) pipes measured along centerline in Rmt including fittings.

**2.11 Signage & Wayfinding:** Extruded aluminum signs and illuminated emergency exit signs measured in Nos or Sets as per BOQ schedule.

# SECTION 3: DETAILED SPECIFICATIONS - CIVIL, MASONRY, DRYWALL & CLADDING WORK

## 3.1 AAC Block Masonry

Autoclaved Aerated Concrete (AAC) blocks Grade-1 (density 551-650 kg/m3, compressive strength >=3.5 N/mm2) conforming to IS 2185 (Part 3). Blocks laid in polymer-modified thin-bed adhesive mortar with 100mm RCC bed bands at sill and lintel levels reinforced with Fe-500D TMT bars.

## 3.2 Chemical Anti-Termite & Pest Control Treatment

Post-construction anti-termite treatment conforming to IS 6313 (Part 3) using Chlorpyriphos 20% EC (1% emulsion concentration) injected along external walls, masonry joints, and slab junctions at 300mm intervals. General pest control for crawling/flying insects. Vendor to issue a 2-year performance guarantee.

## 3.3 2-Hour Fire Rated Drywall Partition (150mm Overall)

150mm thick triple-layered drywall partition achieving 2-Hour Fire Rating per BS 476 Part 22. Framework: 90mm GI floor/ceiling channels (90x45x0.9mm) and 89mm GI C-studs (89x44x12x0.9mm) @ 600mm c/c. Cavity Infill: 100mm Rockwool insulation (68 kg/m3 density, thermal conductivity 0.461 W/mK). Cladding both sides: 1st layer 8mm Cement Bonded Particle Board (IS 14276), 2nd layer 10mm Cement Bonded Particle Board, 3rd layer 12.5mm Gypsum board. Staggered joints, tape jointed, and finished smooth with jointing compound.

## 3.4 1-Hour Fire Rated Drywall Partition (100mm Overall)

100mm thick double-layered drywall partition achieving 1-Hour Fire Rating per BS 476 Part 22. Framework: 51mm GI floor/ceiling channels and 51mm GI C-studs (0.55mm thick) @ 600mm c/c. Cavity Infill: 50mm Rockwool

insulation (60 kg/m3 density). Cladding both sides: 1st layer 12mm Cement Bonded Particle Board, 2nd layer 12.5mm Gypsum board, tape jointed and finished flush.

### 3.5 High Pressure Compact Laminate (HPL) Interior Cladding

6mm thick Greenlam / Merino / Trespa / Fundermax compact laminates conforming to IS 2046, EN 438, NEMA LD3. Core: thermosetting phenolic resin treated Kraft papers; Surface: decorative papers with Amino plastic resin. Anti-bacterial & Anti-fungal (JIS Z2801 / ASTM G21), Greenguard Gold IAQ certified. Density >1.35 g/cm3, boiling water resistance <2% swelling. Mounted on 25x50mm AL tubing framework @ 600mm c/c with expansion gaps. OEM 10-year warranty.

### 3.6 Sintered Stone Slab Cladding

3000x1200x5.5mm Sintered Stone / Porcelain slabs manufactured by 100% natural raw material sintering with fiberglass mesh backing. Weight ~45 kg/slab, Mohs hardness >=8, breaking strength >=1000N, water absorption 0.08%, stain resistance Class 5, fire class A2-s1,d0, IGBC compliant, 25-year color fading warranty. Fixed on 25x50x1.5mm AL rectangular tubing framework @ 600mm c/c using structural silicone (Dow Corning 995/896/795) and VHB tape with weather-resistant silicone joint sealing.

### 3.7 PET Acoustic Panels & Privacy Screens

12mm / 9mm 100% Polyethylene Terephthalate (PET) acoustic panels (density 2400 / 1750 GSM, ASTM E84 Class A/B fire rated, low VOC, NRC 0.75-0.90). CNC V-grooved or UV custom printed with non-fading inks (5-year print guarantee). Fixed to wall/ceiling/screens.

### 3.8 Premium Acoustic Wooden Slatted Tiles & Panels

15mm thick engineered wooden acoustic wall/ceiling panels (MDF / Green Moisture Proof MDF / Solid Wood base) with natural wood veneer / laminate finish, backed with integrated fire-resistant sound-absorbing fleece. Perforation pattern 8-2, 14-2, or 28-2 delivering NRC 0.70 to 1.00, Euro Class B-s1,d0 / ASTM E84 fire rating. Fixed on GI strut/wooden batten grid with mechanical tongue-and-groove locking.

### 3.9 Writable Lacquered Glass Panelling

6mm thick annealed back-painted writable lacquered glass conforming to EN 16477 (50 micron PU lacquer coating, BS EN 1036 humidity resistant, lead/formaldehyde free, compressive strength 1000 MPa). Mounted on 12mm BWP marine plywood with neutral alkoxy structural silicone (SGG Glassmate Ultrafix) and double-sided foam tape.

### 3.10 Demountable Double Glazed Glass Partitions

100x30mm anodized AL profile framework with concealed sealing (no visible gaskets), acoustic insulation rating up to 45 dB (DIN EN ISO 10140-2 / ASTM E-90). Fitted with 10+12mm clear toughened glass. BS 5234 Part 2 structural stability, BS 6262 glass safety, ISO 14025 EPD certified. Convertible from double to single glaze.

### 3.11 Semi-Automatic Operable Acoustic Partitions

100mm thick top-hung individual operable elements achieving sound insulation of 55 dB. Steel tube internal frame with 16mm MDF facia panels hung in acoustic isolation, infilled with high-density rockwool. Top and bottom operable pressure seals activated automatically by 24V DC motor (800N contact pressure). Telescopic end closure element with 120mm travel.

### 3.12 Restroom HPL Cubicles & Modesty Panels

12mm thick Compact Laminate (IS 2046 / EN 438, Greenguard Gold, Anti-virus ISO 21702, Anti-bacterial JIS Z2801) cubicle system. Height 2000mm, ground clearance 100-150mm. SS-316 spring-loaded hinges with antique

gold covers, zinc die-cast slide bolt with occupancy indicator, AL 6063-T6 U/F channels and top rail in Charcoal Black matte anodized finish.

# SECTION 4: DETAILED SPECIFICATIONS - DOORS, WINDOWS & HARDWARE

## 4.1 Solid Core Laminated Flush Doors

35mm thick BWP solid core blockboard flush door shutter (IS 2202 Part 1 / IS 1659 / IS 848 BWP phenol formaldehyde resin). Stiles and rails of seasoned hardwood, 3mm HDF skin both sides, clad in 1mm American Walnut decorative laminate. Edges lipped with 6mm Steam Beech hardwood. Frame: 150x51mm LVL engineered timber frame with 50x12mm architraves and factory recesses.

## 4.2 Fire Rated Metal Exit Doors (120 Minutes)

120-minute fire-rated insulated single leaf metal fire door tested to BS 476 Part 20 and IS 3809. Frame: 120x70mm pressed steel frame with 10x4mm intumescent fire/smoke seal, intumescent primer coating, and concealed drop seal. Shutter: powder coated sheet metal filled with mineral wool insulation. Fitted with 310x310mm vision panel, 5 ball bearing hinges, fire-rated door closer, and SS panic handle/mortise lock.

## 4.3 Frameless Toughened Glass Doors

12mm thick clear frameless toughened glass door with machine polished edges. Peripheral jamb frame in 1.5mm SS 304 satin finish. Hardware: heavy-duty concealed double-action floor spring, top/bottom patch fittings, top pivot, patch center lock with key cylinder, and 600mm SS 304 back-to-back pull handles.

## 4.4 Door Hardware Specifications

- **Door Closers:** Surface-mounted rack-and-pinion door closers (Dormakaba TS 68 EN 2-4 / TS 70 / Geze / Assa Abloy) tested for 500,000 cycles.
- **Locks & Hinges:** SS 304 grade ball bearing butt hinges (102x76x3mm, 4-5 per shutter), heavy-duty mortise sash lock case, brass Euro profile pin cylinder with master key system, SS 304 return-to-door lever handle set, lever-action concealed flush bolts, and SS 304 floor-mounted dome door stops.

# SECTION 5: DETAILED SPECIFICATIONS - FALSE CEILINGS & ACOUSTIC CEILINGS

## 5.1 Plain Gypsum Board False Ceiling & Coves

12.5mm plain/moisture-resistant gypsum board (IS 2095 Part 1) fixed on Gypsteel GI framework. Perimeter channels (20x27x30x0.55mm), intermediate channels (15x45x15x0.9mm @ 1200mm c/c), ceiling angles (25x10x0.55mm) suspended from soffit via GI cleats and dash fasteners @ 1200mm c/c. Ceiling section (80mm wedge, 0.5mm thick) @ 450mm c/c. Drywall screws 3.5x25mm @ 230mm c/c. Jointed seamless with 3 coats of jointing compound and fiber tape. Light coves with 300-600mm horizontal span and 150mm vertical fascia drop.

## 5.2 Torsion Spring Perforated Metal Ceiling

600x1200x0.9mm AL alloy 3105 panels, perforated 2.5mm dia @ 5.5mm c/c (16% open area), downward accessible with 4 torsion springs per panel. Electrostatically polyester powder coated white/wooden finish. Suspended on 24mm deep inverted Tee main runners and cross tees. Non-woven glass tissue backing (NRC 0.70, GreenPro & ISO 9001 certified).

### 5.3 Aluminum U-Baffle Ceiling

100mm deep x 50mm wide x 0.6mm thick rollformed AA 3105 corrosion-resistant AL alloy baffles, double baked coil coated. Clipped to black AL carriers (30x47x0.5mm) @ 150mm module. Suspended via threaded GI rods @ 1.2m c/c. GreenPro & Seismic Zone V certified.

### 5.4 Vertical Linear GMS Baffle Ceiling

120(H) x 30(W) x 0.6mm Galvanized Mild Steel (GMS) vertical linear baffles installed @ 130mm c/c spacing. Woodgrain film finish (flame resistant, VOC free). Attached to 30x30x1.2mm C-channel carriers @ 1200mm c/c via M6 threaded rods per DIN EN 13964, TAIM & ISO 9001.

### 5.5 Triangular Hook-On Metal Ceiling

0.7mm GMS custom perforated panels with 20x20x20mm triangular CNC punched pattern @ 34.7mm c/c (NRC 0.5, acoustic tissue backing). Non-metallic RAL powder coat (70-80 microns). System S4/5 hook-on substructure with U1040 angles and U1005 Z-carriers. Non-combustible Euro Class A2-s1,d0 (EN 13501-1, BS 476 Part 6/7, IGBC LEED certified).

### 5.6 Stonewool Acoustic Tile Ceiling

600x600 / 1200x600 x 12mm factory-finished stone wool tiles (weight 1.6-1.9 kg/m2, EN 13964). Sound absorption Class B (alpha_w = 0.80, NRC 0.80), Reaction to Fire A1 (non-combustible), 100% RH humidity resistance. Installed on Silenzo+ exposed T-Grid (24mm or 15mm main/cross tees) with wall angles and hold-down clips.

## SECTION 6: DETAILED SPECIFICATIONS - FLOORING, TILING & ACCESS FLOORING

### 6.1 Italian & Imported Marble Flooring

18mm thick machine-cut, mirror-polished Italian/Imported Marble slabs (Perlato, Rosso Verona, Pietra Grey, Grey Dayna) laid over 20mm 1:4 CM bed with white cement slurry @ 4.4 kg/Sqm. Jointed with matching white cement slurry with pigment. Treated with penetrating transparent stone sealer and polishing coat (Tenax / Roff Stone Guard) for water/oil repellency.

### 6.2 Vitrified Floor & Wall Tiles

1200x2400mm / 600x1200mm / 600x600mm glazed & double charge vitrified tiles conforming to IS 15622 / ISO 13006 (water absorption <0.08%). Fixed on floors/walls using High Polymer Modified Tile Adhesive (IS 15477 Type 2 / Kerakoll / Mapei) in 3-6mm bed using notched trowels, levelling wedges, and 2mm spacers. Joints filled with 3-part epoxy grout.

### 6.3 Laminated Wooden Flooring

Class 32 (AC4) 8mm planks conforming to EN 13329. Core: HDF Swell Stop Plus board (density >=930 kg/m3, EN 622 Type 5). PEFC/FSC/Blue Angel certified. Fixed over 2mm PE foam underlay and 0.2mm vapor barrier. 20-year residential / 5-year commercial guarantee.

### 6.4 Luxury Vinyl Tile (LVT) Flooring

5mm commercial heterogeneous LVT tiles with 0.5mm wear layer, PUR protective coating, PVC and fiberglass layers. Group T wear resistance (EN 660-2), flammability >=0.45 (ASTM E648), slip resistance R8-R9 (DIN 51130), antistatic and castor chair resistant. Subfloor levelled with 2-3mm cementitious self-levelling underlayment (M-30 grade).

### 6.5 Woven Vinyl Tile Flooring

500x500x4.7mm woven vinyl tiles, Class 33 heavy commercial (EN 1307), with integrated 19dB GREENFELT recycled PET acoustic underlay. Reaction to fire Bfl-s1 (EN 13501-1), slip resistance R10, Eurofins Gold IAQ certified, phthalate-free, Floorscore & BREEAM certified, 15-year warranty.

### 6.6 Raised Access False Flooring

FS800H 600x600x32mm medium grade anti-static HPL steel panels filled with lightweight cementitious core. Top plate 0.6mm, bottom pan 0.7mm welded with 64 hemispherical cones. Mounted on GI tubular pedestals (25mm OD, 2mm wall) with 100x100x3mm base plates, thread adjustment +-50mm (300mm FFH), and rectangular GI stringers (570x20x30x0.8mm). Load capacity: UDL >=1250 kg/m2, concentrated load 363 kg.

## SECTION 7: DETAILED SPECIFICATIONS - PAINTS, WALL FINISHES & BLINDS

### 7.1 Wall Preparation, Primer & Putty

Scraping, cleaning, washing wall surfaces. 1 coat low-VOC water-thinnable cement primer (<50 g/L VOC). Full-surface 1mm skim coat of ready-mixed acrylic wall putty (Asian Paints TruCare) progressively sanded with fine emery paper.

### 7.2 Premium Emulsion & Water-Based Lustre Paint

Two or more coats of premium interior acrylic emulsion paint (VOC <50 g/L) or premium interior water-based lustre paint (Asian Paints Royale Lustre / Dulux Velvet Touch Pearl Glo) applied with felt/sponge rollers for uniform sheen without lap marks.

### 7.3 Sunscreen Roller Blinds

Sunscreen fabric (30% polyester / 70% PVC, openness factor 5%, weight 428 g/m2, thickness 0.73mm, NFPA 701, Oeko-Tex 100, 95% UV protection). 38mm OD extruded AL 6063-T6 silver anodized roller tube, clutch mechanism with 2mm braided nylon ball chain, powder-coated flat bottom rail.

### 7.4 Wooden Venetian Blinds

50mm wide x 2.2mm thick real wood / PVC slats. Headrail: U-shaped powder coated steel (52x58x1mm). 1:6 gear ratio tilt control unit with stainless steel springs and 100% braided polyester ladder tape.

## SECTION 8: DETAILED SPECIFICATIONS - MODULAR FURNITURE & ERGONOMIC SEATING

### 8.1 Executive Cabin Tables & Modular Workstations

**Cabin Tables (CMD, Director, ED, CGM, GM):** Worktop 36mm/40mm E1-grade particle board/MDF in melamine/veneer finish with 2mm PVC edge lipping in reverse chamfer profile. Supporting structure: 75x75x2mm powder-coated MS legs. Modesty panel 25mm melamine. Side return combo storage and concealed wire management tray with AL soft-close flipper which may be provided with height adjustable feature as per BOQ.

**Modular Workstations:** Desk-based system with 25mm E1 particle board worktop, 50x25x1.2mm MS MU/Loop legs (70-80 micron epoxy powder coat). Screen: 28mm AL frame screen (fabric pinup/marker board/lacquered glass). Cable raceways at skirting and under-top level with MS power poles. 3-drawer metal mobile pedestals (CRCA 0.7mm, pencil tray, anti-tilt castor, master keyed lock).

### 8.2 Ergonomic Office Seating

Executive High-Back Chairs: 3D headrest, 1:2 synchro knee-tilt mechanism (4/5 position lock, 107 deg recline), Class-4 Samhongsa gas lift (150-250 kg capacity, BIFMA 150,000 cycles tested), polished die-cast AL 5-star base, 60mm twin-wheel nylon castors, top-grain Italian leather / mesh upholstery. BIFMA Gold & SCS Global IAQ certified.

Task & Managerial Chairs: Glass-filled PP frame, 65 kg/m3 PU foam seat, 2D/4D adjustable arms, synchro tilt mechanism, Class-4 gas lift, BIFMA Gold certified.

### 8.3 Powder Coating Specification for Metalwork

7-tank phosphating pretreatment: (1) Hot water rinse, (2) Knock-off degreasing, (3) De-rusting, (4) Cold water rinse, (5) Activation, (6) Phosphating, (7) Passivation. Pure epoxy-polyester powder coated to 50-60 microns DFT. Salt spray test >=1000 hrs (ASTM B117), scratch hardness test >=3 kg load without bare metal (DIN 53153).

## SECTION 9: DETAILED SPECIFICATIONS - PLUMBING, SANITARY & WASHROOM ACCESSORIES

**9.1 Sanitary Fixtures:** Wall-hung vitreous china WC pan (550x375x355mm) with soft-close seat cover for 2L/4L low-water flush. Wall-mounted urinals with concealed infrared sensor (pre/post flush 0.5-1L, AC220V/battery, IGBC certified). Full frame concealed cisterns (6L/3L). Under-counter rectangular wash basins.

**9.2 Automatic Sensor Taps & Soap Dispensers:** Infrared automatic sensor taps (DC6V/AC220V, 1.0-1.5 L/min flow rate, brass chrome/matte black, IGBC certified) and automatic stainless steel soap dispensers (1100 ml).

**9.3 Multi-Function Washroom Panels:** 3-in-1 recessed SS 304 washroom panel (paper towel dispenser + 1350W hand dryer + 21L waste bin) and 4-in-1 sanitary napkin hygiene panel in SS 304 grade.

**9.4 Piping & Drainage:** CPVC water supply pipes (15mm & 25mm OD) concealed/exposed with gunmetal valves. UPVC soil and waste pipes (110mm & 75mm OD) with multi-inlet PVC floor traps and SS gratings.

## SECTION 10: DETAILED SPECIFICATIONS – FIRE FIGHTING WORK

**10.1 Heavy Duty MS Fire Piping & Sprinklers: 'C'** Class heavy MS pipe (IS 3589 / IS 1239, 25mm to 150mm NB, red enamel paint) with threaded/welded joints. 15mm quartzoid bulb sprinklers (68 deg C Pendent, Upright, Side Wall), SS UL-listed flexible sprinkler drops (1200mm & 1500mm, 175 PSI working pressure), PN 1.6 butterfly valves (IS 13095), and pressure switches.

**10.2 Fire Extinguishers & Clean Agent Suppression:** Portable CO2 4.5kg and ABC MAP Powder 6kg fire extinguishers (21A/55B rating, BS EN 3 / IS 15683). 5kg automatic ceiling-mounted direct low-pressure fire suppression units with DuPont FE-36 zero-ODP clean agent and pressure gauge for Server, UPS & Battery Rooms.

## SECTION 11: DETAILED SPECIFICATIONS - SIGNAGE & WAYFINDING

**11.1 Modular Aluminum Architectural Signages:** Cosign MPI Series extruded aluminum signages (Alloy 6060 EN755-2, 15-20 micron anodizing, 10-year warranty, UV printed bilingual media in Hindi & English: Department Name Sign, Room Nameplate, Reception Suspended Sign, Small Suspended Sign, Floor Directory Sign, Washroom Sign, Shaft Sign, Staircase ID Sign, Lift Sign, Lift Fire Sign).

**11.2 Illuminated Emergency Exit Signs:** Surface/ceiling mounted dual-sided illuminated emergency exit signs (ES01 Series, 3W LED, 3.7V 2200mAh Li-ion battery for 3-hr backup, IP20, auto self-test).

**END OF SECTION**

# TECHNICAL SPECIFICATIONS FOR INTERNAL ELECTRICAL WORKS

## *CHAPTER 1 : WIRING*

## 1 GENERAL

Technical Specifications in this section cover the Internal Wiring Installations comprising of :

- Wiring for lights and convenience socket outlets etc. in concealed/surface conduit/raceways.
- Wiring for telephone outlets.
- Wiring for fire detection system
- Sub main wiring.

