TECHNICAL SPECIFICATIONS

Electrical and Allied works

#### INTERNAL WIRING:

##### System of Wiring:

The system of wiring shall consist of PVC insulated copper stranded conductor flexible FRLS wires in metallic/ non metallic (Rigid heavy Duty ISI -marked fire retarded PVC Conduits of minimum 2mm Wall thickness and Sizes starting from 20 mm diameter) conduits and shall be concealed or surface mounted above false ceiling as called for.

##### General:

Prior to laying and fixing of conduits, the contractor shall mark the conduit route, carefully examine the working drawings prepared by him and approved by the Consultant indicating the layout, satisfy himself about the non interference in the route, sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found shall be brought to the notice of the Owner’s site representative. Any modifications suggested by the contractor should get written approval before the actual laying of conduits is commenced.

In laying of conduits it is important that not more than two right angle bends are provided for each circuit without a pull box. No junction box shall be provided in the entire length of conduit run for drawing of wires. Only switch outlets, lighting fixture outlets, equipment power outlets and socket outlets shall be considered for drawing of wires.

##### Metal Conduits & Accessories:

* + 1. **Conduits:**

Conduits and Accessories shall conform to latest edition of Indian Standards IS-9537 part 1 & 2. 16/14 (16 gauge upto 32mm diameter & 14 gauge above 32 mm diameter) gauge screwed GI or MS conduits as specified on schedule of quantities shall be used. Joints between conduits and accessories shall be securely made by standard accessories, as per IS-2667, IS-3837 and IS-5133 to ensure earth continuity. All conduit accessories shall be threaded type only.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

**Note:** Whatever materials required to be billed by the Contractor should come on site with proper Challan Numbers and quantity mentioned in each such Challan.

##### Joints:

All jointing shall be subject to the approval of the Owner’s site representative. The threads and sockets shall be free from grease and oil. End termination of conduit on GI boxes shall be by means of hexagon check nuts & spring

washer on both sides of the conduit. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits. Rubberised bushes shall be used in the conduit entry and exit from DBs, switch boxes etc, so that wires are protected from damage to insulation of the incoming and outgoing wires

##### Recessed or Exposed Conduits:

All conduits shall be as per Schedule of Quantities.

##### Flexible Conduits:

Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip to have interlocking to avoid opening up. Flexible conduit shall be heat resistant, lead coated steel, water leak, fire and rust proof. The flexible conduit shall be heat resistant on continuous temperature upto 150 deg. C and intermittent temperature upto 200 deg. C. The flexible conduit shall be corrosion resistant as per IS-3480 & BS-731.

##### PVC Conduit and Accessories: PVC Conduit

Conduits and accessories shall conform to latest edition of IS-9537 part 3 and shall be heavy duty with minimum wall thickness of 2.0 mm rigid tubes which are unscrewed without coupling and with plain ends. All conduits used shall be ISI-marked and shall not be less than 20 mm diameter.

. PVC conduit shall be used for all concealed/ embedded installation.

##### PVC Conduit Accessories

Accessories used for conduit shall be of an approved brand and type complying to relevant IS code.

All accessories used shall be of standard white or black colour, identical to conduit used.

Plain conduits shall be jointed by slip type of couplers with manufacturer’s standard sealing

cement.

All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and screwed male bushes.

PVC-switch and socket boxes with round knockouts are to be used. The colours of these boxes and the conduits shall be the same.

Standard PVC circular junction boxes are to be used with conduits for intersection, Tee- junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.

Samples of accessories shall be submitted for approval prior to installation.

All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

##### Bends in Conduit:

Where necessary, bends or diversions may be achieved by means of bends and/ or circular cast iron boxes with inspection cover and with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 7.5 cms or three times the outside diameter of the conduits. For metallic conduits, bends of defined radius shall be made by compactly filling fine sand inside the conduit length, to avoid non- uniform shape, once the bend is done. Proper jigs shall be used to ensure that the Enameling/ Galvanising of the Conduit is not damaged.

##### Fixing of Conduits:

All conduits, shall be installed so as to avoid exposure to steam, hot water or any other process pipes. After the conduits, junction boxes, outlet boxes and switch boxes are installed in position, their outlets shall be properly plugged or covered so that water, mortar, rodents and insects, insects or any other foreign matter does not enter into the conduit system. Surface conduits shall be fixed by means of heavy gauge GI saddles secured at intervals not more than 1000 mm and on either side of couplers or bends or similar fitting saddles shall be fixed at a distance of 300 mm from centre of each fitting. For conduit fixing suitable PVC/ Nylon fasteners shall be used.