## 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 up to 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.

| | | |
|---|---|---|
| 660/1100 V grade PVC insulated wires. | IS | 694 : 1990 |
| Rigid steel conduits for electrical wiring. | IS | 9537 : Part I 1980 |
| | IS | 9537 : Part II 1981 |
| Accessories for rigid steel conduits | IS | 3837 : 1990 |
| Flexible steel conduits for electrical wiring | IS | 3480 : 1990 |
| Switch socket outlets | IS | 4615 : 1990 |
| Switches for domestic and similar purposes | IS | 3854 : 1997 |
| Boxes for the enclosure of electrical accessories | IS | 5133 : Parts I &II 1969 |

| | | |
|---|---|---|
| Code of practice for personal hazard fire safety of buildings | IS | 1644: 1998 |
| Code of practice for electrical installation fire safety of buildings | IS | 1646 : 1997 |
| Code of practice for electrical wiring installations | IS | 732 : 1989 |

## 3 CONDUITS/ RACEWAYS

### 3.1 PVC Conduits

PVC conduits shall be high impact, rigid, FRLS PVC, heavy-duty type and shall comply with relevant Indian Standards.

Conduits up to 32mm dia shall be 2mm thick and above that shall be 2.5mm thick.

Plain conduits shall be joined by slip type of couplers with approved sealing cement. All conduit entries to outlet boxes are to be made with adaptors female thread and screwed male bushes. Conduit fittings and accessories such as inspection boxes, draw boxes and junction boxes shall be of heavy duty rigid PVC installed in such a manner that they can remain accessible for existing wires or for the installation of the additional wires. Fan hook box shall be of M.S. Inspection boxes shall be covered with suitable covers.

Conduit runs shall be so arranged that the cables connected to separate main circuits shall be enclosed in separate conduits and that all lead and return wires of each circuit shall be run with the same circuit.

PVC conduits shall be smooth in bore, true in size and all ends where conduits are cut shall be made carefully smooth. Sharp edges shall be trimmed. All joints between lengths of conduits or between conduits and fittings and boxes shall be held firmly together and glued properly. All joints shall be fully water tight. All jointing of PVC conduits shall be by means of adhesive jointing.

### 3.2 PVC Raceways

Wiring for power convenience socket outlets over work tables in laboratories shall be carried out in 100 mm x 50m PVC raceways in surface on wall just above the laboratory table top as directed by Engineer in charge. The raceway shall be fabricated from superior quality engineering plastics and shall be complete with all standard accessories like couplers, end caps, bends, tees and mounting frames suitable for fixing modular wiring accessories. The raceway and accessories shall be as described in the Schedule of Quantities. Wiring up to the raceway shall be brought in MS conduit and approved adapter box to connect the conduit to the raceway shall be provided. Combined 6/16 amp modular switch socket outlets shall be provided on the raceway at modular intervals or as indicated in layout drawings. Each 6/16 amp outlet shall be wired to a separate circuit. Individual

circuits in the raceway shall be bunched separately. Installation of the raceway wiring system shall be carried out as per manufacturers recommendations.

### 3.3 Laying & Fixing of Conduits

Conduits shall be installed so as to avoid steam and hot water pipes. Conduits for LV systems shall be at least 150mm away from the electrical conduits.

Conduits concealed in the ceiling slab shall run parallel to walls and beams and conduit concealed in the walls shall be vertical or horizontal.

The chase in the walls required for the recessed conduit system shall be neatly made and shall be of ample dimensions to permit the conduits to be fixed in the manner desired. Conduits in chase shall be held by steel clamps of approved design. The chase shall be filled up neatly after erection of conduits and brought to the original finish of the wall with cement plaster/cement concrete. The spacing between each clamp shall be 60 cm center to center.

Surface conduits shall be fixed by means of spacer bar saddles at intervals of not more than 500 mm from both sides of fittings/accessories. The saddles shall be of 3mm x 19mm galvanized M.S. flat properly treated, primed and painted securely fixed to support by means of nuts & bolts / raw plugs and brass machine screws.

Where conduits cross expansion joints in the buildings, adequate expansion fittings shall be used to take care of any relative movement.

Separate conduits shall be laid for the following systems:

a) Normal light, Fan and 6 A socket outlets.
b) Power points.
c) TV outlets.
d) PA system.
e) Telephone points
f) Fire alarm system
g) CCTV System
h) Emergency Lighting

Contractor shall submit the conduting layout to PMC / Owners for approval before start of work. While laying conduting, care should be taken that water, mortar and dirt etc. do not enter the conduits and boxes.

Conduting system should be such that it shall facilitate easy drawing of new wires/additional wires at any stage. All junction boxes/pull boxes/ draw boxes shall be completely accessible for inspection, maintenance or for future expansion. While drawing of wires, care shall be taken to avoid damage to the wire insulation.

All joints in the wiring shall be made only at switches, distribution boards, socket outlets, lighting outlets and switch boxes only. No joint shall be made in conduits and junction boxes.

### 3.4 Bends

Large right angle bends (more than 75 mm radius) or non right angle bends in conduit runs shall be made by means of conduits bending machines carefully so as not to cause any crack in the conduit. Small right angle bends in conduits runs can be made by standard conduit accessories (solid/inspection bends/elbows) no run of conduits shall have more than four right angle bends from outlet to outlet. Bends in multi runs of conduits shall be parallel to each other and neat in appearance, maintaining the same distance as between straight runs of conduits.

### 3.5 Conduit Accessories.

#### 3.5.1 Standard accessories

Heavy duty black enamel painted standard conduit fittings and accessories like standard/extra-deep circular boxes, looping in boxes, junction boxes, normal/ inspection bends, solid/inspection elbows, solid/inspection tees, couplers, nipples, saddles, check nuts, earth clips, ball socket joints etc. shall be of superior quality and of approved makes. Heavy duty covers screwed with approved quality screws shall be used. Superior quality screwed PVC bushes shall be used Samples of all conduits fittings and accessories shall be got approved by Owners/Architects before use.

#### 3.5.2 Fabricated accessories

Where ever required, outlet/junction boxes of required sizes shall be fabricated from 1.6 mm thick MS sheets excepting ceiling fan outlet boxes which shall be fabricated from minimum 2 mm thick sheets. The outlet boxes shall be of approved quality, finish and manufacture. Suitable means of fixing connectors etc., if required, shall be provided in the boxes. The boxes shall be protected from rust by zinc phosphate primer process. Boxes shall be finished with minimum 2 coats of enamel paint of approved colour. A screwed brass stud shall be provided in all boxes as earthing terminal.

3.5.2.1 Outlet Boxes For Light Fittings.

These shall be minimum 75mm x 75mm x 50mm deep and provided with required number of threaded collars for conduit entry. For ceiling mounted florescent fittings, the boxes shall be provided 300 mm off centre for a 1200 mm fitting and 150 mm off centre for a 600 mm fitting so

that the wiring is taken directly to the down rod. 3 mm thick Perspex/hylam sheet cover of matching colour shall be provided.

3.5.2.2 Outlet Boxes For Ceiling

Outlet boxes for ceiling fans shall be fabricated from minimum 2 mm thick MS sheet steel. The boxes shall be hexagonal in shape of minimum 100 mm depth and 60 mm sides. Each box shall be provided with a recessed fan hook in the form of one 'U' shaped 15 mm dia rod welded to the box and securely tied to the top reinforcement of the concrete slab for a length of minimum 150 mm on either side. 3 mm thick Perspex/xylem sheet cover of matching colour shall be provided.

### 3.5.3 Boxes For Modular Wiring Accessories

3.5.3.1 Switch Boxes - Modular Type

Switch boxes suitable to house modular type switches of required ratings, and fan regulators as required shall be provided. In case the number of switches in one box is not tallying with that available in standard manufacture, the box accommodating the next higher number of switches shall be provided without any extra cost. In case fan regulator/regulators is /are to be provided at a later dated, suitable provision for accommodating such regulators shall be made in the switch boxes and blank off covers shall be provided without any extra cost.

Switch boxes shall be so designed that accessories are mounted on a grid plate with tapped holes for brass machine screws leaving ample space at the back and on the sides for accommodating conductors, check-nuts and screwed bushes at conduit entries etc... The grid plates and M.S. boxes shall be fitted with a brass earth terminal. Boxes shall be attached to conduits by means of check-nuts on either sides of their walls. Moulded front covers made from high impact resistant, flame retardant and ultra violet stabilized engineering plastics shall be fixed by means of counter sunk chromium plated brass machine screws. No timber shall be used for any supports. Switch boxes shall be located with bottom at 1200 mm above floor level unless otherwise indicated.

3.5.3.2 Modular Type Boxes For Socket/ Telephone/Call Bell Outlets

Outlet boxes shall be suitable for housing modular type switched socket outlets/ telephone outlets/ buzzers and any other outlet as required. These shall be so designed that accessories are mounted on a grid plate with tapped holes for brass machine screws leaving ample space at the back and on the sides for accommodating conductors, check nuts and screwed bushes at conduit entries etc. The grid plates and M.S. boxes shall be fitted with a brass earth terminal. These shall be attached to conduits by means of check nuts on either sides of their walls. Moulded front covers made from high impact resistant, flame retardant and ultra violet stabilized engineering plastics shall be used to mount the outlets and shall be fixed to the outlet M.S. boxes by means of counter sunk chromium plated brass machine screws. No timber supports shall be used. Boxes shall be located at skirting level or bottom at 1200 mm from floor or inside raceways on laboratory work tables., as indicated in drawings and/or as directed.

### 3.6 Cross Section

The conduits shall be of ample sectional area to facilitate simultaneous drawing of wires and permit future provision also. Total cross section of wires measured overall shall not normally be more than half the area of the conduit. Maximum number of PVC insulated 660/1100 Voltage grade copper conductor cable conforming to IS - 694 - 1990 as per table give below.

Maximum no of PVC insulated 660/1100 V grade aluminium/copper
Conductor cable conforming to IS : 694 - 1990

| Normal Cross Sectional area of conductor in sq. mm | 20 mm | | 25 mm | | 32 mm | | 38 mm | | 51 mm | | 64 mm | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S | B | S | B | S | B | S | B | S | B | S | B |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| | | | | | | | | | | | | |
| 1.50 | 5 | 4 | 10 | 8 | 18 | 12 | - | - | - | - | - | - |
| 2.50 | 5 | 3 | 8 | 6 | 12 | 10 | - | - | - | - | - | - |
| 4 | 3 | 2 | 6 | 5 | 10 | 8 | - | - | - | - | - | - |
| 6 | 2 | - | 5 | 3 | 4 | 8 | 7 | - | - | - | - | - |
| 10 | 2 | - | 4 | 3 | 6 | 5 | 8 | 6 | - | - | - | - |
| 16 | - | - | 2 | 2 | 3 | 3 | 6 | 5 | 10 | 7 | 12 | 8 |
| 25 | | | | | 3 | 2 | 5 | 3 | 8 | 6 | 9 | 7 |
| 35 | | | | | | | 3 | 2 | 6 | 5 | 8 | 6 |

Note :

**4.** The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

**5.** The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw boxes and which do not deflect form the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect form the straight by an angle of more than 15 degrees.

**6.** Conduits sizes are the nominal external diameters.

## 4. WIRES

Wiring shall be carried out with PVC insulated 660/1100 volt grade unsheathed single core wires with electrolytic annealed stranded copper (unless otherwise stated) conductors and conforming to IS 694/1990. All wire rolls shall be ISI marked. All wires shall bear manufacturer's label and shall be brought to site in new and original packages. Manufacturer's certificate, certifying that wires brought to site are of their manufacture shall be furnished as required.

## 5 COAXIAL CABLES

The coaxial cables shall be of vide band type with operation up to 300 MHz capability. Aging resistance shall comply with DIM 472.52 part 2 i.e maximum 5% increase in attenuation at 200 MHz measured by artificial aging (14 days at 80o C) cables shall meet all exceed following specifications

| | |
|---|---|
| Center core Dia | 0.8 mm |
| Dielectric Dia | 4.8 mm |
| Dielectric | PE |
| Outer Conductor Dia | 5.4 mm |
| Outer Dia | 7.0 mm |
| Bending radius | more than 30 mm |
| Impedance | 75 ohms |
| D.C Resistance | 50 ohms/KM |
| Screening factor | more than 50 |
| Attenuation | |
| 50 MHz | 6.5 |
| 100 MHz | 9 |
| 200 MHz | 13 |
| 300 MHz | 16 |

## 6 LAYING OF CONDUITS

- Conduits shall be laid either recessed in walls and ceilings or on surface on walls and ceilings or partly recessed and partly on surface, as required.
- Same rate shall apply for recessed and surface conduting in this contract.
- Stranded copper conductor insulated wire of size as per schedule of quantities shall be provided in entire conduting for loop earthing.
- GI wire of suitable size to serve as a fish wire shall be left in all conduit runs to facilitate drawing of wires after completion of conduting.

## 6.1 Recessed Conduting

Conduits recessed in concrete members shall be laid before casting, in the upper portion of slabs or otherwise as may be instructed, so as to embedded the entire run of conduits and ceiling outlet boxes with a cover of minimum 12 mm concrete. Conduits shall be adequately tied to the reinforcement to prevent displacement during casting at intervals of maximum 1 meter. No reinforcement bars shall be cut to fix the conduits. Suitable flexible joints shall be provided at all locations where conduits cross expansion joints in the building.

Conduits recessed in brick work shall be laid in chases to be cut by electrical Contractor in brick work before plastering. The chases shall be cut by a chase cutting electric machine. The chases shall be of sufficient width to accommodate the required number of conduits and of sufficient depth to permit full thickness of plaster over conduits. The conduits shall be secured in the chase by means of heavy duty pressed steel clamps screwed to MS flat strip saddles at intervals of maximum 1 meter. The chases shall then be filled with cement and coarse sand mortar (1:3) and properly cured by watering.

Entire recessed conduit work in concrete members and in brick work shall be carried out in close coordination with progress of civil works. Conduits in concrete members shall be laid before casting and conduits in brick work shall be laid before plastering. Should it become necessary to embed conduits in already cast concrete members, suitable chase shall be cut in concrete for the purpose. For minimizing this cutting, conduits of lesser diameter than 25 mm and outlet boxes of lesser depth than 50 mm could be used by the Contractor for such extensions only after obtaining specific approval from Architects/Owners. For embedding conduits in finished and plastered brick work, the chase would have to be made in the finished brick work. After fixing conduit in chases, chases shall be made good in most workmanlike manner to match with the original finish.

Cutting chases in finished concrete or finished plastered brick work for recessing conduits and outlet boxes etc shall be done by the Contractors without any extra cost.

## 6.2 Surface Conduting

Wherever so desired, conduit shall be laid in surface over finished concrete and/or plastered brickwork. Suitable spacer saddles of approved make and finish shall be fixed to the finished structural surface along the conduit route at intervals not exceeding 600 mm. Holes in concrete or brick work for fixing the saddles shall be made neatly by electric drills using masonry drill bits. Conduits shall be fixed on the saddles by means of good quality heavy duty MS clamps screwed to the saddles by counter sunk screws. Neat appearance and good workmanship of surface conduting work is of particular importance. The entire conduit work shall be in absolute line and plumb.

## 6.3 Fixing of conduit fittings and accessories

For concealed conduting work, the fittings and accessories shall be completely embedded in walls/ceilings leaving top surface flush with finished wall/ceiling surface in a workman like manner.

Loop earthing wire shall be connected to a screwed earth stead inside outlet boxes to make an effective contact with the metal body.

### 6.4 Painting and Colour coding of conduits

Before laying, conduits shall be painted specially at such places where paint has been damaged due to vice or wrench grip or any other reason.

If so specified, surface conduits shall be provided with 20 mm wide and 100 mm long colour coding strips as below

| Use | Code colour |
|---|---|
| Low voltage | Grey |
| Fire alarm | Red |
| Telephone | Black |
| PA system | Brown |
| Earthing system | Green |
| Control system lighting | Purple |

### 6.5 Protection of Conduits

To safeguard against filling up with mortar/plaster etc. all the outlet and switch boxes shall be provided with temporary covers and plugs which shall be replaced by sheet/plate covers as required. All screwed and socketed joints shall be made fully water tight with white lead paste.

### 6.6 Cleaning of Conduit Runs

The entire conduit system including outlets and boxes shall be thoroughly cleaned after completion of erection and before drawing in of cables.

### 6.7 Protection Against Dampness

All outlets in conduit system shall be properly drain and ventilated to minimize chances of condensation/sweating.

### 6.8 Expansion Joints

When crossing through expansion joints in buildings, the conduit sections across the joint shall be through approved quality heavy duty metal flexible conduits of the same size as the rigid conduit.

### 6.9 Loop Earthing

Loop earthing shall be provided by means of insulated stranded copper conductor wires of sizes as per Schedule of Quantity laid along with wiring inside conduits for all wiring outlets and sub-mains. Earthing terminals shall be provided inside all switch boxes, outlet boxes and draw boxes etc.

## 7 LAYING AND DRAWING OF WIRES

### 7.1 Bunching of Wires

Wires carrying current shall be so bunched in conduits that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not be run in the same conduit.

### 7.2 Drawing of Wires

The drawing of wires shall be done with due regard to the following precautions:-

- No wire shall be drawn into any conduit, until all work of any nature, that may cause injury to wire is completed. Burrs in cut conduits shall be smoothen before erection of conduits. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire. Approved type bushes shall be provided at conduit terminations.

- Before the wires are drawn into the conduits, conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction by forcing compressed air through the conduits if necessary..

- While drawing insulated wires into the conduits, care shall be taken to avoid scratches and kinks which cause breakage of conductors.

- There shall be no sharp bends.

- The Contractor shall, after wiring is completed, provide a blank metal/sun mica plate on all switch / outlet / junction boxes for security and to ensure that wires are not stolen till switches / outlets etc.. are fixed at no extra cost the contractor shall be responsible to ensure that wires and loop earthing conductors are not broken and stolen. In the event of the wire been partly / fully stolen , the contractor shall replace the entire wiring along with loop earthing at no extra cost to the Owners. No joint of any nature whatsoever shall be permitted in wiring and loop earthing .

## 7.3 Termination /Jointing of Wires

- Sub-circuit wiring shall be carried out in looping system. Joints shall be made only at distribution board terminals, switches/buzzers and at ceiling roses/connectors/lamp holders terminals for lights/fans/socket outlets. No joints shall be made inside conduits or junction/draw/inspection boxes.

- Switches controlling lights, fans or socket outlets shall be connected in the phase wire of the final sub circuit only. Switches shall never be connected in the neutral wire.

- Wiring conductors shall be continuous from outlet to outlet. Joints where unavoidable, due to any special reason shall be made by approved connectors. Specific prior permission from Architect/Owners in writing shall be obtained before making such joint.

- Insulation shall be shaved off for a length of 15 mm at the end of wire like sharpening of a pencil and it shall not be removed by cutting it square or wringing.

- Strands of wires shall not be cut for connecting terminals. All strands of wires shall be twisted round at the end before connection..

- Conductors having nominal cross sectional area exceeding 4 sq. mm shall always be provided with crimping sockets.

- At all bolted terminals, brass flat washer of large area and approved steel spring washers shall be used.

- Brass nuts and bolts shall be used for all connections.

- The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less.

- Switches controlling lights, fans, socket outlets etc. shall be connected to the phase wire of circuits only.

- Only certified valid license holder wiremen shall be employed to do wiring / jointing work.

## 7.4 Load Balancing

Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

### 7.5 Colour Code of Conductors

Colour code shall be maintained for the entire wiring installation - red, yellow, blue for three phases, black for neutral and green for earth.

## 8. MEASUREMENT AND PAYMENT OF WIRING

Wiring for lights, fans, convenience socket outlets and telephone outlets etc. shall be measured and paid for on POINT BASIS as itemized schedule of quantities and as elaborated as below unless otherwise stated.

### 8.1 Primary and Secondary light point wiring

In respect of group control of lights (more than one light controlled by one switch or MCB), wiring up to the first light in the group shall be measured and paid for as a primary light point. Wiring for other lights looped in one group for switch controlled as also MCB controlled lights shall be measured and paid for as secondary light points. Primary light points for switch controlled lights shall include the cost of control switch whereas primary light points controlled by MCBs shall not include the switch cost. The cost of MCB controlling such lights shall not be included in the primary light point rate since the MCB shall be paid for in the item of DB.

The point wiring basis shall assume average wiring length and average conduting length per point based on parameters stipulated in para 8.2 below. The average wiring length and average conducting length forming the basis of point wiring payment, shall take the electrical layouts of the entire project into consideration. Tenderers are advised to seek clarifications, if they so desire, on this aspect before submitting their tenders. No claim for extra payment on account of electrical layouts in part or whole of the project requiring larger average wiring and conduting length per point, whether specifically shown in tender drawings or not, shall be entertained after the award of contract.

**8.2 Parameters:** Wiring shall be carried out as per following parameters in recessed/ surface conduit system.

- Only looping system of wiring shall be adopted throughout. No joints excepting at wiring terminals shall be permitted.
- All accessories shall be flush type unless otherwise stated.
- For estimation of load, following loads per point shall be assumed.

Light points 100 Watts.

6 amps socket outlet points 100 Watts.

Fan points 60 Watts.

Exhaust fan points 300 Watts or as specified.

16 amp socket outlet points 1000 Watts.

- Lights, fans and 6 amp socket outlets may be wired on a common final such circuit. Such circuit shall not normally have more than a total of ten lights, fans or socket outlets or a load of 800 watts whichever is lesser.
- Power circuits shall normally have maximum one 16 amps socket outlet unless otherwise stated. Separate circuit shall be run for each geyser, kitchen equipment, window air conditioners and similar appliances.
- Wiring rates shall include painting of conduits and other accessories as required.
- Wiring rates shall include cleaning of dust, splashes of colour wash or paint from all fixtures, fans, fittings etc. at the time of taking over of the installation.
- Wiring rates shall include blanking of outlet boxes to prevent damage/pilferage of wires as elaborated in Para 7.2.

## 8.3 Definitions

### 8.3.1 Wiring for Lights

**Primary Light Points :** Wiring for primary light points, as defined in para 8.1 above, shall commence at the Distribution Board terminals and shall terminate at the ceiling rose/connector in ceiling box/lamp holder via the control switch (for switch controlled lights). Rates for primary light point wiring shall be deemed to be inclusive of the cost of entire material and labour require for completion of primary light point thus defined including : .

- Recessed / surface conduting system with all accessories, junction/draw/inspection boxes, bushes, check nuts etc. complete as required,

- Wiring with stranded copper conductor PVC insulated 660/1000 volt grade wires including terminations etc. complete as required.

- Control switch with switch box and cover plate of specified type including fixing screws, earth terminal etc. complete as required. Cost of this switch is applicable only for switch controlled points. This cost shall not be applicable for DB controlled points.

- Loop earthing with insulated copper wires.

**Secondary Light points :**

Secondary light points, as defined in para 8.1 above, shall cover the cost of interconnection wiring between group controlled light fittings and shall be deemed to be inclusive of the cost of entire materials and labour required for completion of the secondary light point thus defined including

- Recessed / surface conduting system with all accessories, junction/draw/inspection boxes, bushes, check nuts etc. complete as required,

- Wiring with stranded copper conductor PVC insulated 660/1000 volt grade wires including terminations etc. complete as required.

- Loop earthing with insulated copper wires.

### 8.3.2 Wiring for Ceiling Fans

Wiring for ceiling fan points shall be same as for primary light points and shall, in addition, include ceiling outlet box with recessed fan hooks and provision in the switch box for mounting the fan regulator.

### 8.3.3 Wiring for Exhaust Fans

Wiring for exhaust fan points shall be same as for primary light points and shall in addition include the cost of providing a 3/5 pin 6 amp socket outlet near the fan and a 6 amp control switch at convenient location near the room entry.

### 8.3.4 Wiring for Call Bell Points

Wiring for call bell points shall be the same as for primary light points and shall in addition include the cost of a call bell/buzzer of approved type and make in the required location and a call bell in lieu of the control switch at a convenient location as required.

### 8.3.5 Wiring for Telephone Outlets

Wiring for telephone outlets points shall include the entire wiring and conduting from the telephone tag block to the telephone outlet including the telephone outlet complete as required and as itemized in the Schedule of Quantities

### 8.3.6 Wiring for Convenience Socket Outlets

3/5 pin 6 amps and 3/6 pin 16 amps single phase switched convenience socket outlets shall be provided in the building as indicated in the layout drawings. In addition, combined 3 pin 6 / 16

amps socket outlets at modular intervals in special PVC raceway over the work tables in laboratories shall be provided. Wherever required, 20/32/50 amps single phase and 32/50 amps 3 phase outlets shall also be provided.

**Wiring for 3/5 pin 6 amps convenience socket outlets**

Point wiring for 3/5 pin 6 amps socket outlets (in locations other than over the laboratory work tables) on point wiring basis shall be the same as primary light point defined in para 8.3.1 and shall in addition include 3/5 pin 6 amp socket outlet with 6 amp control switch in MS box with cover. Including loop earthing of the third pin complete as required as itemized in scheduled of quantities.

**Wiring for 3/6 pin 16 amps convenience socket outlets**

Point wiring for 3/6 pin 16 amps socket outlets (in locations other than over the laboratory work tables) on point wiring basis shall be the same as primary light point defined in para 8.3.1 and shall in addition include 3/6 pin 16 amp socket outlet with 16 amp control switch in MS box with cover. Including loop earthing of the third pin complete as required as itemized in scheduled of quantities.

**Wiring for combined 3 pin 6/16 amps socket outlets in laboratories**

Wiring for 3 pin 6/16 amp combined socket outlets in existing PVC raceways (provided over laboratory work tables) on point wiring basis shall include the cost of wiring from DB terminals to the outlets along with loop earrthing of the earth pin and the switched combination 6/16 amp outlet with 16 amp control switch housed in the existing raceway, as indicated in layout drawings and as itemized in schedule of quantities. PVC raceway/conduit required for this wiring shall be paid extra as itemized in the schedule of quantities.

**Wiring for special socket outlets**

In addition to the above, special convenience outlets of 20/32/50 amps single phase and 32/50 amps three phase, required in few locations as indicated in the layout drawings, shall be paid for on linear basis as itemized in schedule of quantities. Outlets only shall be paid separately in numbers as per actuals. Wiring along with loop earthing shall be paid separately on running meter basis and conduting /PVC raceway shall be paid separately on running meter basis.

## 9. ROUTINE AND COMPLETION TESTS

### 9.1 Installation Completion Tests

At the completion of the work, the entire installation shall be subject to the following tests:

1. Wiring continuity test
2. Insulation resistance test

3. Earth continuity test
4. 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.

### 9.2 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 energized.

### 9.3 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 meg.ohms divided by the number of points provided on the circuit the whole installation shall not have an insulation resistance lower than one meg.ohms.

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 meg.ohms or when PVC insulated cables are used for wiring 12.5 meg.ohms 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 Meg.ohms is acceptable.

### 9.4 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 along with 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.

### 9.5 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 as well as the local authorities.

### 9.6 Earth Resistivity Test

Earth resistivity test shall be carried out in accordance with IS Code of Practice for earthing IS 3043.

### 9.7 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.

### 9.8 Tests And Test Reports

The Contractor shall furnish test reports and preliminary drawings for the equipment to the Architect/owners 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.

# CHAPTER 2: 415 VOLTS MV SWITCHBOARDS

## 1.0 GENERAL

This section covers specification of Switchboards

## 2.0 STANDARDS AND CODES

The Standards and Codes applicable to the works are listed in Annexure I of the tender document and may be referred to.

## 3.0 SWITCHGEAR

### 3.1 LT Air Circuit Breakers

| | | |
|---|---|---|
| 3.1.1 | Type | Air Break |
| 3.1.2 | Operating voltage | 415 volt 3 phase 50 Hz |
| 3.1.3 | Insulation Voltage | 660 volts |
| 3.1.4 | Current rating | As per Schedule of Quantities |
| 3.1.5 | Fault Level withstand Ices | As per Schedule of Quantities |
| 3.1.6 | Ice | 100% Ices |
| 3.1.7 | Icy | 100% Ices |
| 3.1.8 | Isolation function | As per IEC 60947-2 Section 7.12 |
| 3.1.9 | Insulation | Cass II insulation between the front panel and internal power circuits |
| 3.1.10 | Cubicle mounting | Draw out unless otherwise stated. |
| 3.1.11 | Operating mechanism | Trip free such that the circuit breaker is at all times free to open immediately the trip coil is energized<br><br>Independent Manual spring closing (IMS) or motor wound spring closing mechanism (MWS) as per Schedule of Quantities |
| 3.1.12 | No of Poles | 3 or 4 as required |

| | | |
|---|---|---|
| 3.1.13 | All current carrying parts | Silver plated |
| 3.1.14 | Arcing contacts | Shall be provided to protect the main contacts and shall be separate from the main contacts and easily replaceable. |
| 3.1.15 | Arc chutes | Shall be provided for each pole, and shall be suitable for being lifted out for the inspection of the main and the arcing contacts. |
| 3.1.16 | Isolating Contacts | Self aligning cluster type |
| 3.1.17 | Safety Shutters | Earthed metal or insulated automatically operated shutters to screen live cluster contacts when the Breaker is withdrawn from the cubicle |
| 3.1.18 | Auxiliary Contacts | Self aligning sliding auxiliary contacts.<br>Free / minimum 6 NO/NC auxiliary contacts rated at 16 amps 415 volts 50 Hz<br>These shall be approachable from the front for connecting all external wiring<br>They shall close before the main contacts when the Circuit Breaker is plugged in and vice versa when the Circuit Breaker is Drawn Out of the cubicle.<br>The fixed portion of the sliding contacts shall have easy access for maintenance purposes. |
| 3.1.19 | Indications and Operations integral with ACB on front | • Mechanical ON/OFF indication<br>• Operating handle<br>• Mechanical trip push button<br>• Mechanical indicator for 'Ready to close' situation for the breaker by checking all interlocking.<br>• Indication of mechanical wear of contacts and hence contact life |
| 3.1.20 | Anti pumping mechanism | Mechanical and electrical devices integral to Breaker |
| 3.1.21 | Circuit Breaker operational positions | Four distinct and separate positions and shall be indicated on the face of the panel.<br>"Service" -- Both main and secondary isolating contacts closed<br>"Test" -- Main isolating contacts open and |

| | | |
|---|---|---|
| | | secondary isolating contacts closed<br>"Isolated" -- Both main and secondary isolating contacts open<br>"Maintenance"-- Circuit Breaker fully outside the panel ready for maintenance |
| 3.1.22 | Accessories | Control wiring and all accessories shunt trip coil, under voltage release etc shall be fit table and accessible from front. |
| 3.1.23 | Circuit Breaker Interlocking | Sequence type strain free interlocks shall be provided to ensure the following:<br>• Breamer cannot be withdrawn from the cubicle when in the "ON" position. Suitable mechanism shall be provided to lock the Breaker in the tripped position before the Breaker is isolated.<br>• Breaker cannot be switched "ON" until it is either in the fully inserted position or, for testing purposes, it is in the fully isolated position.<br>• Circuit Breaker cannot be plugged in unless it is in the OFF position.<br>• A safety latch shall be provided to ensure that the movement of the Breaker is checked when being withdrawn to prevent its accidental fall due its weight.<br>• Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position. |
| 3.1.24 | Protection | Microprocessor based releases EMC (Electro Magnetic Compatible) having built in overload, short circuit & earth fault protection and/or EMI (Electromagnetic indication)/ numeric relays shall be provided for the Circuit Breakers as stipulated in the Schedule of Quantities |
| 3.1.25 | Earthing | The frame of the Circuit Breaker shall be positively earthed when the Circuit Breaker is racked into the cubicle. |
| 3.1.26 | Types of terminals | Flexibility in changing at site to suit the bus bar |

| | | |
|---|---|---|
| | | orientation |
| 3.1.27 | Electrical endurance with maintenance | Breakers up to 4000 amps ……greater than 5000 cycles<br>Breakers 4000 amps and above.... 1500 cycles |
| 3.1.28 | Type test certificates | Submit Certificates from a recognized test house for the Circuit Breakers offered. |

## 3.2 Moulded Case Circuit Breakers (MCCB)

| | | |
|---|---|---|
| 3.2.1 | Type | Air Break |
| 3.2.2 | Operating voltage | 415 volt 3 phase 50 Hz |
| 3.2.3 | Insulation Voltage | 660 volts |
| 3.2.4 | Current rating | As per Schedule of Quantities |
| 3.2.5 | Fault Level withstand Ices | As per Schedule of Quantities |
| 3.2.6 | Ice | 100% Ices |
| 3.2.7 | Icy | 100% Ices |
| 3.2.8 | Isolation function | As per IEC 60947-2 Section 7.12 |
| 3.2.9 | Insulation | class II insulation between the front panel and internal power circuits |
| 3.2.10 | Cubicle mounting | Fixed unless otherwise specified |
| 3.2.11 | Operating mechanism | Trip free<br>Independent Manual spring closing (IMS) or motor wound spring closing mechanism (MWS) as per Schedule of Quantities |
| 3.2.12 | No of Poles | 3 or 4 as required |
| 3.2.13 | All current carrying parts | Silver plated |
| 3.2.14 | Arcing contacts | Shall be provided to protect the main contacts and shall be separate from the main contacts and easily replaceable. |
| 3.2.15 | Arc chutes | Shall be provided for each pole, and shall be suitable for being lifted out for the inspection of the main and the arcing contacts. |

| | | |
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| 3.2.16 | Common Operating handle | Required for Three phase MCCBs for simultaneous operation and tripping of all the three phases. |
| 3.2.17 | Indications and Operations integral with ACB on front | • mechanical ON/OFF/ Tripped indication<br>• Operating handle<br>• mechanical trip push button |
| 3.2.18 | Accessories | Following accessories shall be provided as required<br>• Under voltage trip<br>• Shunt trip<br>• Alarm switch<br>• Auxiliary switch |
| 3.2.19 | Circuit Breaker Interlocking | Interlocks shall be provided to ensure the following:<br>• Handle interlock to prevent unnecessary manipulations of the breaker.<br>• Door interlock to prevent door being opened when the breaker is in ON position<br>• Deinterlocking device to open the door even if the breaker is in ON position.<br>• Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position. |
| 3.2.20 | Protection | Microprocessor based releases and/or thermal magnetic releases shall be provided for the Circuit Breakers as stipulated in the Schedule of Quantities |
| 3.2.21 | Electrical endurance | Upton 250 amps……. minimum 10,000 operations<br>For 400 amps & above…….minimum 4,000 operations |
| 3.2.22 | Type test certificates | Submit Certificates from a recognized test house for the Circuit Breakers offered. |

## 4.0 SWITCHBOARDS

| | | |
|---|---|---|
| 4.1 | Supply System | Three phase 4 wire, 415 volt, 50 Hz, Indian TN-S system |
| 4.2 | Short circuit level withstand | As per Schedule of Quantities |
| 4.3 | Ingress protection | IP 42 unless otherwise stated<br>Metal based neoprene gaskets between all adjacent units and beneath all doors and covers shall be provided to render the joints dust and vermin proof |
| 4.4 | Pressure relief devices | Shall be provided to minimize danger to operator during internal fault conditions. |
| 4.5 | **Panel Compartmentation** | |
| 4.5.1 | Compartment | Tier 3A as per IEC 6043 (Part-I) unless otherwise stated in Schedule of Quantities |
| 4.5.2 | Circuit Breaker Metering | Separate segregated compartment shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, bus bars and connections. |
| 4.5.3 | Control wiring compartment | A horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between vertical sections. |
| 4.6 | **Panel Configuration** | |
| 4.6.1 | Panel configuration | MCCB's arranged……. multi-tier formation<br>Air Circuit Breakers……. Single or Double tier formation |
| 4.6.2 | Spare Space provision | **The Switchboards shall have a provision of 25% spare space to accommodate possible future additional switch gear.** |
| 4.6.3 | Extensible | **Shall be extensible on both sides** |
| 4.7 | **Panel Construction** | |
| 4.7.1 | Panel construction | • Metal clad totally enclosed,<br>• Dead front<br>• floor mounted<br>• free standing type<br>• modular extensible design<br>• suitable for indoor mounting. |
| 4.7.2 | Switchboard | Fabrication with.... CRCA Sheet Steel |

| | | |
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| | cubicles, doors and covers | Cubicles……. thickness not less than 2.0 mm<br>……..……..folded and braced<br>……to ensure rigid support for all components.<br>Doors/ covers….. thickness not less than 1.6 mm.<br>Joints ……seam welded<br>Welding slag ……ground off<br>Welding pits ……..wiped smooth with plumber metal. |
| 4.7.3 | Switchboard frames | Fabrication with ….electro galvanized MS sheets<br>'U' Channel switchboard frames……. **2.5 mm** thick<br>All joints…….. neatly formed and<br>…….....finished flush with adjacent surfaces<br>No joints shall be located in corners.<br>Bare edges shall be lipped.<br>Structural members and bracings where ever required shall be welded or bolted to the frame. The frame shall be of modular design and extensible. |
| 4.7.4 | Cable compartment | Rear Access switchboards……all cabling from rear<br>Front access switchboards……Separate vertical cable Accessible from front only<br>Adequate space shall be provided for ease of installation and maintenance with safety for working without coming into contact with any live parts.<br>The cable chambers shall be complete with<br>• Adequate support for cables.<br>• tinned brass cable sockets,<br>• tinned brass compression glands,<br>• 3 mm thick gland plates,<br>• supporting clamps and brackets etc<br>for termination of 1100 volt grade aluminium conductor XLPE/ PVC/ PVCA cables. |
| 4.7.5 | Door handles | Good quality door handles fitted with toggles to operate rods to latch with suitable slots in both top and bottom of switchboards shall be provided. Latching |

| | | |
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| | | rods and associated brackets shall be cadmium plated. |
| 4.7.6 | Operating handles | All operating device shall be located in front of switchgear only. |
| 4.7.7 | Fixing Screws | Fixing screws shall enter holes tapped into an adequate thickness of metal or provided with hank nuts. Self threading screws shall not be used in switchboards. |
| 4.7.8 | Dimensional Limitations | • Base channel 75 mm x 5 mm thick shall be provided at the bottohm.<br>• Minimum 200 mm blank space between the floor of switchboard and bottom most unit shall be provided.<br>• Overall height shall be limited to 2300 mm unless otherwise stipulated.<br>• Height of the operating handle, push buttons etc shall be restricted between 300 mm and 1700 mm from finished floor level. |
| 4.8 | **Switchboard Bus Bars, Interconnections etc rating** | |
| 4.8.1 | Rating of Bus Bars, interconnections and to feeders | These shall be designed as per requirements in Schedule of Quantities to<br>• Carry full load current for phase and neutral bus bars<br>• withstand the stresses of fault level<br>• for aluminium shall have a minimum cross section of 1 amp per sq.mm.<br>• Copper 0.6 amps per sq mm |
| 4.9 | **Switchboard Bus Bars** | |
| 4.9.1 | Bus Bar material | High conductivity, high strength aluminium alloy, complying with requirements of grade E 91E of IS 5082 – 1981<br>Alternatively<br>Electrical grade 99.99% pure copper<br>As per Schedule of Quantities |
| 4.9.2 | Bus Bar Insulation | Heat shrunk PVC sleeking of 1.1 kV grade and bus bar joints provided with clip-on shrouds. |
| 4.9.3 | Bus Bar supports | Non-breakable, non-hygroscopic epoxy resin or glass |

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| | | fiber reinforced polymer insulated supports able to withstand operating temperature of 110$^{O}$ C at regular intervals, to withstand the forces arising from a fault level as stipulated in schedule of quantities. | |
| 4.9.4 | Colour Coding | All bus bars shall be colour coded. | |
| 4.9.5 | Auxiliary Bus | Electrolytic copper Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These shall be insulated, adequately supported and sized to suit specific requirement. | |
| 4.10 | **Switchboard Interconnections** | | |
| 4.10.1 | Interconnection material | Unit ratings up to 100 amps, | FRLS PVC insulated copper conductor wires with crimped terminations. |
| | | Rating of 100 amps and above | Solid copper/ aluminium connections PVC sleeved |
| 4.10.2 | Interconnection jointing | All connections, tapings etc<br>• Shall be made to ensure minimum contact resistance.<br>• shall be firmly bolted and clamped with even tension.<br>Before assembly<br>• joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints.<br>All screws, bolts, washers shall be cadmium plated.<br>Approved spring washers shall be used with cadmium plated high tensile steel bolts with BSF threads. | |
| 4.10.2 | Instrument and control wiring | All wiring for relays and meters shall be with ZHFR PVC insulated copper conductor wires. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 2.5 sq. mm. | |
| 4.11 | **Earthing** | Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors | |

| | | |
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| | | / frames shall be connected to earth through adequately sized flexible braids. |
| 4.12 | **Ventilation Fans** | Panel mounting type ventilation fans shall be provided in each panel with switchgear rated for 2500 amp and above. The fan shall be interlocked with switchgear operation. |
| 4.13 | Space Heaters | Anti- condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 230 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by $5^{O}$ C operation interlocked with switchgear. |
| 4.14 | **Sheet Steel Treatment And Painting** | Sheet steel used in the fabrication of switchboards shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognized phosphating process after which a coat of primer paint comp actively with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 50 micron thickness, of sheet approved by Engineer-in-Charge shall then be provided. |
| 4.15 | Labels | Suitable engraved white on black metal identification labels shall be provided for each switchgear cubicle in front and back identifying the circuit, switchgear type, rating and duty. |
| 4.16 | Testing at manufacturers works | • All wiring checks and connections<br>• Relay adjustment<br>• Interlock function check<br>• Continuity checks of wiring, fuses<br>• Insulation test<br>• Trip test<br>• Hight voltage test |
| 4.17 | Testing and commissioning | • Assembly of various sections of panels<br>• Grounding the units<br>• Connecting up bus bars and jointing insulated<br>• Insulation test with 500 volts megger. The insulation resistance not more than 100 mega ohms |

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| 4.18 | Local Authority Requirements | All requirements by the local Authority including those listed below shall be complied with<br>• Provisoon for Gas nozzles within each cubicle<br>• Danger Notice Plate<br>• Rubber floor mat of 6 m thickness and 1 m width provided for the full length of the switchboard.<br>• A dry chemical type fire extinguisher of required capacity with approved label |

# CHAPTER 3: EARTHING

## 1.0 GENERAL

This section covers specifications for earthing systems comprising of earth electrodes, earth leads and loop earthing conductors.