Recessed conduiting shall be done by making chase in the masonry by chase cutter, the conduit shall be fixed in the chase by means of GI hooks not more than 600 mm apart. After fixing of conduit the chase shall be filled with cement mortar after fixing of chicken mesh and brought to the original finish level of the surface to the entire satisfaction of Owner

##### Switch outlets and Junction Boxes:

All outlet boxes for switches, sockets and other receptacles shall be rust proof and shall be of

1.6 mm thick mild steel sheets with HOT dipped galvanizing (or as specified in SOQ), having smooth external and internal surfaces to true finish. All outlet boxes for receiving plug sockets and switches shall be fabricated to approved sizes. All boxes shall have adequate number of knock out holes of required diameter and earthing terminal screws. Outlet boxes shall generally be of 50mm depth subject to maximum depth of 65 mm.

##### Inspection Boxes:

50 mm dia inspection boxes and pull boxes shall have smooth external and internal finish to facilitate removal and replacement of wires, where required.

##### Fish Wire:

To facilitate subsequent drawing of wires in the conduit, GI fish wires of 2.0 mm (14 SWG) shall be provided along-with the laying of recessed conduit.

##### Conductors:

All PVC insulated copper conductor flexible FRLS or ZHFR, as specified in SOQ, wires shall conform in all respects to Standards as listed under sub-head Indian Standards and shall be IS approved and ISI marked.

##### Bunching of Wires:

Wires carrying current shall be so bunched that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not run in the same conduit. All wires shall have ferrules for identification. Lighting and power circuits shall be separate. Each Power/ Light Circuit‘s Neutral shall be individual per Circuit and shall not be looped from any other Circuit.

##### Drawing Conductors:

The drawing and jointing of PVC insulated copper conductor wires shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends. Wire reel stands to be used for pulling of wires to avoid kinks. Care shall be exercised while drawing the wires from reels, by taking appropriate measures to ensure that wires are not spread on ground, causing dust and dirt accumulation on the new wires.

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into metallic Conduits are given below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Size of wires Nominal Cross**  **Section Area (Sq. mm.)** | **Maximum number of wires within conduit size (mm)** | | | | |
| **20** | **25** | **32** | **40** | **50** |
| 1.5 | 5 | 10 | 14 | -- | -- |
| 2.5 | 5 | 8 | 12 | -- | -- |
| 4 | 3 | 7 | 10 | -- | -- |
| 6 | 2 | 5 | 8 | -- | -- |
| 10 | -- | 3 | 5 | 6 | -- |
| 16 | -- | 2 | 3 | 6 | 6 |
| 25 | -- | -- | 2 | 4 | 6 |
| 35 | -- | -- | -- | 3 | 5 |

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or PVC Conduits are given below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Size of wires Nominal Cross**  **section Area (Sq. mm.)** | **Maximum number of wires within conduit size (mm)** | | | | |
| **20** | **25** | **32** | **40** | **50** |
| 1.5 | 7 | 12 | 16 | -- | -- |
| 2.5 | 5 | 10 | 14 | -- | -- |
| 4 | 4 | 8 | 12 | -- | -- |
| 6 | 3 | 6 | 8 | -- | -- |
| 10 | -- | 4 | 5 | 6 | -- |
| 16 | -- | 3 | 3 | 6 | 6 |
| 25 | -- | -- | 2 | 4 | 6 |
| 35 | -- | -- | -- | 3 | 5 |

Insulation shall be removed by insulation stripper only. Few Strands of wires shall not be cut/ reduced for convenience in connecting into terminals. The terminals shall have sufficient cross sectional area to take all strands and it’s connecting brass screws shall have flats ends. All looped joints shall be connected through terminal block/ connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. All light points shall be terminated through a connector.

Condutors having nominal cross sectional areas exceeding 10 sq.mm shall always be provided with cable sockets. At all bolted terminals brass flat washer of large area and approved steel spring washer shall be used. Brass nuts and bolts with brass washers shall be used for all connections.

Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring licence to Owner) and cable jointers shall be employed to do jointing work. Before entrusting cable jointing work to any technician, or before appointing Cable Jointers or Wiremen on Site, Contractor has to submit such Technicians’/ Wireman’s/ Cable Jointer’s licence to Owner.