## 2.0 STANDARDS

The Standards and Codes applicable to the works are listed in Annexure I of the tender document and may be referred to.

## 3.0 EARTHING NETWORK

| | | |
|---|---|---|
| **3.1** | **EARTH NETWORK PARAMETERS** | |
| **3.1.1** | General Guidelines | All the non-current carrying metal parts of electrical installations including metal conduits, turnings, cable armour, switchboards, DB's, light fittings and all other non current carrying parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. |
| **3.1.2** | Earthing Material | The earthing system shall be constructed from bare or insulated GI, Aluminium or Copper as specified in the Schedule of Quantities. |
| **3.1.3** | Ecarts vis-à-vis phases | All three phase equipment shall have two separate and independent distinct body earths and single phase equipment shall have a single body earth. |
| **3.2** | **EARTH ELECTRODES** | |
| **3.2.1** | Guidelines for earth electrodes location | Minimum distances<br>• Any electrode and building structure shall be 1.5 m.<br>• Two adjacent electrodes shall be 2 m.<br>• As far as possible earth connections shall be visible for inspections<br>• Drawing showing the main earth connection and earth electrodes be prepared for each installation. |

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| | | Electrodes shall be located in accessible locations and not under entrances, pavements and roads. |
| **3.2.2** | **Plate Earth Electrodes** | |
| **3.2.2.1** | Material | Copper or GI as per Schedule of Quantities |
| **3.2.2.2** | Plate size | Plate size shall be based on fault level as per IS 3043 but shall be minimum<br>Copper……Minimum 600 mm x 600 mm x 3 mm thick<br>GI……Minimum 600 mm x 600 mm x 6 mm thick |
| **3.2.2.3** | Earth Pit | • Plate electrode shall be buried in ground with its face vertical depth from GL to top plate 3 m<br>• The depth shall be increased if required so that permanently moist soil level is reached.<br>• The electrode shall be surrounded by 15 cams thick of alternate layers of charcoal and salt.<br>• The 20 mm class B of GI watering pipe shall have a watering funnel attachment with a wire mesh which shall be housed in the masonry inspection chamber.<br>• Main earth lead shall be securely terminated at the electrode by means of 2 bolts, nuts, check nuts and spring washers to be of GI for GI plate and tinned bras for copper plate<br>• The earth lead from the electrode up to the test link in masonry chamber shall be drawn in a suitable diameter class B GI pipe for mechanical protection as per BOQ<br>• The lead shall terminate in a test link provided in the inspection chamber to enable the earth electrode to be isolated for measuring earth resistance. |
| **3.2.3** | **Pipe Earth Electrodes** | |
| **3.2.3.1** | Material | Class B (medium) GI pipe |
| **3.2.3.** | Pipe Size | 40 mm dia 4500 mm long |

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| **2** | | Pipe shall be tapered at the bottom and shall be provided with 12 mm dia holes drilled at every 75 mm. |
| **3.2.3.3** | Earth pit | • Pipe electrode shall be installed with its top not less than 200 mm below ground level.<br>• The top shall be provided with a 40 mm x 20 mm reducer to fix watering funnel with mesh on top.<br>• The 2 mtrs length of pipe below the inspection chamber shall be surrounded by 15 cams alternate layers of charcoal and salt<br>• Earth lead shall be provided for pipe electrode and shall be terminated using a through GI bolt, nuts, check nuts, spring washers etc. at the top of pipe electrode |
| **3.2.4** | **Masonry Chamber for pipe and earth electrode** | • Shall have earth test link and watering funnel<br>• 400 mm x 400 mm x 400 mm deep masonry inspection chamber<br>• Lockable 10 mm thick cast iron hinged cover plate with frame<br>• The hinged cover marked on top with identifier. |
| **3.3** | **EARTH MATS** | |
| **3.3.1** | **Separate Earth Conductors** | Separate earth conductors of appropriate size shall be provided for.<br>• Electrical Network<br>• UPS system earth bus<br>• Computer system earth bus<br>• Telephone system earth bus |
| **3.3.2** | **Earth Mats** | • Shall be constructed as per IEEE 80-2000, IS 3043:1987 and NBC with Copper /Aluminium /GI for horizontal and vertical conductors as per BOQ and drawing<br>• Brazed / welded joints shall be coated with bituminous compound<br>• Shall be constructed to achieve maximum resistance to earth as per par 3.8 |
| **3.3.3** | **Masonry chamber** | • 450 mm x 450 mm x 450 mm deep<br>• Shall have joint plate of earth mat riser as per drawing |

| | | |
|---|---|---|
| **3.4** | **CHEMICAL EARTHING** | |
| | | • Suitable for any type of soil conditions<br>• Shall be constructed with "Chemical component" and copper /SS/GI electrodes to achieve maximum resistance as per Para 3.8<br>• Shall not require any maintenance after commissioning and shall have a minimum life of 50 years |
| **3.5** | **EARTHING CONDUCTOR** | |
| **3.5.1** | **Main Earth Lead**<br>From earth electrode inspection chamber to main switchboard | Minimum depth …300 mm below ground<br>Minimum depth….600 mm below road crossings/ pavements<br>Earth lead……..routed through GI pipe of adequate size.<br>GI / copper wire…15 mm dia class B GI pipe.<br>GI pipe…….. Provided with a coat of bituminous paint on the outside for minimizing corrosion or wrapped with bituminous jute wrapping. |
| **3.5.2** | **Secondary conductors** | Secondary conductors shall be interconnected to form the earthing network throughout the installation and shall cover<br>• Main earthing conductors from the main switchboards to all other switchboards<br>• Sub-mains earthing conductors from switchboard to the sub distribution boards and to final distribution boards.<br>• Loop earthing conductors from the sub/final distribution boards to any point on the internal wiring system.<br>• Final point earthing within internal wiring to all light fixtures, fans, convenience outlets etc.<br>• Cable armouring shall be earthed at the ends adjacent to switchboards which they connect<br>• Use a permanent fittings (like a screwed down plastic label at copper label at the connection point that is clearly marked with the words "EARTHING LEAD – DO NOT |

| | | |
|---|---|---|
| | | DISCONNECT" |
| **3.5.3** | **Equipotential grid** | All earth electrodes shall be interconnected with GI strip enclosed in GI pipe laid directly in the ground to ensure Equipotential within the entire earthing network. |
| **3.5.4** | **Galvanizing** | Galvanizing of Earth Electrodes and Earthing Conductors shall conform to class – IV of IS 4736 : 1986. |
| **3.6** | **INSTALLATION AND JOINTING OF EARTHING CONDUCTORS** | |
| **3.6.1** | **General specifications** | • Earthing conductor routings shall minimize jointing of the conductors in between terminations.<br>• All exposed joints shall be provided with 2 coats of anti corrosive paint.<br>• If the connection is on a painted surface, the paint shall be thoroughly removed and the metal exposed for making effective electrical contact. |
| **3.6.2** | **Copper conductors** | • Strip conductors shall be secured to building walls etc. with appropriate size of saddles<br>➢ Spacing not exceeding 900 mm.<br>➢ Saddle shall be gun metal for copper<br>• Jointing of strips<br>Copper…. butt welding /brazing<br>or the mating surfaces shall be tinned, riveted and soldered.<br>• Jointing of wires by means of lugs of appropriate size connected by bolts, nuts, check nuts and washers. For<br>Copper wires …Lugs and bolts shall be of brass |
| | **GI Conductors** | • GI Strip conductors shall be secured to building walls etc. with appropriate size of saddles<br>➢ Spacing not exceeding 900 mm.<br>➢ Saddle shall be made from GI |

| | | |
|---|---|---|
| | | • Jointing of GI strips with<br>GI bolts, nuts, check nuts<br>and spring washers of appropriate size.<br>• Jointing of wires by means of lugs of appropriate size connected by bolts, nuts, check nuts and washers. For<br>GI wires……..Lugs and bolts shall be of brass / COPPER |
| **3.7** | **Prohibited Connections** | Sprinkler pipes, or pipes conveying gas, water, or inflammable liquid shall not be used as a means of earthing an installation or even as a link in an earthing system. |
| **3.8** | **Resistance to Earth** | Holmic resistances as measured by an approved earth testing apparatus shall be as follows<br>• Earth electrode maximum holmic resistance 1 ohms<br>• Earth electrode in rocky soil holmic resistance max 3 ohms.<br>• Electrical resistance between earth connection at the main switchboard and any other point on the completed installation shall not exceed 1 ohm. |
| **3.9** | **Site Testing** | |
| **3.9.1** | **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.<br>The electrical resistance of the same along with 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.** |
| **3.9.2** | **Earth Resistivity Test** | Earth resistivity test shall be carried out in accordance with IS Code of Practice for earthing IS 3043. |

## CHAPTER 4: MCB DISTRIBUTION BOARDS (SUB DISTRIBUTION BOARDS)

## IV. MCB DISTRIBUTION BOARDS (SUB DISTRIBUTION BOARDS)

### 1. DESCRIPTION OF WORK

This section covers specification of Distribution Boards (DBs) suitable for operation on 415 V 3 Phase 4 wire 50 Hz supply feeding final lighting and power sub circuits.

### 2. APPLICABLE CODES, STANDARDS AND APPLICABLE PUBLICATIONS

Updated and current 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, Indian Electricity Rules 1956, National Building Code 1997, National Electric Code 1985, Code of Practice for Fire Safety of Building (general): General Principal and Fire Grading – IS 1641 - 1988 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

| | |
|---|---|
| Miniature Air Circuit Breakers for AC circuits | IS 8828 : 1996 and IEC 947 |
| Residual current operated Circuit Breakers | IS 12640 : 1988 |
| Low voltage switchgear and controlgear Part II | IS 13947 : 1993 |
| 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. Submittals

#### 3.1 Drawings and Data

a) The following minimum information shall be furnished with the Shop Drawings :-

(a) Overall dimensions showing front view, plan, elevation and cross section.

(b) Complete bill of material module wise.

(c). Complete one line diagram.

### 3.2 INSTRUCTION MANUALS

Contractor shall furnish 6 copies of instruction manual which shall contain detailed instruction for installation, testing, commissioning, operation and maintenance requirements.

## 4. SPECIFICATION

### 4.1 General

a) Distribution Boards shall be suitable for operation on 3 phase/single phase 415/230 Volts, 50 Hz neutral grounded at Transformer.

a) The Distribution Boards shall comply with the relevant Indian Standards and Indian Electricity Rules and Regulations.

### 4.2 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 Ics. The MCB's shall have inverse time delayed thermal overload and instantaneous magnetic short circuit protection. The MCB time current characteristic shall coordinate with PVC cable characteristic. Watt loss per pole of MCB shall confirm to value specified in IS 8828 – 1996. Type test certificates from independent authorities shall be submitted with the tender.

### 4.3 RESIDUAL CURRENT CIRCUIT BREAKERS (RCCB)

RCCBs shall comply to IS 12640 – 1988 and shall be of the current operated type. The RCCB shall be designed to trip within 20 mili sec at a current sensitivity of 100 mA. The RCCB shall be of 2 pole construction for single phase and 4 pole construction for 3 phase. All RCCB shall be complete with test buttons. RCCB shall have a minimum life expectancy of 20,000 operations.

### 4.4 DISTRIBUTION BOARDS

- DBs shall be wall mounting, recessed/surfaced type, totally enclosed, dust and vermin proof and shall comprise of miniature circuit breakers, earth leakage circuit breakers, busbars, neutral link etc as required, of ratings detailed in the schedule of quantities.

- DBs shall be double door type access to the wiring shall not be possible with opening of the outer hinged cover. A cover shall be provided inside the DB to protect all live parts. Only the operating handle/knobs shall project outside the cover plate. The door shall be earthed with insulated copper braded flexible wires.

- Components forming a part of the DBs shall comply to the relevant Standards and Codes of the Bureau of Indian Standards.

- DBs shall be fabricated from minimum 18 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 54/55 degree of protection unless otherwise stated.

- 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. The minimum spacing between phases shall be 25 mm and between phase and earth 19 mm

- Separate neutral link for each phase shall be provided.

- All the internal connections shall be with either solid copper PVC insulated or copper conductor FRLS 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 Project Manager.

- A sample of the completed board is to be got approved by the Project Manager before commencement of supply and erection.

- Before commissioning, the distribution boards shall be megger tested for insulation and earth continuity.

The following colour coding shall be used for identification of the busbars and wiring as per IS 5578:1984.

Red phase - Red

Yellow phase - Yellow

Blue phase - Blue

Neutral – Black

Earthing - Green

Control wiring - Grey

The incoming and outgoing terminals shall be suitable for the termination of cables as required.

All terminals, bus bars shall be insulated and shrouded to avoid accidental contact.

All metal parts shall be adequately earthed. An earth bus of tinned copper shall be provided of adequate section and length to accommodate all circuits

## 4.5 SHEET STEEL TREATMENT AND PAINTING

- Sheet steel used in the fabrication of DBs shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process after which a coat of primer paint compactively with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 50 micron thickness, of sheet approved by Project Manager shall then be provided.

- 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.

## 4.6 NAME PLATES AND LABELS

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

## 5. TYPE TEST

Type test certificates as per IS 8623 shall be submitted.

## V. METER BOARD

### 1. description of work

This section covers the detailed requirements for design, testing at works, supply of Meter Board suitable for 415 Volts, 3 phase, 50 HZ 4 wire system, in line with schematic diagram, schedule of quantities and as specified.

### 2. CODES AND STANDARDS AND APPLICABLE PUBLICATION

IS : 13947 (Part – I) : Degree of protection for enclosures for LV siwtchgear.

IS : 1248 : Ammeter & Voltmeter (Part – III)

IS : 13947 (Part – II) :

IS : 8623 : Factory assembled switchboard

IS : 3072 (Part – I) :

IS : 2705 (Part – I to IV) :

IS : 375, 5578 & 11353 :

IS : 13947/IEC-947 : MCCB

IS : 13947-2/IEC-157-I : ACB

IS : 8828/IEC-898 : MCB

IS : 2707 : Current Transformers.

IS : 2147 : Degree of Protection

## 3. SUBMITTALS

### i) Drawing Data

a) General arrangement Drawing.
b) Single Line Diagram.
c) Bill of Materials indicating quantity, rating & make of all components, along with typical catalogues.

### ii) Tests & Test Reports

a) Typical type test certificates shall be submitted.

b) Routine test certificates of routine test carried out on the panels shall be submitted.

## 4. SPECIFICATIONS

### i) GENERAL

The panel shall be indoor type having incoming and outgoing feeders as specified in the schedule of quantity. The design shall be cubicle type as specified. The degree of enclosure protection shall be IP 42 as per IS : 2147. The boards shall be of single front construction suitable for top cable/conduit entry.

### ii) VERTICAL SEGREGATION

The panel shall be divided into distinct vertical section of :-

a) Completely enclosed busbar compartment running horizontally.

b) Individual feeder modules in multi-tier fixed execution arrangement.

c) Enclosed vertical busbars serving all the modules.

d) Vertical cable alley covering entire height.

### iii) GENERAL CONSTRUCTION

The panel shall be totally enclosed and extensible type. It shall be dust and vermin proof and shall be suitable for the ambient conditions as specified. The design shall include all provisions for safety of the operating and maintenance personnel. The switch board shall be naturally convection cooled. Cubicle type switch board shall be fabricated out of CRCA sheet steel 2.0 mm thick. Wherever necessary, such sheet steel member shall be stiffened by angle iron frame work. General construction shall employ the principle of compartmentalization and segregation for each circuit. As the panel shall be placed against the wall with no rear access, cable alley will have to be in the front. Overall height of the board shall not exceed 2.0 meters. Operating levers, handle etc. of highest unit shall not be at a height more than 1.7 m, and that of the lowest unit at a height not less than 300 mm above finished floor level. Multi-tier mounting of feeders is permissible. The general arrangement for multi-tier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look. The general arrangement shall be got approved before fabrication. Cable entries for various feeders shall be from the front through cable alleys located in between two circuit sections. All cable entries shall be through gland plates. There shall be a separate gland plate for each cable entry so that there will not be any dislocation of already wired circuit when new feeders are added. Cable entry plates shall therefore be sectionalised. The construction shall include necessary cable supports for clamping in the cable alley for rear cable chamber. Partitions and compartments will be plated and solidly connected to eliminate vibration problems and ensure grounding integrity. Enclosure shall be such that special tool is required to open it. Doors shall be grounded to frame for grounding integrity. Sufficient clearance shall be provided at the bottom for cooling airflow.

### iv) INDICATOR LAMPS

Indication lamps shall be provided as per the schedule of quantities. Necessary filter G/Y/R/A shall be provided depending upon the function. All lamps shall be protected by proper HRC fuses/MCB, and shall be LED type.

### v) CONTROL WIRING

Control wiring for indication etc. shall be with stranded copper conductor PVC insulated cable conforming to IS : 1554 Part I. Wiring shall be suitably protected within the switchboard. Runs of wires shall be neatly bunched and suitably supported and clamped. Where wires are drawn through steel conduits, the works shall conform to IS 732. Identification ferrules shall be used at both ends of the wires. All control wiring meant for external connection are to be bought out on terminal boards. Size of wires used for control circuits and current Transformer circuits shall be 2.5 Sq.mm. Brass thimbles, insulation tapes etc. shall be provided at joints and terminations as required.

### vi) BUS BAR & BUS BAR CHAMBERS

The bus bar shall be of high conductivity Aluminium alloy of E 91 grade and of adequate section. The bus bar system shall comprise a system of totally enclosed horizontal bus bars run at top and vertical bus bars serving all modules in vertical section on either side in cable alleys. All connections to individual circuits from the bus bar shall be with solid connections. All bus bars and connections shall be suitably sleeved with heat shrinkable PVC sleeves. Maximum temperature of bus bars shall not exceed 850C i.e. 400C temperature rise over 450C.

vii) **BUS BAR SUPPORTS AND ATTACHMENTS**

Bus bar shall be firmly fixed on supports constructed from SMC (glass fibre reinforced thermosetting plastic). The supports shall be sufficiently robust to effectively withstand electro-mechanical stresses produced in the event of short circuit.

viii) **CONNECTION TO BUS BAR**

Connections to bus bar shall be made with use of holes drilled into bus bar with bolts and nuts. The bolts and nuts used for connections to bus bars shall be of Aluminium alloy, tinned forged brass or galvanised iron. Further for tapping off connections from bus bars PVC insulated wire may be used for current capacities upto 100 amps and for higher current capacities solid conductors/strips suitably insulated with PVC sleeves/tape shall be used. Wherever copper bus bar and Aluminium bus bars are connected to each other, bimetallic strip shall be used.

ix) **CLEARANCES**

The minimum clearances to be maintained for open and closed indoor air insulated bus bars/electrically non-exposed and working at system voltage upto 600 volts shall be as follows :

For AC bus bars and Main connections

| Between | Minimum Clearances |
|---|---|
| Phase to Earth | 20 mm |
| Phase to Neutral | 25 mm |
| Phase to Phase | 25 mm |

x) **BUS BAR MARKING**

The colours and letters (or symbols) for bus bars ,Main bus bar connections and auxiliary wiring etc. shall conform to relevant Indian Standard and shall be as follows :-

For AC bus bars and Main connections

| S.No. | Bus Bar & Main Connection | Colour | Letter/Symbol |
|---|---|---|---|
| 1. | Three Phase | Red, Yellow, Blue. | R,Y,B. |
| 2. | Two Phase | Red, Blue | R,B |
| 3. | Single Phase | Red | R |
| 4. | Neutral Connection | Black | N |
| 5. | Connection to earth | Green | E |

xi) **PHASE SEQUENCE AND POLARITY**

Bus bars and main connections, when marked shall be marked in accordance with the following table to indicate the order in which the voltages in phases reach their maximum values.

| System | As indicated by Colours or letters | Phase sequence as indicated Vectorially |
|---|---|---|
| Three Phase | Red, Yellow, Blue | R, Y, B. |
| Two Phase | Red, Blue | R, B. |

xii) **ARRANGEMENT OF BUS BARS & MAIN CONNECTIONS :**

Bus bars and main connections which are substantially in one plane shall be arranged in order given as follows :

a. **A.C. System**

i The order of phase connections shall be Red, Yellow and Blue.

ii When the run of the conductors is horizontal, the red shall be on the top or farthest away from the centre line as viewed from the front.

iii When the run of the conductor is vertical, the red shall be on the extreme left.

iv When the system has a neutral connection in the same plane as the phase connections, the neutral shall occupy an outer position.

v Unless the neutral connections can be readily distinguished from the phase connections, the order shall be red, yellow, blue and black.

xiii) **MOULDED CASE CIRCUIT BREAKERS**

a) Moulded case circuit breakers shall comply with the latest Indian Standards and IEC standards. They shall have the voltage and current ratings, rated duty, rated short circuit service breaking capacity and rated short - time withstand current as indicated.

b) MCCB's shall be of the independent manual closing air-break type, rated for an uninterrupted duty, unless otherwise indicated.

c) Each MCCB shall have a facility for padlocking in the "OFF" position.

d) Each MCCB shall be provided with rotary operating mechanism.

xiv) **CIRCUIT COMPARTMENTS**

Each circuit breaker shall be housed in separate compartments and shall be enclosed on all sides. CRCA sheet steel hinged lockable doors shall be duly interlocked with the breaker in 'ON' and 'OFF' position. Safety interlocks shall be provided for breakers to prevent the breaker from being drawn out when the breaker is in 'ON' position. The instruments and indicating lamp shall not be mounted on the air circuit breaker compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

xv) **INSTRUMENT ACCOMMODATION**

Separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of circuit breaker, bus bars or connections.

xvi) **TERMINALS**

The outgoing terminals of the breaker and neutral link shall be brought out to a terminal block suitably located at the rear side of the panel. Separate cable compartments shall be provided for incoming and outgoing cables.

xvii) **WIRE WAYS**

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

xviii) **CURRENT TRANSFORMERS**

Current transformers of cast resin type shall be provided for main distribution boards carrying current in excess of 30 amps wherever shown in drawing. The current transformers shall have accuracy class I and suitable VA burden to operate associated metering. Current transformers shall be in accordance with IS 2705. Separate C.T.'s shall be used for protective devices.

xix) **EARTHING**

G.I. earth bars of size 25 mm x 6 mm for shall be provided for the full length of the panel and connected to the frame work. Provisions shall be made for connection from this earth bar to the main earthing bar on both sides of Distribution Panel.

xx) **LABELS**

Anodised aluminimum PVC coated labels shall be provided on all incoming and outgoing feeder switches. Circuit diagram showing the arrangement of the circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet. All the distribution boards shall be subject to tests specified in relevant Indian Standards and test certificates shall be furnished.

xxi) **METERS**

All the meters shall be housed in a separate compartment and accessible from front only. Lockable doors shall be provided for the metering compartments. All meters and indicating instruments shall be in accordance with relevant Indian Standard. The meters shall be flush mounted type. Indicating lamps shall be LED type.

xxii) **PAINTING**

All CRCA sheet steel shall undergo process of degreasing, pickling in acid, cold rinsing, phosphating, passivating and then sprayed with a high corrosive resistant primer. The primer shall be baked in an oven. The finishing treatment shall be by powder coating.

xxiii) **CABLE COMPARTMENTS**

Cable compartments of adequate size shall be provided in the cubical type boards for easy termination of all incoming and outgoing cables. Adequate supports shall be provided in cable compartments to support cables. All incoming and outgoing switches, terminals shall be brought out to terminal blocks in cable compartments. The Boards shall be suitable for both top and bottom cable entry.

## VI. INVERTER FOR EMERGENCY LIGHTING

### 1. SCOPE

This section covers supply, installation, testing and commissioning of Inverter for Emergency lighting.

### 2. INVERTER

**a) Input** : 170 TO 270 Volts

**b) Output Voltage :-**

Mains : As per incoming Voltage

Inverter : 220V Nominal

**c) Output Frequency :-**

Mains : As per incoming Frequency

Inverter : 50 Hz ± 1%

**d) Output Wave Form :-**

Mains : Sine Wave

Inverter : Stepped approximate to Sine wave

**e) Overall Efficiency** : Minimum 80%

**f) Power Factor** : 0.8

**g) Back up Time**: 90 minutes on full load

## 3. BUILT IN ELECTRONIC PROTECTION

Reverse Battery polarity protection shall be provided with an audio signal. Electronic Controller shall prevent overcharging or deep discharge of batteries. The unit shall be protected against overload, short circuit and reverse phase connection. Isolators shall be provided at the mains and battery inputs for instances of short circuits.

## 4. FILTERS

Suitable filters shall be provided inside the inverter to prevent damage to lighting fixtures and to avoid noise generation.

## 5. COMPONENTS RATING

All the components including the Transformer shall be of 24 hour rating.

## 6. TECHNOLOGY

MOSFETS shall be used for switching devices. The charging of batteries shall be SCR Controlled giving Constant charging for the entire input voltage range of 170-270 Volts.

### i) Back-up Time

This should be measured with a fully charged battery (same Voltage and specific gravity). The cut-off voltage should be taken as 10 Volts per battery system on the inverter side. The same load should be connected to each equipment to be tested and any unusual level of noise in fans should be recorded.

### ii) Low battery Cut off

The battery should not be discharged below 10 Volts. When the inverter is ON and the battery has discharged to this voltage, it should automatically switch off. This control is a must

because if the battery is allowed to discharge further it will become deep discharged and its life will drastically reduce.

**iii) Reverse Polarity Protection**

This protection is normally required when untrained persons do installation. However, many times this protection is provided in such a way that it does not allow a battery, which has gone very low to be charged. Even if the battery voltage has gone down to 6 volts, the system should come on and the batteries should be charged without calling the technicians.

**iv) Charging Current**

With a fully discharged battery, at 10 Volts, during the entire AC mains voltage range of 160 to 270 Volts the charging current should be nearly constant and should not exceed 6% of the AH rating of the battery. When the battery is fully charged (approx. 14.2 Volts), the inverter should go into trickle charge with the charging rate not exceeding 1% of the AH rating of the battery. During the testing, by adjusting the input voltage, the charging should be done at the highest rate and the battery temperature measured. The maximum charging rate and the maximum temperature permitted by the battery manufacturers should be compared with the readings obtained.

**v) Transformer**

The temperature rise of the transformer during the charging and inverter phases should be measured. If the temperature goes beyond 105 degrees Centigrade, the transformer insulation will start to become brittle and will breakdown after a year or so.

**vi) Output Voltage**

For proper functioning of the equipment, for most of the time, the output voltage should remain between 200-220 Volts. It should not drop below 185 Volts under any circumstances. It should be possible to switch on tube-lights even when the other load is on.

**vii) Wave form**

The inverter output wave form should be observed to find out if it has spikes and whether it is square or has been filtered for necessary protection to the equipment.

## VII. IMPORTANT INSTRUCTION FOR ELECTRICAL WORKS

### 1. GENERAL

- Rates quoted shall be for work to be carried out at all heights and levels as required at site. No extra payment on this account shall be admissible.

### 2. SUB-MAINS AND MAINS.

- Payment of **submain wiring in conduit** shall be as per the length of conduit measured between conduit terminations. Wires without conduits inside equipments for making terminal connections at either end shall not be payable extra.

- Payment of **cables** shall be based on length of cable laid between cable termination glands on either end. Length of cable leads inside the cable termination arrangement shall not be payable extra..

- Single core cables shall be armoured with non magnetic material. The core insulations shall be colour coded (Red/Yellow/Blue for phases and Black for neutral)

- Annular space around cables, conduits, busducts and rising mains shall be filled by fire resistant compound of approved make and type in accordance with the compound manufacturers instructions.

- Annular space around cables/earth strips entering below ground level into the building shall be filled up with suitable mastic compound to prevent ingress of rodents and water into the building.

### 3. SWITCHBOARDS AND DISTRIBUTION BOARDS

Quoted rates shall be inclusive of the cost of the following.

- Details of sub-circuits being fed by DBs shall be affixed on the back of the DB door of each DB

- Earth bonding of all hinged doors (of DBs and SDB cubicles/panels) shall be effectively done by braided flexible copper wire .

- All doors and operable covers shall be gasketted with neoprene gaskets.

- 3 mm thick gland plate shall be provided at top/bottom of SDBs for cable entry.

- 1 no. sample DB shall be got approved from Project Manager before undertaking bulk procurement /fabrication.

- All DBs and SDBs shall be designated by engraved name plates of approved material, finish and lettering fixed by countersunk nickel/cadmium plated screws. Danger plates shall be affixed on all three phase boards.

- An as-built schematic wiring diagram in stenciled permanent ink and housed in wooden frame with clear non- reflective acrylic cover shall be provided near main LT panel in substation/electrical room.

- Framed safety instructions complete with emergency telephone numbers shall also be provided inside each switchroom and generator room..

- Contractor shall provide bus bar rating calculation for current carrying capacity, short circuit thermal and electro dynamic stresses to comply to the current and fault current withstand specified for each item of switchboard, rising main, bus ducts etc. for approval of project manager prior to fabrication. Changes if any required by contractor shall be incorporated without any additional cost.

## 4. FIXING OF LIGHTING FIXTURES

Quoted rates shall include the following:

- All components that may be required to make the installation complete in all respects such as,

  - Suitable length of down rod, hanger and connecting wires where called for..
  - Internal wiring between accessories.
  - Wiring for connecting the fixtures to the point through connection blocks.

- Metal blocks to serve as base of fixtures.
- Bonding with earth.
- Drilling holes in supports where required.
- Fixing clamps, GI bolts and nuts, brass screws, saddles, rawl plugs and other fixing accessories as required.

- 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..

## 5. SUPERVISION

The installation, testing and commissioning of Main LT panel, 11KV Panels, Transformers, Bus ducts, Rising mains, 11 kV cables termination shall be supervised and certified by the respective manufacturers

# VIII. CONDUITING AND WIRING

## 1. GENERAL

The system of wiring shall consist of single-core/multi-core PVC insulated Copper conductor wires in Metallic/PVC conduits concealed/exposed or Raceways as called for.

## 2 STANDARDS AND CODES

Updated and current Indian Standard Specifications and Codes of Practice as stipulated below shall apply to the equipments and the work covered in this section. In addition the relevant clauses of the Indian Electricity Act 1910, Indian Electricity Rules 1956, National Building Code 2005, National Electric Code 1985, Code of Practice for Fire Safety of Building (general) : General Principal and Fire Grading – IS 1641 and IEE wiring regulation 16th edition as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

660/1100 V grade FR PVC insulated wires. IS 694 : 1990

PVC Conduits IS 2509, 3419, 6946

Accessories for rigid steel conduits IS 3837 : 1990

Flexible steel conduits for electrical wiring IS 3480 : 1990

Switch socket outlets IS 4615 : 1990

3 pin plugs and socket outlets upto 250 volts IS 1293 : 1988

Glossary of items for electrical cables and conductors IS 1885 : 1971

Conductors for insulated electric cable IS 8130 : 1984

General and safety requirements for fluorescent lamps luminaries IS 1913 : 1978

Switches for domestic and similar purposes IS 3854 : 1997

Boxes for the enclosure of electrical accessories IS 5133 : Parts I &II 1969

Danger notice plates IS 2551 : 1982

Code of practice for personal hazard fire safety of buildings IS 1644: 1998

Code of practice for electrical installation fire safety of buildings IS 1646 : 1997

Code of practice for electrical wiring installations IS 732 : 1989

Code of practice of fire safety buildings (General- Electrical installations) IS 1646 : 1982

Guide for safety procedure and practices in electrical works IS 5216 : 1982

## 3. CHECKING OF DRAWINGS

Before commencing the conduiting work, the Contractor shall carefully examine the drawings indicating the layout of conduits, check the number and size of conduits with respect to number of wires , location of junction boxes, sizes and location of switch boxes and other relevant details. Any changes suggested by the Contractor shall be got approved from the Consultants before the actual laying of conduits. Any discrepancy found in the drawings shall be brought to the notice of the Architects/ Consultants promptly before execution of the work.

## 4. Material

**4.1** Conduits shall be black enameled mild steel and be solid drawn or lap welded conduits, stove enameled inside and outside with minimum wall thickness of 1.6 mm for conduits upto 25 mm diameter and 2 mm wall thickness for conduits above 25 mm diameter. The PVC conduits shall be 2 mm thick. PVC Conduits shall be rigid unplasticised PVC conduits of 2 mm thickness. The conduits shall be delivered to the site in original bundles and each length of conduit shall bear the label of the manufacturer. The number of insulated copper conductor wires that may be drawn in the conduits of various sizes are given below and the conduit fill shall not exceed 40%. The minimum size of conduits shall be 20mm diameter for lighting and outlets and conduit size shall be increased as per relevant IS code depending on the number of wires. Wires shall be PVC insulated copper conductor and ISI marked.

### 4.2 FR PVC insulated wires

Flame Retardant (FR) PVC insulated wires shall be single core unsheathed in voltage grade 1100 V as per IS 694 – 1990 with 99.97% pure electrolytic grade bright annealed stranded bare copper conductors. Special parameters of FR PVC insulation like critical oxygen index, temperature index, smoke density and flammability test shall conform to relevant IEC and ASTM Standards. Coil packings shall be ISI marked as stipulated in IS 694

## 5. CONDUIT FILL:-

The maximum number of 650/1100 Volts grade single core PVC insulated copper conductor wires that may be drawn in the conduits of various sizes are given below.

| **Size of wire** | **Size of Conduit (MS/PVC)** | | | | |
|---|---|---|---|---|---|
| **Area of the wire** | **20** | **25** | **32** | **40** | **50** |

| Sq. mm | (Number of wires maximum) | | | | |
|---|---|---|---|---|---|
| 1.5 | 6 | 10 | 14 | - | - |
| 2.5 | 5 | 8 | 12 | - | - |
| 4.0 | 3 | 6 | 10 | 14 | - |
| 6.0 | 2 | 5 | 8 | 11 | - |
| 10.0 | - | 4 | 7 | 9 | - |
| 16.0 | - | 2 | 4 | 5 | 12 |
| 25.0 | - | - | 2 | 2 | 6 |
| 35.0 | - | - | - | 2 | 5 |

**6. JOINING OF CONDUITS: -**

PVC Conduits shall be joined by means of PVC solvent cement. Proper jointing compound recommended by manufacturers shall be used for the same. Where there are long runs of straight conduit, inspection boxes shall be provided at 10 meter intervals. Junctions between conduits and adapatable boxes, switch outlet boxes must be provided with entry spouts and smooth PVC bushes.

**7. CONDUIT CONNECTIONS**: -

The threads of pipe and sockets shall be free from grease and oil and shall be thoroughly cleaned before making the screwed joints. All joints shall be fully water tight. Junction boxes and running joints shall be provided at suitable places to allow for subsequent extension if any, without undue dismantling of conduit system. As far as possible, diagonal run of conduits and adaptable boxes, back outlet boxes, switch boxes and the like must be provided with entry spouts and smooth rubber bushes. Joint between conduit and iron clad distribution boards and control gear shall be effected by means of conduit couplers into each of which will be coupled smooth rubber bushes from the inside of box or case.

Conduit system shall be vertical and straight as far as possible. Traps where water may accumulate from condensation shall be avoided, however if it is unavoidable suitable provision for draining the water shall be made. Separate conduits shall be run for lighting and 15 amps power outlet wiring. Wires belonging to different phases shall no be run in the same conduit . For every phase wire a separate neutral wire shall be run. Conduits connections for MS conduits shall be screwed metal to metal and be painted with one coat of self etching zinc chromate primer and two coats of enamel paint. The threads and sockets shall be free from grease and oil. Connections between screwed conduit and sheet metal boxes shall be by means of a rubber bush. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduit. External conduits ( exposed to elements ) should be insulated through clamp and water tight fitting.

## 8. BENDS IN CONDUIT :-

Where necessary, bends may be carried out by means of conduit bends and/or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system, each junction box shall be provided with a cover properly secured and flushed with the finished wall/ceiling surface, so that the conductors inside the conduit are accessible. No bends shall have radius less than 2.5 times the outside diameter of the conduit. Special spring may be used for bending the conduit. Heating to soften the conduit for bending is not allowed. Caution should be excersied in using PVC conduits in location where ambient temperature is 50° C. Use of PVC conduits where temperature is 60°C. or above is prohibited

Large right angle bends (more than 75 mm radius) or non right angle bends in conduit runs shall be made by means of conduits bending machines carefully so as not to cause any crack in the conduit. Small right angle bends in conduits runs can be made by standard conduit accessories (solid/inspection bends/elbows). No run of conduit shall have more than four right angle bends from outlet to outlet. Bends in multi runs of conduits shall be parallel to each other and neat in appearance, maintaining the same distance as between straight runs of conduits.

## 9. Flexible Conduit

All final connections specially to vibrating equipments shall be made through steel flexible conduits. However the use shall be restricted to only those areas where it is not possible to use rigid PVC conduits with approval of Project Manager.

## 10. Conduit Accessories.

### 10.1 Standard accessories

PVC standard conduit fittings and accessories like standard/extra-deep circular boxes, looping in boxes, junction boxes, solid /inspection elbows , solid/inspection tees, couplers, nipples, saddles, check nuts, earth clips, ball socket joints, bushes etc. shall be of superior quality and of approved makes. Heavy duty covers screwed with approved quality screws shall be used. Samples of all conduits fittings and accessories shall be got approved by Project Manager before use.

## 11. CONDUIT INSTALLATION

### 11.1 System

The whole conduit system shall be installed to comply fully with relevant provision in Indian Standard Specifications, Indian Electricity Rules and IE wiring regulations. Conduits shall be laid either recessed in walls and ceilings or on surface on walls and ceilings or partly recessed and partly on surface, as required. **Same rate** shall apply for recessed and surface conduiting in this contract. Stranded copper conductor insulated wire of size as per schedule of quantities shall be provided in entire conduiting for loop earthing. steel wire of suitable size to serve as a fish wire shall be left in all conduit runs to facilitate drawing of wires after completion of conduiting.