All wires and cables shall be embossed with the manufacturer’s label with ISI mark and shall be brought to site in original packing. For all internal wiring. PVC insulated wires of 1100 volts grade (FRLS) shall be used.

The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. No wire shall be drawn into any conduit until all defective work of conduit installation of any nature that may cause injury to wire is completed. Care shall be taken while pulling out the wires so that no damage occurs to conduits/ wire itself, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. The minimum size of PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 2.5 sq.mm copper. Separate neutral to be pulled for each circuit.

##### Joints:

All joints shall be made at main switches, distribution boards, socket outlets, lighting outlets and switches boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to inlet.

##### Mains and Sub-Mains:

Mains and sub-mains cable or wires where called for shall be of the rated capacity and approved make. Every main and sub main wires shall be drawn into an independent adequate size of conduit. Earthing shall be in conformity with relevant IS codes and calculations shall be submitted for verification. An independent earth wire of the proper rating shall be provided for every single phase sub-main. For every 3 -phase sub-main, 2 Nos. earth wires of proper rating shall be provided along-with the sub-main. The earth wires shall be drawn along with circuit wires through conduit. Where mains and sub-mains cables are connected to switchgear, sufficient extra lengths of cable shall be provided to facilitate easy connections and maintenance. Where ever necessary, powder-coated 1.6 mm thick sheet steel covering (also called trunking) shall be provided to cover the group of conduits and cables entering and exiting the Wall mounted/ Floor mounted SubDBs, DBs, and FDBs, so that the Installation looks neat. The colour of such sheet steel covering (trunking) shall be matching with the colour of the SDBs, DBs and FDBs

##### Load Balancing:

Balancing of circuits in three phase installation shall be as planned by the Consultants in the tender drawings and shall be checked by the contractor before the commencement of wiring and shall be strictly adhered to.

##### Colour Code of Conductors:

Colour code shall be maintained as indicated by the Consultant for the entire wiring installations. Red, yellow, blue shall be for three phases, black for neutral and green with yellow band shall be for earthing.

#### (A) SWITCHES, RECEPTACLES (MODULAR), LIGHTING FIXTURES & LIGHTING CONTROL EQUIPMENT:

##### Switches:

All switches shall be enclosed type flush mounted suitable for 240 volts AC. All switches shall be fixed inside the switch boxes on adjustable flat MS strips/ plates with tapped holes and brass machine screws, leaving ample space at the back and sides for accommodating wires. Switch controlling the light point shall be connected to the phase wire of the circuit and load on

each switch shall be restricted to maximum **800 watts & maximum 1500 watts per circuit**. All wiring accessories shall be BIS approved. Perfect alignment shall be maintained while fixing of the back boxes.

##### Socket Outlet

Socket outlets shall be of the three pin. The switch controlling the socket outlet shall be on the phase wire of the circuit and not more than two socket outlets of 16 amps shall be connected on one circuit. An earth wire shall be provided along-with the circuit wires and shall be connected to earthing screw inside the box. All sockets shall be shuttered type.

* + 1. Every socket outlet shall be controlled by an individual switch unless mentioned otherwise.
    2. The switch controlling the socket outlet shall be on the `Live’ side of the line.
    3. 6 amps and 16 amps socket outlet shall normally be fixed at any convenient height above the floor level as desired by the Architect. The switch for 6 and 16 amps, socket outlet shall be kept alongwith the socket outlet. However, in special case, if desired by the Architect the 6 amp. socket outlet can be placed at the normal switch level.

16 amps socket outlet in the kitchen of the residential or commercial buildings shall be fixed at any convenient height above working platform or as specified in drawings/ schedule of equipments.

In a room containing a fixed bath or shower, there shall be no socket outlet and there shall be no provision for connecting a portable appliance. Any stationary appliance connected permanently in the bath room shall be controlled by an isolator switch or circuit breaker having outlets at such location where water/ moisture does not effect. Generally, switches and outlets shall be planned at a minimum distance of 1.5 Metre away from any water supply outlet, so that splashed water may not affect the live installation.

* + 1. Where socket outlets are placed at lower level, they shall be enclosed in a suitable metallic box with the system of wiring adopted or shutter type sockets shall be provided as specified.
    2. In an earthed system of supply, a socket outlet and plug shall be of three pin type, the third terminal shall be connected to earth.
    3. Conductors connecting electrical appliance with socket outlet shall be flexible twin cord with an earthing cord which shall be secured by connecting between the earth terminal of plug and the metallic body of the electrical appliance.
    4. Where use of shutter type of interlocking type of socket is required for any special installation, the items should be separately and specifically listed in the Schedule of Quantities of that particular work.