### 11.2 Layout

- Conduits layout and routes shall be submitted for Project Manager's approval prior to execution. Allowance for adjustments due to site conditions shall be provided with no extra cost.
- Conduit routes shall be chosen for easy, straight runs with a minimum of bends and crossings. Generally they shall follow the structure of building, running at right angles or in parallels to floors and ceilings. Conduit shall be kept within 300 mm of floors and ceiling when running parallel to them.
- Outlets boxes for housing accessories shall be used as draw boxes. The total number of draw boxes shall be kept to a minimum and shall be provided so that conduits runs do not exceed 12 m or have more than two right angle bends.
- All conduits shall be kept clear of gas and water pipes. In particulars, conduits shall be at least 150 mm away from gas pipe. Where proximity to these pipes is unavoidable, they shall be effectually segregated e.g. using rubber or other insulating material to prevent appreciable voltage difference at possible points of contact. Segregation from extra low voltage circuits and telecommunication circuits shall also apply unless these are wired to the same voltage requirements as lighting and power circuits.

- Conduits from different distribution boards shall not be connected to the same junction box. Each run of conduit shall be assembled complete with draw in wires.

## 11.3 Joints and terminations

- Electrical and mechanical continuity shall be maintained throughout all conduits joints and terminations. Conduit threads shall be thoroughly cleaned and the conduits tightly screwed. The conduit system shall be watertight after installation.
- Conduits shall be connected using couplers or via boxes. With a coupler, the ends of the conduit shall butted close together and the running coupler is screwed tightly on and tightened by a locknut.
- Conduits terminating into boxes provided with spouts shall be threaded so that there are no exposed threads. For boxes with no spouts, the termination shall be made using a brass bush and a coupler. The conduit is pushed through the knockout or drilled entry and the bush is screwed tightly onto its end. The coupler is screwed to butt firmly against the exterior wall of the box.
- Where conduits are not jointed or terminated in boxes, they shall be terminated in a screwed brass bush.
- In all joints and terminations, conduits threads shall not be exposed. Where this cannot be avoided as in a running coupler, the exposed threads shall be coated with red lead paint to seal against the ingress of water.

## 11.4 Bends

- Conduits shall be bent cold with an approved type of bending block or bending machine, without altering the dimensions of their sections.
- All conduits bends shall be such as to permit compliance to the requirements for bends in cables to as stated in the IEE regulations
- Bends shall be made with as large a radius as the position of the conduit within the building permits. Where the bend is more than 90 degree, circular or rectangular junction boxes shall to be used for connecting conduits.

## 11.5 Recessed Conduiting

Conduits recessed in concrete members shall be laid before casting, in the upper portion of slabs or otherwise as may be instructed, so as to embedded the entire run of conduits and ceiling outlet boxes with a cover of minimum 12 mm concrete. Conduits shall be adequately tied to the reinforcement to prevent displacement during casting at intervals of maximum 1 meter. No

reinforcement bars shall be cut to fix the conduits. Suitable flexible joints shall be provided at all locations where conduits cross expansion joints in the building.

Conduits recessed in brick work shall be laid in chases to be cut by electrical Contractor in brick work before plastering. The chases shall be cut by a chase cutting electric machine. The chases shall be of sufficient width (minimum 10 mm spacing between adjacent conduit) to accommodate the required number of conduits and of sufficient depth to permit full thickness of plaster (minimum 6 mm) over conduits. The conduits shall be secured in the chase by means of heavy duty pressed steel clamps screwed to MS flat strip saddles at intervals of maximum 1 meter. The chases shall then be filled with cement and coarse sand mortar (1:3) and properly cured by watering. For chases more than 75 mm width, a wiremesh shall be provided for the full length and width of the chase in the plaster to prevent cracking.

Junction boxes intended for facilitating drawing of wires in conduiting system shall be located in accessible locations to permit redrawing of wires in future. Open ends of conduits laid in slabs and walls shall be suitably plugged before pouring concrete / plastering to prevent ingress of water / debris in to the conduits

Entire recessed conduit work in concrete members and in brick work shall be carried out in close coordination with progress of civil works. Conduits in concrete members shall be laid before casting and conduits in brick work shall be laid before plastering. Should it become necessary to embedd conduits in already cast concrete members, suitable chase shall be cut in concrete for the purpose. For minimising this cutting, conduits of lesser diameter than 25 mm and outlet boxes of lesser depth than 50 mm could be used by the Contractor for such extensions only after obtaining specific approval from Project Manager. For embedding conduits in finished and plastered brick work, the chase would have to be made in the finished brick work. After fixing conduit in chases, chases shall be made good in most workmanlike manner to match with the original finish.

Cutting chases in finished concrete or finished plastered brick work for recessing conduits and outlet boxes etc shall be done by the Contractors without any extra cost. In the concealed MS/PVC conduit system all boxes for accessories and draw/junction boxes shall be installed such that the outer rim is flush with the finished surface of the wall.

### 11.6 Surface Conduiting

Wherever so desired, conduit shall be laid in surface over finished concrete and/or plastered brickwork. Suitable spacer saddles of approved make and finish shall be fixed to the finished structural surface along the conduit route at intervals not exceeding 600 mm. Holes in concrete or brick work for fixing the saddles shall be made neatly by electric drills using masonry drill bits. Conduits shall be fixed on the saddles by means of good quality heavy duty GI clamps screwed to the saddles by counter sunk screws. Neat appearance and good workmanship of surface conduiting work is of particular importance. The entire conduit work shall be in absolute line and

plumb. Conduits above false ceiling shall be fixed on suitable hangers supported from the structural ceiling. All surface conduits shall be run in a vertical or horizontal direction. Diagonal runs shall not be permitted.

### 11.7 Fixing of conduit fittings and accessories

For concealed conduiting work, the fittings and accessories shall be completely embedded in walls/ceilings leaving top surface flush with finished wall/ceiling surface in a workman like manner.

Loop earthing wire shall be connected to a screwed earthstead inside outlet boxes to make an effective contact with the metal body.

### 11.8 Protection of Conduits

To safeguard against filling up with mortar/plaster etc. all the outlet and switch boxes shall be provided with temporary covers and plugs which shall be replaced by sheet/plate covers as required. All screwed and socketed joints shall be made fully water tight with white lead paste.

### 11.9 Cleaning of Conduit Runs

The entire conduit system including outlets and boxes shall be thoroughly cleaned after completion of erection and before drawing in of cables.

### 11.10 Protection Against Dampness

All outlets in conduit system shall be properly drain and ventilated to minimise chances of condensation/sweating.

### 11.11 Expansion Joints

When crossing through expansion joints in buildings, the conduit sections across the joint shall be through approved quality heavy duty metal flexible conduits of the same size as the rigid conduit.

### 11.12 Loop Earthing

Loop earthing shall be provided by means of insulated stranded copper conductor wires of sizes as per Schedule of Quantity laid alongwith wiring inside conduits for all wiring outlets and sub-mains. Earthing terminals shall be provided inside all switch boxes, outlet boxes and draw boxes etc.

## 12. LAYING AND DRAWING OF WIRES

## 12.1 Bunching of Wires

Wires carrying current shall be so bunched in conduits that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not be run in the same conduit. No joint shall be permitted in the run of wires.

## 12.2 Drawing of Wires

The drawing of wires shall be done with due regard to the following precautions:-

- No wire shall be drawn into any conduit, until all work of any nature, that may cause injury to wire is completed. Burrs in cut conduits shall be smoothened before erection of conduits. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire. Approved type bushes shall be provided at conduit terminations.

- Before the wires are drawn into the conduits, conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction by forcing compressed air through the conduits if necessary..

- While drawing insulated wires into the conduits, care shall be taken to avoid scratches and kinks which cause breakage of conductors.

- There shall be no sharp bends.

- The Contractor shall, after wiring is completed, provide a blank metal/sunmica plate on all switch / outlet / junction boxes for security and to ensure that wires are not stolen till switches / outlets etc.. are fixed at no extra cost. The contractor shall be responsible to ensure that wires and loop earthing conductors are not broken and stolen. In the event of the wire being partly / fully stolen , the contractor shall replace the entire wiring alongwith loop earthing at no extra cost. No joint of any nature whatsoever shall be permitted in wiring and loop earthing .

## 12.3 Termination /Jointing of Wires

- Sub-circuit wiring shall be carried out in looping system. Joints shall be made only at distribution board terminals, switches/buzzers and at ceiling roses/connectors/lamp holders

terminals for lights/fans/socket outlets. No joints shall be made inside conduits or junction/draw/inspection boxes.

- Switches controlling lights, fans or socket outlets shall be connected in the phase wire of the final sub circuit only. Switches shall never be connected in the neutral wire.

- **Wiring conductors shall be continuous from outlet to outlet. Joints where unavoidable, due to any special reason shall be made by approved connectors. Specific prior permission from Project Manager in writing shall be obtained before making such joint.**

- Insulation shall be shaved off for a length of 15 mm at the end of wire like sharpening of a pencil and it shall not be removed by cutting it square or wringing.

- Strands of wires shall not be cut for connecting terminals. All strands of wires shall be twisted round at the end before connection..

- Conductors having nominal cross sectional area exceeding 1.5 sq. mm shall always be provided with crimping sockets. Tinning of the strands shall be done wherever crimping sockets are not available as per instructions of the Project Manager

- All wiring shall be labelled with appropriate plastic ferrules for identification.

- At all bolted terminals, brass flat washer of large area and approved steel spring washers shall be used.

- Brass nuts and bolts shall be used for all connections.

- The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less.

- Only certified valid license holder wiremen shall be employed to do wiring/jointing work.

## 12.4 Load Balancing

The Contractor shall plan the load balancing of circuits in 3 phase installation and get the same approved by Project Manager before commencement of the work.

### 12.5 Colour Code of Conductors

**Colour code for normal supply – Red, Yellow, Blue for three Phases, Black for Neutral and Green for Earth – shall be maintained for the electrical wiring installation**

**Colour code for UPS supply – Red/white, Yellow/white, Blue/white for three Phases, white for Neutral and Green for Earth**

## 13. ROUTINE AND COMPLETION TESTS

### 13.1 Installation Completion Tests

At the completion of the work, the entire installation shall be subject to the following tests:

1. Wiring continuity test
2. Insulation resistance test
3. Earth continuity test
4. 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.

### 13.2 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.

### 13.3 Insulation Resistance Test

The insulation resistance shall be measured between earth and the whole system conductors, or any section thereof with all protection 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 LT 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 he 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 12.5 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.

### 13.4 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.

### 13.5 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 Project Manager as well as the local authorities.

### 13.6 Earth Resistivity Test

Earth resistivity test shall be carried out in accordance with IS Code of Practice for earthing IS 3043.

### 13.7 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.

### 13.8 Tests And Test Reports

The Contractor shall furnish test reports and preliminary drawings for the equipment to the Project Manager 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. All test reports shall be approved by the Project Manager prior to energizing of installation.

## II. SWITCHES, SOCKETS, OUTLETS, LIGHTING FIXTURES

### 1. Switch-Outlet & Junction Boxes

All Switches, socket outlets shall be provided with rust proof outlet boxes of MS as called for, having external and internal surface true to finish. Where called for, outlet boxes for receiving switches shall be fabricated to approved sizes and covered with approved **White Polycarbonate modular** cover plate secured to the box with brass countersunk screws. All boxes shall have adequate number of knock- out holes of required diameter and an earthing terminal screw. Outlets exposed to the weather shall be fully water tight, complete with rubber gasketed covers. The outlet boxes shall be painted with two coats of bituminous paint before they are fixed in position. Outlet boxes fixed in concrete shall be of a minimum depth of 75 mm and the wall thickness of the boxes and spouts shall not be less than 2mm. Outlet boxes fixed in wall shall be of a minimum depth of 50 mm and the wall thickness of the boxes and spouts shall not be less than 20 guage.

### 2. SWITCHES

All 6/16 amp switches shall be enclosed type and flush mounted type of 250 V AC grade. All switches shall be fixed inside the switch boxes on adjustable MS strips/plates with tapped holes and brass machine screws, leaving ample space at the back and sides for accommodating wires. The switch controlling the light shall be located at 1000 m.m. above finished floor level, unless otherwise indicated.

### 3. Wall Socket Outlets

All 6 amp wall socket outlets where called for on the drawings shall be combined type with 5 pins. All 16 amp or 13 amp socket outlets where called for shall be combined and 6 pin type. The sockets shall be erected approximately 150 mm above floor level, unless otherwise specified.

The switch controlling the point outlets and socket outlets shall be on the phase wire of the circuit. The earth terminal of the socket shall be connected to the earth terminal provided inside the box by means of insulated copper conductor wire.

### 4. LIGHTING FIXTURES

The light fixtures and fittings shall be assembled and installed complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Project Manager.

- Wires brought out from junction boxes shall be encased in GI flexible pipes for connecting to fixtures concealed in suspended ceiling. The flexible pipes shall be provided with a checknut at the fixture end.

- Pendant fixtures specified with overall lengths are subject to change and shall be checked with conditions of the job and installed as directed.
- All suspended fixtures shall be mounted rigid and fixed in position in accordance with drawings, instructions and to the approval of the Project Manager.
- Fixtures shall be suspended true to alignment, plumb, level and capable of resisting all lateral and vertical forces and shall be fixed as required.
- All suspended light fixtures etc. shall be provided with concealed suspension arrangement in the concrete slab/roof members. It is the duty of the Contractor to make these provisions at the appropriate stage of construction.
- Wires shall be connected to all fixtures through connector blocks.
- Flexible pipes, wherever used, shall be of make and quality approved by the Project Manager.

**END OF SECTION**

## TECHNICAL SPECIFICATIONS FOR HVAC WORKS

1. The specifications under this section cover the supply, installation, testing and commissioning of the **VARIABLE REFRIGERANT VOLUME / FLOW SYSTEM** conforming to these specifications and in accordance with the **Detailed Bill of Quantities** given in the tender.
2. For the subject project minimal brazing shall be done; and shall be limited only to outside building area i.e. non-air-conditioned area. Further distribution shall be with PPM/ header kits and using fire/ brazing free connection joints as required. This is to minimize the fire risk in the operational building. All indoors up to 4 TR shall be connected through header connection kit. At least one port shall be kept spare in each kit for future modifications, if required. The connection kit shall be supplied accordingly as no brazing shall be allowed at site.

### 3. General

Each VRV / VRF Unit shall be air cooled, split type multi-system air conditioner consisting of outdoor units and multiple number of indoor units, each refrigerant circuit having capability to either cool or heat for the requirements of the individual area to be air-conditioned. The VRV / VRF unit should be capable of connecting minimum ten different type of indoor units to one refrigerant circuit and controlled individually.

Each VRV / VRF unit shall have all scroll compressor/ Rotary shall be inverter Compressor (With inverter controller) capable of changing the rotating speed to follow variations in cooling loads. Each indoor units having capability to cool or heat for the requirement of the rooms.

Compressor shall be inverter-controlled Compressor installed in each outdoor module unit shall be equipped with all inverter compressor in equal 2N/3N module (if modular) machines for higher reliability, improved life, better backup and duty cycling purpose. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load. VRV unit and compressor should be of same OEM make. Each refrigerant circuit other than applicable for AHUs shall have 2 or more modules.

The Outdoor units shall be suitable for mix-match connection of following type.

- Ceiling mounted cassette type (Double flow)
- Ceiling mounted cassette type (Multi flow)
- Ceiling mounted duct type.
- Ceiling suspended type.
- Wall mounted type
- Floor standing type

- Concealed floor standing type.

Please note that the refrigerant piping shall be capable of extending up to 100m with 50m level difference without any oil traps.

## 4. OUTDOOR UNIT

i. The outdoor unit shall be factory assembled, weather proof casing (Material of construction of casing shall be vendor's standard design), constructed from heavy gauge GI sheets steel panels and coated with baked enamel finish. The outdoor unit shall be completely factory wired, tested with all necessary controls & filled with first charge of refrigerant before delivering at site.

ii. The inverter technology-based D.C Twin Rotary / Scroll modular type VRF equipment should be capable so that refrigerant piping between indoor units and outdoor unit shall be extendable upto 165m of equivalent length with maximum height difference between outdoor & indoor unit of 90m & level difference between two indoor units shall be maximum upto 30m. All the outdoor units comprising of multiple modules should have 100% inverter type compressor in each module.

All the details pertaining to power consumption as per ARI standards should be duly filled and furnished as per the sheet enclosed.

The above COP values as indicated are required to be furnished in Original by the tenderer directly from the original equipment Manufacturer (OEM) with OEM's seal and signature on all documents.

Outdoor units shall be factory assembled, tested and filled with first charge of refrigerant. These being very hi-tech in construction with lots of factory checks being conducted, hence no sub assembly should be done at site preferably. The proposed system shall able to operate up to outside ambient temperature up of 48 °C.

The minimum COP of proposed system shall be 6.3 at 50% part load conditions at 35 Deg C outdoor ambient DBT and IDU at 27 Deg C DBT & 19 Deg C WBT.

iii. The outdoor unit shall be factory tested and filled with first charge of refrigerant R-410A before delivering at site.

iv. It should also be provided with duty cycling for D.C inverter Twin Rotary/ Scroll compressors capable of changing the rotating speed of compressor by inverter controller to follow variation in cooling & heating loads & switching starting sequence for better stability and prolonging equipment life or similar features if available in D.C Twin Rotary / Scroll will also be accepted.

v. The machine must have a sub cool feature to use coil surface more effectively through 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.

vi. The outdoor unit should be fitted with low noise level and should not be more than 67 db (A) at normal operation when measured at a point 1 mtr. In front of the unit at a height of 1.5 mtrs.

vii. 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.

viii. In case of trouble occurs in an indoor units (s), the continuous operation of system should be possible after taking corrective bypass action.

ix. The unit shall be designed in such as way that cleaning of drain Pan should be easy & inspection/ replacement of compressor should be easy.

x. The condensing unit shall be designed to operate safely when connected to multiple fan coil units.

xi. The outdoor unit shall have suitable cooling mechanism preferably refrigerant cool PCB chamber for better operation at high ambient temperature.

xii. The outdoor unit shall have feature to change the evaporative temperature with respect to load for better comfort and energy efficiency from 6 to 11 Deg C.

xiii. The systems shall have free phase technology & operation shall be continuous in case of phase reverse in supply electricity. In case the same is not provided automatic phase corrector shall be provided without any additional charge.

xiv. The system shall have automatic refrigerant charge function is preferred for optimal charging for additional refrigerant.

xv. The system shall deliver at minimum at least 87% of mentioned nominal capacity at 43.3 Deg C ambient temperatures.

xvi. The fan static pressure of the outdoor unit shall be minimum 75 Pa to avoid hot air recirculation.

## 5. Compressor

i. The compressor in inverter based D.C Twin Rotary / Scroll System shall be highly efficient. The system should response efficiently in accordance to the variation in cooling or heating load requirement.

ii. All outdoor units shall have step less capacity control from 15-100% to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.

iii. Oil heaters shall be provided in the compressor casing.

## 6. Oil Recovery system

i. 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.

ii. The system must be provided with oil balancing circuit to avoid poor lubrication.

## 7. Refrigerant Circuit

i. The refrigerant circuit shall include liquid and gas shut-off valves and a solenoid valves at condenser end.

ii. The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

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

## 8. Heat Exchange

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

ii. The aluminum fins shall be covered by anti-corrosion resin film. Further to this all the condensing coil shall be have special spray anti corrosion treatment site based.

iii. The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

## 9. Safety Devices

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

ii. Whatever safety devices are required shall be part of outdoor unit:- high pressure switch, fuse, fan drive overload protector, fusible plug, crankcase heater, over load relay, overload protection for inverter based technology.

**9.1** The outdoor roof mounted units shall be provided in such a fashion that these do not affect the overall aesthetics and ambience of the building. If required these units shall be suitably camouflaged to give good aesthetic look. These provisions, however, shall be discussed, if required, at a later date and the prices for the same shall be worked out separately as extra item.

## 10. OIL RECOVERY SYSTEM

Entire system shall be designed and capable of oil recovery to ensure stable operation with long refrigeration piping lengths.

The system should have inbuilt (avoid external) oil balancing circuit to avoid poor lubrication.

**END OF SECTION**

## STANDARD SPECIFICATION OF INDOOR UNITS

## 1.0 INDOOR UNITS

This section deals with supply, erection, testing and commissioning of Various Type of Indoor Units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be as specified in **Detailed Bill of Quantities.**

## 2.0 GENERAL

Indoor units shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or other as specified in BOQ. Each unit shall have electronic control valve to control refrigerant flow rate respond to load variations of the room.

a) The address of the indoor unit shall be set automatically in case of individual and group control

b) In case of centralized control, it shall be set by liquid crystal remote controller touch screen type display.

The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.

The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water.

Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall be slide away type and neatly inserted.

Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling or cooling and heating.

Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self-diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap individually as per requirement.

## 2.2 CEILING MOIUNTED CASSETTE TYPE UNIT

The unit shall be ceiling mounted cassette type. The unit shall include pre-filters, fan section and DX-coil section. The plastic body shall be light in weight and shall be able to suspend. The fan shall be aerodynamically designed diffuser turbo fan type. Unit shall have an external attractive panel for supply and return air. (Technical data may be furnished).

All cassettes having panel dimensions of 800 x 800 mm or above shall have dual sensor consisting of multi zone occupancy sensor which detect the presence of people & floor temperature sensor to provide comfortable air-conditioning and energy saving. The sensor should detects human presence and adjust the airflow direction automatically to prevent drafts. Room temperature should be increase up to 4 Deg C when no people are detected in 15 to 30 mins as per user preference. The sensor should detect the floor temperature and automatically adjusts the operation of the indoor unit to reduce the temperature difference between the ceiling and the floor. All 4 louvers of the unit shall be independently adjustable for position as per user preference.

### 3.3 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.

### 3.4 CEILING SUSPENDED TYPE

Unit shall be suitable for ceiling suspended arrangement below false ceiling. The unit include pre filter, fan section & DX coil section . The housing of unit shall be light weight powder coated galvanized steel.

### 3.5 HIGH WALL MOUNTED UNITS

The units shall be wall-mounted type. The unit includes pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel. Unit shall have an attractive external casing for supply and return air.

### 3.6 FLOOR STANDING TYPE

Unit shall be suitable for floor standing arrangement. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

## 3.7 AHU TYPE

### DOUBLE SKINNED CASING

The casing shall be self supporting type, factory fabricated & assembled made of extruded anodised aluminum hollow sections to make a rigid frame structure. The frame shall be assembled using pressure die cast aluminum joints. The self supporting unit shall consist of sandwiched panel made out of 0.8mm thick pre-plasticide / pre-coated GI sheet outside & 0.8mm GI sheet inside duly factory fabricated & insulated with 25 mm thick injected PU foam insulation of 36 Kg/m³ density in between as specified in **Detailed Bill of Quantities.** The insulated panels shall be bolted to main frame with neoprene rubber gaskets held captive in the framed extrusion to make it leak proof. Suitable air tight access doors / panels with pressure die cast aluminum hinges & nylon handles and locks shall be provided for access to various sections for maintenance. The Entire housing shall be mounted on Extruded Aluminum channel frame work having pressure die cast aluminum jointers or the frame work shall be joined together with corner plates Condensate. Drain Pan shall be constructed of 18 gauge polished stainless steel sheet with all corners welded with uniform slope from all sides leading to drain pan ensuring no stagnation of condensate water. Drain Pan shall be sandwich type insulated with 10 mm thick nitrile foam. Maximum coil connection kit shall be 20 HP for improved refrigerant distribution in the circuit.

### MOTOR & DRIVE FOR AIR HANDLING UNITS

The fan motors shall be 415 ± 10% volts, 50 ± 5 % HZ, 3 phase TEFC SQ. Cage induction motor. The motor shall be specially designed for quiet operation & motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt drive arrangement. Belts shall be of the resistant type only.

### FAN OF AIRHANDLING UNITS

The casing shall have heavy gauge GI construction forward curved DIDW imported fan statically & dynamically balanced mounted on EN8 solid shaft or C 40 carbon steel. The supply air DIDW fan shall be forward curved. The fan impeller shall be supported to housing with angle iron frame & pillow block heavy duty ball bearing. The fan shall be selected for a fan outlet velocity below 10.2 meter / sec. The fan housing with TEFC Sq. Cage motor shall be mounted on a common adjustable base frame on vibration isolators in case the impeller diameter is exceeding 450 mm & rubber turret mounts vibration isolators for fan diameter up to 450mm diameter. The fan motor shall be installed inside the housing of air handling unit to keep low noise level. The fan & motor assembly shall be of aluminum extruded section only. **The Fan speed should be selected not more 1000 RPM. The Noise Level not more than 70 db Level.**

### REFRIGERANT COIL

The Refrigerant Coil shall be made of aluminum fins and copper tubes of Ø3/8" coil is with Inner Grooved Tube material (IGT). The minimum no. of fins / cm for cooling coils shall be 4.72. The bonding of aluminum fins with copper should be done hydraulically. **The tube thickness shall be 0.50 mm & fin thickness shall be 0.15 mm the cooling coil** should be tested for leaks at a hydraulic pressure of at least 10 Kg / sq.cm. for a minimum period of 3 hours at works. The velocity across face should be limited to 152 metre / minute. In case of chilled water coils the design should be such to limit water velocity to maximum of 2.5 m / sec.

**FILTERS**

Each unit shall be provided with a factory assembled filter section containing washable synthetic tube air filters having extruded aluminum frame having filtration capacity of 10 micron particle size with an efficiency of 90% efficiency. Filters shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filters cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels. Face velocity across filters shall not exceed 152 MPM

| **Sr. No.** | **AIR-FILTER TECHNICAL** | |
|---|---|---|
| **(A)** | **Pre Filter ( 3 Micron)** | |
| | Efficiency | 99% down to 3 Micron |
| | IPD | 8 - 9 mm WG |
| | FPD | 20 - 21 mm WG |
| | Casing | Aluminium Frame |
| | Media | Non Woven Synthetic Media Supported by Al. Mesh on one side and finished with HDPE mesh on the other side |
| | Eurovent Class | EU – 7 |
| | Filter Class | F – 7 |
| | MERV Rating | MERV -13 |
| | Temperature | Ambient |
| | Gasket | Food Grade |
| | | |

## 3.8 HEAT RECOVERY SECTION

The Heat Recovery section shall include enthalpy wheels and shall have minimum recovery of 75 % of total heat, i.e both sensible and latent (each being 75 %). Necessary computerized selection of the wheel should be provided along with the bid to justify the same. The wheel shall be made of

pure aluminium foil coated with molecular sieve desiccant with pore diameter of 3°A.The cross contamination between the two air streams shall be nil and leakage less than 0.04%. The vertical and radial run of the wheel shall be less than 1 mm per meter of diameter. The wheels shall have non-contact labyrinth seals for effective sealing between the two air streams.

Detailed specification for the wheel shall be as per 8.3 i.e. “HEAT RECOVERY WHEEL”

Heat Recovery Wheel specifications:

Rotor/wheel matrix shall have following Matrix —

The substrate: The substrate or wheel matrix should be made of pure aluminum foil so as to allow.

a) quick and efficient uptake of thermal energy.

b) sufficient mass for optimum heat transfer

c) maximum sensible heat recovery at a relatively low rotational speed of 20 to 25 rpm.

The substrate shall not be made from any material which is combustible or supports combustion like synthetic fibrous media.

The wheel shall have minimum 75% both Sensible and Latent Balanced Effectiveness as per AHRI 1060.

The wheel has to be certified as per DIN EN ISO 846 with 0% fungal and bacterial growth at 95% Relative humidity and above.

Fire rating: NFPA - 90A certification with 0% for Flame spread classification should be confirmed by manufacturer.

The Wheel shall be AHRI certified in accordance with standard 1060 and carry the AHRI certification stamp.

The product shall be produced in an ISO certified facility

NECESSARY SOFTWARE SELECTION OF THE WHEEL HAS TO BE ENCLOSED TO JUSTIFY THE PRESSURE DROP AND EFFICIENCY CALCULATIONS. THE SELECTION SOFTWARE SHALL SHOW HRW PERFORMANCE IN SUMMER, MONSOON & WINTER.

**The Desiccant:** The desiccant should be water molecule selective and non-migratory.

The desiccant should be molecular sieve 3Å, (certified by a third party lab to have an internal pore diameter of 3Å), so as to keep the cross contamination to absolute minimum and also ensure the exclusion of contaminants from the air streams, while transferring the water vapour molecules.

The desiccant, of sufficient mass which should not be less than 5 kg per 1000 cfm of air, should be coated with non-masking porous binder adhesive on the aluminum substrate so as to allow quick and easy uptake and release of water vapour. A confirmation has to be provided by manufacturer of wheel to this effect. A matrix with desiccants impregnated in nonmetallic substrates, such as synthetic fibre, glass fibre, etc. will not be accepted.

The rotor/wheel matrix shall have equal sensible and latent recovery.

The weight of desiccant coating and the mass of aluminum foil shall be in a ratio so as to ensure equal recovery of both sensible and latent heat over the operating range. Accordingly, a rotor matrix which has an etched or oxidised surface to make a desiccant on a metal foil and results in insufficient latent recovery and hence unequal recovery, or a rotor matrix made from desiccant integrated in a synthetic fibre matrix which result in insufficient sensible recovery, high rotation speed, and unequal recovery, will not be accepted.

**Rotor:** With optimum heat and mass through matrix formed by desiccant, of sufficient mass, coated on an aluminum foil, the rotor should rotate at lower than 20 to 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 aluminum foil of uniform width.

The rotor honeycomb matrix foil should be so wound and adhered (full node line adhesive to be provided) so 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 upto 2400 mm shall have spokes to reinforce the matrix. The internal threaded rod type spokes shall not be acceptable as it weakens the wheel structural strength thereby reducing the service life. From 2000 mm 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 2600 mm in diameter.

Wheels above 3400 mm in diameter shall be segmented and provided with wing structures spokes and flanged rim. The segmented wheels shall be provided with field rotation adjustment mechanism.

The HRW hub shall be fabricated out of heavy duty steel in order to have high mechanical strength. Light duty Aluminum hub shall not be accepted.

The surface of the wheel/rotor should be highly polished (FACED) to ensure that the vertical run out does not exceed ± 1 mm 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 ± 1 mm 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 aluminum media, having a multitude of narrow aluminum foil channels, thus ensuring a laminar flow, and will allow particles upto 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 Cassette / casing**

The recovery wheel cassette/casing shall be manufactured from tubular / sheet metal structure to provide a self supporting rigid structure, complete with access panels, purge sector, rotor, bearings, seals, drive mechanism complete with belt. The sheet metal should be coated with a special corrosion inhibitor coating and a certificate for the same should be provided.

The rotor/wheel should have a field adjustable purge mechanism to provide definite separation of airflow 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 non contact labyrinth seals / brush seals for effective sealing between the two air streams, and also for a minimum wear and tear ensuring long life of the seals.

PERFORMANCE TESTING

The HRW manufacturer shall have test facilities for performance testing of HRWs. If required the manufacturer shall be able to offer type testing of HRWs at their works and submit a type test report.

The manufacturer shall have test facilities for carry over testing at the same facilities where HRWs are manufactured.

## 3.9 CENTRALIZED TYPE REMOTE CONTROLLER

A multifunctional compact centralized controller shall be provided with the system.

The controller should be I touch LCD remote controller to act as an advanced air-conditioning management system to give complete control of VRV / VRF air-conditioning Equipment, It should have ease of use for the user and must have a user friendly panely and LCD display.

It shall be able to control up to minimum 64 indoor units with the following functions:-

a) Starting/stopping of Air-conditioners as a zone or group or individual unit.
b) Temperature settling for each indoor unit or zone.
c) Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.

d) Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.

e) OPTIONAL-Display of air conditioner operation history.

f) OPERATIONAL-Daily management automation through yearly schedule function with possibility of various schedules.

The controller shall have wide screen user friendly LCD display and can be wired by a non polar 2 wire transmission cable to a distance of 1 km. away from indoor unit.

### 3.10 COLOUR

The colour of indoor units should be white or to suit interiors as designed by the architects / clients.

**END OF SECTION**

**STANDARD SPECIFICATION**

### 2.0 SCOPE OF WORK

The complete scope of work shall cover supply, erection, testing and commissioning of the entire HVAC system as detailed under specification.

### 2.10 BASIS OF DESIGN

The entire system has been based and designed on climatological data available as given under Basis of Design and Scheme.

### 2.20 TERMS AND DEFINATIONS

The followings terms have been used in the tender specifications, drawings etc.

ISI Bureau of Indian Standards.

ASHRAE American Society of Heating Refrigeration & Air-conditioning Engineers, USA.

| | |
|---|---|
| ASME | American Society of Mechanical Engineers. |
| ASA | American Standard Association. |
| B.S. | British Standards. |
| CMH | Cubic Meter per Hour. |
| US GPM | US Gallons per minute. |
| IGPM | Imperial Gallons per Minute. |
| RPM | Revolutions per Minute. |
| BTU/Hr. | British Thermal Unit per Hour. |
| Kcal/Hr. | Kilo Calories per Hour. |
| HZ | Hertz. |
| H.P. | Horse Power |
| Kg/Cm2 | Kilo Gram per Square Centimeter. |
| SAG | Supply Air Grills. |
| SAD | Supply Air Diffuser. |
| SAF | Supply Air Filters. |
| FD | Fire Damper. |
| VCD | Volume Control Damper. |
| RAD | Return Air Damper. |

| | |
|---|---|
| FAD | Fresh Air Damper. |
| RH | Relative Humidity. |
| DB | Dry Bulb Temperature. |
| WB | Wet Bulb Temperature. |
| MV | Mechanical Ventilation. |
| DP | Drain Point. |
| VRF | Variable Refrigerant Flow |

**2.30** The codes, regulation as detailed below shall be followed in this contract:-

1. Safety code for air conditioning
   IS 659 : 1964 (reaffirmed 1991) (revised) amendment 1

2. Safety code for mechanical Refrigeration
   IS 660 : 1963 (reaffirmed 1991)

3. Testing of refrigeration compressors
   IS 5111 : 1993

4. Air-cooled heat exchangers
   IS 10470 : 1983 (amendment 1) (reaffirmed 1991)

5. Thermostats for use in refrigeration etc.
   IS 11338 : 1965 (reaffirmed 1991)

6. Metal Duct Work
   IS 655 : 1963 (reaffirmed 1991)

7. Steel for general structural purpose
   IS 2062 : 1992

| | | |
|---|---|---|
| 8. | Welding<br>IS : 3589 | |
| 9. | Refrigeration | As per ASHRAE / ISHRAE |
| 10. | Hot Dip Zinc Coated Steel Tubes | IS 4736 : 1968 |
| 11. | Colour code for the identification of pipelines | IS 2379 : 1963 |
| 12. | Specific requirements for the direct switching of the individual motors. | IS 4064 ( Part II) 1978 |
| 13. | PVC insulated ( HD) Electric Cables for working voltage up Including 1100 Volts. | IS : 1554 ( Part I) |
| 14. | HRC Cartridge fuse links upto 650 Volts. | IS 2208 : 1976 |
| 15. | Starter | IS 8554 ( Part I) 1979 |
| 16. | Inspection and testing of installation | IS 732 ( Part III) 1979 |
| 17. | PVC insulated ( heavy duty ) cables for working voltage up to 1.1. KV and up to 11 KV Grade respectively. | IS 1554 : 1981 Part I & II |
| 18. | Code for practice for electrical wiring installations. | IS 732 : 1989 |
| 19. | Code for practice for earthing | IS 3043 : 1966 |

| | | |
|---|---|---|
| 20. | Wrought aluminium & aluminium alloy sheet and strip for general engineering purposes. | IS : 737 |
| 21. | Mild steel tubes, tublar and other wrought steel fittings. | IS : 1239 |
| 22. | Contactors for A.C for voltage upto 1100 V. | IS 2959 : 1975 |
| 23. | Low voltage switch gear and control gear assemblies. | IS 8623 : 1993 Part I & II |
| 24. | Code of practice for selection of starters for AC induction motors | IS 3914 |
| 25. | Specification for cables glands | IS 4821 |
| 26. | Code for selection, installation & maintenance of switch gear and control gear. | IS 10118 : 1982 Part I to IV |
| 27. | Conduits for electrical installations | IS 9537 : 1981 Part I to IV |
| 28. | Permissible limits of noise level for rotating electrical machines. | IS 12065 : 1987 |
| 29. | Code of practice for installation and maintenance of motors | IS 3106 : 1966 |
| 30. | Unbounded glass wool for thermal insulation ( 1st. Revision) | IS 3690 : 1974 |

## 2.40 SAFETY CODES

The following IS codes shall be followed:

| | |
|---|---|
| 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 |

## 2.50 SPACE

All shop drawings shall be prepared by the A.C Contractor after examining the Architectural drawings, site conditions and consultants tentative layout plans.

## NOISE AND VIBRATION CONTROLS

**1.0** The air conditioning contractor must take all necessary precautions to have minimum noise generation and its transmission. Minimum vibration as permitted by IS relevant code shall be ensured. A few points for guidance only are given below:

**2.1** a) Double fire retardant flexible connections shall be provided from air discharge to outlet of air-handler to the duct.

b) Vibration isolation pads of suitable thickness commensurate to loading for isolation of vibration shall be provided under all VRV systems. in consultation with manufacturer for proper selection of vibration isolators

c) Flexible conduit connections of minimum diameter of 50mm to motors shall be provided. All loops should be large enough to allow connections to remain flexible.

d) All conduit connection where conduits are 60mm or larger shall be made of 1.2 meters minimum length conduit installed in the shape of U and grossly slack to provide maximum vibration isolation.

e) Operating clearance of 40mm shall be kept between the base and the inertia base.

f) All items suspended from false ceiling shall be isolated on separate hangers.

g) In case of ducts, conduits, pipes & tubes the annular space between construction and penetrating element shall be sealed with sand cement plaster.

h) The air-conditioning contractor shall take all other precautions or shall make his own arrangements even if not specified in the tender documents for eliminating high noise levels & shall minimize vibrations in all mechanical equipments without any additional cost.

## 3.00 MOTORISED COMBINED SMOKE & FIRE DAMPERS - SPRING RETURN TYPE

a) All supply air Ducts in AHU room crossing shall be provided with approved make fire and smoke dampers of at least 90 minutes fire rating certified by CBRI, Roorkee as per UL555:1973.

b) The fire damper blades & outer frame shall be formed of 1.6 mm galvanised steel sheet. The damper blade shall be pivoted on both ends using chrome plated spindles in self lubricating bushes. Stop seals shall be provided on top & bottom of the damper housing made of 16G Galvanised steel sheet. For preventing smoke leakage side seals will be provided.

In normal operating conditions damper blade shall be held in open position with the help of a 24 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

c) The damper shall be actuated through electric actuator. The actuator shall be energised with the help of a signal from smoke detector installed in AHU Room / R. A. Duct. The fire damper shall close due to temp. rise in S. A. Ducts through the electric temp. sensor which is factory set at 165 °F .

d) Each motorized 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 show 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 audio cum video signal in Central Control Room.

e) Damper actuator shall be such that it should close the damper in the event of power failure automatically and open in the same in case of Power being restored.

f) The fire Damper shall be mounted in fire rated wall with a duct sleeve 600 MM long. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of GI Sheet shall be 18G.

g) The damper shall be installed in accordance with the installation method recommended by the manufacturer.

h) Hinged access doors of suitable size complete with air tight gaskets shall be provided in all fire dampers & plenums.

## STANDARD SPECIFICATION OF THERMAL / ACOUSTIC INSULATION

### 3D.10 INSULATION ON SHEET METAL DUCTING

The thickness of insulation used on ducting shall be as detailed below:

**Conditioned space**

**a) Supply Air Duct 12 mm thick Closed Cell Cross Linked Polythylene (XLPE) Foam Insulated with factory Laminated Al PE Foil.**

**b) Return Air Duct 9 mm thick Closed Cell Cross Linked Polythylene (XLPE) Foam Insulated with factory Laminated Al PE Foil.**

**c) Fresh Air Duct 12 mm thick Closed Cell Cross Linked Polythylene (XLPE) Foam Insulated with factory Laminated Al PE Foil.**

**d) Plenums 12 mm thick Closed Cell Cross Linked Polythylene (XLPE) Foam Insulated with factory Laminated Al PE Foil.**

**e) FCU Collars 12 mm thick Closed Cell Cross Linked Polythylene (XLPE) Foam Insulated with factory Laminated Al PE Foil.**

The application of insulation should be carried out in workman like manner as detailed below.

## 3D.20 INSULATION OF DUCTING WITH ALUMINUM FACED FIBERGLASS

## TECHNICAL SPECIFICATIONS OF CLOSED CELL, CHEMICALLY CROSS-LINKED POLYETHLENE (XLPE) INSULATION

The insulation material for the ducts, pipe and under-deck insulation shall be Closed Cell Cross-Linked Fire Retardant Polyethlene Foam. The thermal conductivity of the material shall not exceed 0.035 w/mk at an average temperature of $40^0$c.

Thermal conductivity of the material shall not be affected by **ageing**, as per **DIN 52616**. The material must be tested for ageing effect in an accredited laboratory for a minimum period of **five years** to satisfy the **ageing** criteria.

The material must be in a **single layer upto 12 & 09 mm thickness** and not formed by laminating several layers.

The product will have bending trial and the dimensional stability as per DIN 51949 and DIN 53431 for an operating range of – $40^0$c to + $110^0$c.The density of the material shall be **33 +/- 3 kg/m$^3$ or 0.030 gm/cc.**

The material shall be rated as **Class 1**, as per BS **476 PART 7**. The rating as per **DIN 4102** shall be **B1**.The **smoke density** of the material as per **AS-1530.3** shall not exceed **1.** There shall be no toxicity in the emitted smoke, both under flaming and non-flaming conditions as per **AITM** 3.000 (1993).

The water vapour permeability, as per **DIN 52615**, shall not exceed **0.15ng/m.sec.pa**

The material shall have a fire approval from CBRI / FIRE advisor (Govt of India)/Chief fire officer.

For providing **UV** protection the insulation shall be cladded with minimum 30 micron aluminum PE foil. The cladding shall be factory finished to avoid site work. The minimum thickness will be as per specs.

The **duct** surfaces will be thoroughly cleaned prior to applying the insulation. Adhesive of suitable grade shall be uniformly applied on the insulation and cured, before sticking to the duct. The insulation can be wrapped around the duct as one piece, where size does not permit the same be cut to exact width/height of duct.

The duct /pipe insulation joints will be overlapped with a self adhesive tape of the same material. The tape shall be minimum 2.5mm thick and 50mm wide.

A self adhesive strip of same material, of suitable thickness (height), to cover the complete height of the flange will be provided around the flanges and the flange joint neatly covered with insulation, so as to reduce heat loss through flages, in addition to covering the flange connection/joint.

### 3D.22 ACOUSTIC LINING OF DUCT.

- Material shall be engineered Nitrile Rubber open cell foam
- The Random Incidence Sound Absorption Coefficient (RISAC); tested as per ISO 354, should be minimum as per enclosed chart

| Freq (Hz) | 125 | 250 | 500 | 1000 | 2000 | 4000 | NRC |
|---|---|---|---|---|---|---|---|
| 10 mm | 0.03 | 0.04 | 0.14 | 0.04 | 0.88 | 1.00 | 0.35 |
| 15 mm | 0.01 | 0.09 | 0.29 | 0.74 | 1.08 | 0.83 | 0.55 |
| 20 mm | 0.04 | 0.13 | 0.4 | 0.9 | 1.04 | 0.90 | 0.60 |
| 25 mm | 0.02 | 0.25 | 0.86 | 1.14 | 0.88 | 0.99 | 0.80 |
| 30 mm | 0.07 | 0.32 | 0.99 | 1.16 | 0.93 | 1.08 | 0.85 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 50 mm | 0.23 | 0.73 | 1.29 | 0.99 | 1.09 | 1.11 | 1.05 |

- The material should be fibre free
- The density of the same shall be within 140-180 Kg/m3
- It should have Microban®*; antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180.
- The material should have a thermal conductivity not exceeding 0.047 W/m.K @ 20 Deg. C
- The material should withstand maximum surface temperature of +850C and minimum surface temperature of -200C
- The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & UL 94 (HBF, HF 1 & HF 2) in accordance to UL 94, 1996.
- The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7).

Thickness of the material shall be as specified for the individual application. The insulation should be installed as per manufacturer's recommendation.

### 3D.23 REFRIGERANT PIPE INSULATION

a.) Refrigerant Pipe Insulation

The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be insulated with 25 mm /19 mm thick Nitrile rubber Insulation as specified in **Detailed Bill Of quantities.**

### 3D.24 DRAIN PIPE INSULATION

a.) Drain Pipe Insulation

Drain pipes carrying condensate water shall be insulated with 9 mm thick Nitrile rubber Insulation.

## STANDARD SPECIFICATION FOR AIR CIRCULATION SYSTEM

**1.0** This section deals with supply, erection, testing & balancing of GI sheet metal duct work and air registers conforming to specifications as given below:

### 2.1 MATERIAL FOR DUCTING

The duct shall be fabricated out of galvanised sheet, class VIII (Zinc coating 120 gm/m² as per the parameters given below which are conforming to IS 655-1963.

| MAXIMUM SIDE | THICKNESS | TYPE OF TRANSVERSE JOINT OF GI SHEET | BRACING CONNECTIONS |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| mm | mm | | |
| Up to 300 | 0.63 | S-drive, pocket or bar Slips, on 2.5m centers | None |
| 301 to 600 | 0.63 | S-drive, pocket or bar slips, on 2.5m centres | None |
| 601 to 750 | | S-drive, 25mm pocket or 25 mm bar slips on 2.5m centers. | 25 x 25 x 3 mm angles, 1.2m from joint |
| 751 to 1000 | 0.80 | Drive, 25-mm pocket or 25mm bar slips, on 2.5 m centres 40 x 40 mm angle connections, | 25 x 25 x 3 mm angles, 1.2 m from joint |
| 1001 to 1500 | | or 40-mm bar slips, with 35 x 3 mm bar reinforcing on 2.5 m centres. | 40 x 40 x 3 mm angles, 1.2 m from joints |
| 1501 to 2250 | 1.00 | 40 x 40 mm angle conn-ections, or 40-mm bar slips, 1 m maximum centres with 35 x 3 mm bar reinforcing . | 40 x 40 x 3 mm diagnol angles, or 40 x 40 x 3 mm angle 60 cm from joint. |

| | | | |
|---|---|---|---|
| 2250 to above* | 1.25 | 50 x 50 mm angle connections, or 40 mm pocket or 40 mm bar slips, 1 m max. centres with 35 x 3 mm bar reinforcing. | 40 x 40 x 4 mm diagnol angles, or 40 x 40 x 3 mm angles, 60 cm From joint. |

* Ducts 2250 mm and larger require special field study for hanging and supporting methods.

In addition to above the following points should be also taken into account while fabrication of ducts.

* Ducts 2250 mm and larger require special field study for hanging and supporting methods.

In addition to above the following points should be also taken into account while fabrication of ducts.

a) All ducts of size larger than 450mm shall be cross broken.

b) All ducts shall be supported from the ceiling / slab by means of wire hanger system. Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, at one end or hook or eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The system should be secured and tensioned with a Hanger self-locking grip (double channel lock) at the other end. The correct specification of wire hanger should be as per manufacturer's recommendation.

c) Wire Hangers should have been independently tested by Lloyds Register. APAVE, TUV, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002.

d) The vanes shall be provided wherever required and shall be securely fastened to prevent noise & vibration.

e) The rubber gasket shall be installed between duct flanges in all connections and joints.

f) All flanges and supports should be primer coated.

g) The flexible joints shall be fitted to the delivery side of AHU fans with Fire Retardant Double canvass. The length of flexible joints should not be less than 150 mm and not more than 300 mm between faces.

h) The ducting work can be modified if deemed necessary in consultation with the Engineer in Charge to suit actual site conditions in the building.

### 3.1 FRESH AIR INTAKE LOUVERS WITH BIRD SCREEN

The fresh air intake louvers at least 50mm deep will be made of powder coated extruded aluminum construction. Bird / insect screen will be provided with the intake louvers. The blades shall be inclined at 45 degree on a 40mm blade pitch to minimize water ingress. The lowest blade of the assembly shall be extended out slightly to facilitate disposal of rain water without falling on door / wall on which it is mounted.

The intake louvers shall be provided with factory fitted aluminum construction volume control dampers in black anodised finish.

### 4.2 PAINTING

All ducts collar / shoot behind the grills / diffuser shall be given at least two coats oil black enamel paints.

### 5.3 TESTING

The complete duct system shall be tested for air leakage & complete air distribution system shall be balanced in accordance with air quantities indicated on the approved drawing.

**Technical Specification of Pre- Insulated Ducting System**

**Pre-Insulated Rectangular Ducting:**

**SMART PIR Ducting system (Using Sandwiched Panels of Polyisocyanurate Foam between Aluminium Foils)**

The duct shall be fabricated out of sandwiched panels made up of complete CFC & HCFC Free **P**oly**I**socyanurate **R**igid **F**oam between Aluminium Foils as per the parameters given below:-

**Duct Materials Specifications**

The duct shall be fabricated out of sandwiched panels made up of Embossed Aluminum foils (With Anti-microbial, Anti-fungal, Anti Rodent, Anti-corrosion, UV Protection coating) on both sides and in between sandwiched with PIR foam. Insulating foam material shall be Expanded Rigid Polyisocyanurate Foam having closed cell content not less than 90%, Non-Toxic, Non-Combustible, Zero Ozone Depletion, Zero Global Warming Potential as per the parameters given below:

**Physical Characteristics of the panels shall be as follows:**

| **Thickness of Panels** | **Internal Ducting** | | **External Ducting** | |
|---|---|---|---|---|
| | 18 | Mm | 20 | Mm |
| **Thickness of Aluminium** | 80/45 | Microns | 45/200 | Microns |
| **Density of the Foam- Minimum** | 45 | kg/m³ | 45 | kg/m³ |
| **Finishing of Aluminium** | Embossed | Embossed | Embossed | Embossed |

**For Internal and External Ducting** 20mm Thick Panels should be used Irrespective of Duct size & Internal Stiffener to be provided for all the ducts in size 1000mm & above.

Both sides of the Aluminium foils should act as vapour barrier.

The said panel material should be test certified for **Fire Properties** by competent authority:

1) PIR Panel should Class 'O' listed from WARRINGTON FIRE or TUV or SGS according to BS 476 Part 6 & 7.
2) PIR Panel should comply with fire certificate from Underwrites Laboratories (UL).
3) PIR Panel's Flame Spread Index it should be certified for Class "A.
4) For Smoke Developed Index, it should be certified for Class "A" certification as per 'ASTM E84' and similar safety codes by relevant international authorities.
5) Toxicity Index shall less than 10.00 ppm .according to 'NES 713'.
6) Fire rating of 2 hours at 250°C by NTL, India
7) Product should be listed by TUV.
8) Panel should be BIS Certified.
9) The panel should comply Green norms to achieve net zero target.
10) Adhesive should be used of Pidilite make & should be slow drying glue where the performance is seen for last 15 years.
11) The product should comply as per EN 13403 for non-metallic ducts.

The Panel Manufacturer should additionally comply with following **Quality and Operational Standards** for not only panels but accessories also:

1) ISO 9001:2015 for Quality Management System
2) ISO 14001:2004 for Environmental Management System

**Pressure Range:**

No relevant modification of insulation, chemical or physical characteristics of the panels to be measurable, when conveying air up to the pressure of 2000 Pascal for 20 mm thick panels.

**Thermal insulation characteristics:**

Thermal insulation characteristics shall be as follows:

- Physiologically and chemically inert and insoluble.
- Vermin proof.
- Fungus proof.
- Non-Metabolisable.
- Thermal Conductivity: 0.021 W/mK at Delta 30°C.
- Water Absorption shall be less than 0.03% by 24 hours immersion test.

**Temperature Range:**

No relevant reduction of insulation, chemical or physical characteristics of the panels to be measurable, when conveying air in the temperature range of –45°C to +150°C.

**Extended Warranty on Insulation Characteristics:**

Original Panel Manufacturer should offer 12-years Warranty for the Insulation (Thermal Property) material Characteristics.

**Duct Accessories:**

All the duct accessories like duct jointing profiles, profile inserts, adhesives, sealants, tape, Special Tape, corner covers of profiles are to be used from the original Duct Panel Manufacturers only to achieve accuracy and best efficiency in construction of duct.

**Duct Fabrication and Installation Standards:**

The ducts shall be fabricated as per the drawing provided and should be supplied at site in Pre-Cut form (Cut on CNC Machine only) and should be boxed at site complete with all suitable joint fittings & profiles, inserts, using proper adhesive and sealing arrangements etc.

Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer – In – Charge.

For Duct sizes below 400mm shiplap joints with adhesive would be used covered with special reinforced tape and tiger clamp from top.

**Governing Standards:**

Unless otherwise specified here, all duct work shall be provided with adequate pre- fabricated hangers or support and to prevent vibrations.

All ducts shall be supported from the ceiling/ slab/ Purlins by means of fully threaded GI rods of 6mm diameter, with suitable capacity GI Slotted Channel or through Wire Supporting Systems supplied by Manufacturer.

**Installation Supervision:**

Installation to be carried out by Manufacturer's trained Installation team and shall be Supervised & Certified by the Manufacturer's representative.

**Joint System:**

The joints between the ducts shall be using polymer invisible flanges and slide-in-channel (Patented) to be used and to be connected by special cover corners, having a holding pin, which goes inside the flange and the insulation, to avoid any field connection and to give the system more strength.

Ductwork shall be installed, using supports, as described in DW144 & according to manufacturer's requirements. Maximum distance between supports shall not exceed:

- 4000mm for ducts with section not exceeding 1200 x 1000mm.
- 2000mm for ducts with section exceeding 1200 x 1000mm.

All duct work shall be of high quality approved PIR Sheets guaranteed not to crack or peel on bending or fabrication of ducts. Care should be taken at site so that the Aluminum foil covering the panel is maintained intact during Installation to ensure Vapour Barrier continuity.

All joints shall be air tight and shall be made in the direction of air flow. All duct joints shall be inserted with exact size cut inserts to suit the profiles and corners should be covered with PVC corners.

For Duct sizes below 400mm shiplap joints with adhesive would be used covered with special reinforced tape and tiger clamp from top.

For External Duct patented bayonet to be used between the joining profiles with special reinforced tape to cover on the joints.

Fixing of Pre-Insulated Ducts with various ducting items like Volume Control Dampers or Fire dampers etc. shall be done using Polymer Flanges of the desired type of manufacturer's make only.

**Reinforcements:**

Appropriate number of internal stiffeners of Threaded Rod, Nut and Bolt and load-distribution GI Discs for very large ducts are provided.

For positive pressure (supply ducts) and for negative pressure (return ducts) load distributing GI Discs are placed externally and internally for better strength.

Reinforcements will be fixed perpendicular to the larger duct dimension. These will be installed on ducts exceeding 1000 mm W/H any dimension, as per following spacing.

1200 – 1500 – 1 No x 1/2 - 1/2

1500 – 1800 – 2 Nos x 1/4 – 1/2 -1/4

1800 – 2100 – 3 Nos x 1/6 – 1/3 – 1/3 – 1/6

2100 – 2400 – 4 Nos x 1/8 – 1/4 – 1/4 – 1/4 – 1/8

However, as per site requirement and constraints, certain duct pieces can be fabricated and made at site using the same above standards to suit pieces.

Great care should be taken to ensure that the ducting work does not extend outside and beyond height limits as noted on the drawings.

The ducting work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer – In – Charge. The contractor shall verify all measurements at site and shall notify the Engineer – In – Charge. All duct measurements to be done on outer to outer size.

## STANDARD SPECIFICATION ON REFRIGERANT PIPING WORK

This section deals with supply, installation, testing & commissioning of refrigerant piping as detailed below in specifications.

### 1.10 REFRIGERANT PIPING

All refrigerant piping for the air conditioning system shall be constructed from soft seamless up-to 19.1mm and hard drawn copper refrigerant pipes for above 19.1mm with copper fittings and silver-soldered joints. The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. Before 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.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 20Kg per sq.cm and 10 Kg per sq.cm (low side). Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum if 700mm hg and held for 24 hours.

The air-conditioning system supplier shall be design sizes and erect proper interconnections of the complete refrigerant circuit.

The thickness of copper piping shall not be less than 20gauge for pipes up to 19.1mm and 18 gauge for bigger sizes

The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturers specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure 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.

The OD wall thicknesses & wall thickness size of Copper refrigerant piping shall be as follows:

| | **Outside Diameter (mm)** | **Wall Thickness (mm)** |
|---|---|---|
| a) | 41.3 | 1.43 |
| b) | 34.9 | 1.21 |
| c) | 28.6 | 1.00 |
| c) | 22.2 | 0.80 |
| d) | 19.1 | 0.80 |
| e) | 15.90 | 1.00 |
| f) | 12.70 | 0.80 |
| g) | 9.5 | 0.80 |
| h) | 6.4 | 0.80 |

**For Drain Pipe - UPVC Pipes-**Providing and fixing in position UPVC plumbing pipes of APPRVED 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.

25/ 32 mm dia UPVC plumbing pipe line laid complete

## STANDARD SPECIFICATION OF MOTOR CONTROL CENTRE (MV PANEL), AHU SUB-PANEL, POWER & CONTROL CABLING

**1.00** This section deals with supply, installation, testing & commissioning of Motor Control Centre (MV panel) & shall be manufactured by CPRI approved venders. The power / control cabling & earthing work shall be carried out as per the specification given below:

## 1.10 SCOPE

All work shall confirm to CPWD specification, 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 armored multicore cables as specified in B.O.Q.

## 1.20 MOTOR CONTROL CENTRE (MV PANEL)

Motor control centre (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 sectionalised 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 provided for holding the cables in position.

All power/control wiring inside the panel shall be colour 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.

## 1.30 BUS-BARS

The bus-bar and its connections shall be aluminum Electrolytic grade E-91 as per IS: 5082 and shall be of rectangular section. The amperage capacity of aluminium bus bar shall 1A / 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 colour 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 moulded 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.

**1.40 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.

**1.50 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.

**1.51 OVERLOAD RELAYS**

All the motors shall have overload relay protections conforming to relevant IS.

**1.52 TIME DELAY RELAYS**

These shall be adjustable type with time delay adjustments of 0-180 or as per manufacturers standards.

## 1.53 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 filament type and with very low burden & economy resistor.

## 1.54 VOLTMETER AND AMMETERS

Motor Control Centre (MV Panel) shall have flush type voltmeter & ammeter of size 96 x 96 mm as detailed in B.O.Q.

## 1.55 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/equipments as per normal practices. The contacts shall be suitable for 6AMP current capacity.

## 1.56 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.

## 1.57 CABLES

These shall be PVC insulated, pre-sheathed, aluminum conductor armoured 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.

## 1.58 LAYING OF CABLES

These shall be laid as Indian Standard code of practice. All cables shall be laid on **16G Cadmium Plated U shaped Channel** 40mm x 20mm 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.

## 1.59 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 coloured beads shall be provided for easy identification in control wiring. The minimum size of control wiring shall be 1.5sq.mm. Testing of panels as per code of practice shall be done at works by AC contractor before inspection & dispatch to site.

## 1.60 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.

## 1.61 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.

## 1.62 PAINTING OF PANELS

All sheet metal enclosures shall be powder coated only after de-rusting & hot-dip phosphating degreasing etc. at works only.

**NOTE**: Rubber mats of 1100 volts shall be laid in front of all switch boards as specified in BOQ.

## 1.70 SIZES OF POWER CABLING

The following size of power cabling shall be used only:

| | **HP of Motors** | **Cable size** |
|---|---|---|
| a) | Up to 5 HP | 3c x 4 sq.mm aluminium conductor armoured cable. |
| b) | 5 to 7.5 HP | 3c x 6sq.mm aluminium conductor armoured cable. |
| c) | 10 to 15 HP | 2no. 3c x 6sq.mm aluminum conductor armoured cable. |

d) 20 to 25 HP 2 nos. 3 x 16sq.mm aluminum conductor armoured cable.

e) 30 to 35 HP 2 nos. 3c x 25sq.mm aluminum conductor armoured cable.

f) 40 to 50 HP 2 nos. 3c x 35sq.mm aluminum conductor armoured cable.

g) 60 HP 2 nos. 3c x 35sq.mm aluminum conductor armoured cable.

h) 75 HP 2 nos. 3cx 50sq.mm aluminum conductor armoured cable.

## 1.71 CAPACITY OF RELAYS AND CONTACTS

The following capacity relays and contacts shall be used for various rating of motors:

**Type of Starter Contactor Overload Relay**

| | | | **Current** | **Phase Relay Range** |
|---|---|---|---|---|
| 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. |

## 1.72 EARTHING

The earthing of all equipments shall be carried out by Copper strips / wires as mentioned in **Bill of Quantities.** 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 equipments after removal of paint, grease etc.

**END OF SECTION**