##### Lighting Fixtures & Accessories:

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

##### Scope:

Scope of work under this section shall include inspection at suppliers/ manufacturer’s premises at site, receiving at site, safe storage, transportation from point of storage to point of erection, erection and commissioning of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting etc as required.

##### Standards:

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc., shall comply with the latest applicable standards, more specifically the following:

General and safety requirements for Luminaires:

Part-1 Tubular flourescent lamps - IS – 1913 (Part-1) Industrial lighting fittings with metal reflectors - IS - 1777 Decorative lighting outfits - IS - 5077

Bayonet lamp holders - IS - 1258

Bi-pin lamp holders for tubular fluorescent lamps - IS - 3323 Electronic Ballasts for fluorescent lamps –

General & Safety requirement - IS – 13021 (Part-1)

Electronic Ballasts for fluorescent lamps –

Performance requirement - IS – 13021 (Part-2)

Ballast for HP MV lamps - IS - 6616

Tubular Fluorescent lamps - IS - 2418 (Part-1 to 4)

Luminaries – General requirement - IS – 10322 (Part-1) Luminaries – Constructional requirement - IS – 10322 (Part-2) Luminaries – Screw and Screwless termination - IS – 10322 (Part-3) Luminaries – Methods of Tests - IS – 10322 (Part-4) Particular requirement – General purpose Luminaries - IS – 10322 (Part-5/Sec-1) Particular requirement – Recessed Luminaries - IS – 10322 (Part-5/Sec-2)

Particular requirement – Luminaries for Road and

Street lighting - IS – 10322 (Part-5/Sec-3)

Particular requirement – Portable General purpose

Luminaries - IS – 10322 (Part-5/Sec-4)

Particular requirement – Flood Lighting - IS – 10322 (Part-5/Sec-5) High pressure mercury vapour lamps - IS – 9900 (Part-1)

Tungsten filament general electric lamps - IS - 418

##### Light Fittings-General Requirements:

* + - 1. Fittings shall be designed for continuous trouble free operation under atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Degree of protection of enclosure shall be IP-65 for outdoor fittings except bulkhead fitting. Bulkhead fitting shall be provided with IP-54 protection.
      2. Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps/ ballasts.
      3. All fittings shall be supplied complete with lamps. All mercury vapour and sodium vapour lamp fittings shall be complete with accessories like ballasts, power factor improvement capacitors, starters, etc. Out door type fittings shall be provided with weather proof junction boxes (IP-55) and IP-54 Control gear boxes. All fluorescent and CFL fittings shall be provided with electronic ballast as per schedule of quantities.
      4. Each fitting shall have a terminal block suitable for loop-out connection by 1100 V PVC insulated copper conductor wires upto 4 sq.mm. the internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.
      5. All hardwares used in the fitting shall be suitably plated or anodized and passivated.
      6. Earthing: Each lighting fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of the housing shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.
      7. Painting/ Finish: All surfaces of the fittings shall be thoroughly cleaned and degreased and the fittings shall be free from scale, rust, sharp-edges, and burns.
      8. The housing shall be powder coated/ stove-enamelled or anodised as required. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 12 mm dia mandrel.
      9. Metal used in BODY of lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with specification of standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burns and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.

##### Light Fittings – Special Requirements: Box Channel Type Industrial Fittings

Box type slim line channel must be in screwless construction manufactured from M.S. CRCA sheet steel powder coated with MS CRCA cover, powder coated white. Light reflection surface in Box/ Channel type fittings shall be in a POLYESTER PRECOATED STEEL having a reflection factor of not less than 80%. SCREWLESS DESIGN & CONSTRUCTION Light fixtures shall be preferred due to their ease of maintenance, especially for box/ channel for box/ channel type fixtures.

##### Moisture Proof Industrial Fittings

Surface mounted totally enclosed moisture proof fixtures must be in polycarbonate body and diffuser with transparent prismatic interior and smooth exterior and frosted end. Fixture must be completely sealed with polyerethane double gasket to achieve IP 65 protection. Fixture is complete with CRCA steel white powder coated/ enameled finish reflector.

##### 18 W/ 36 W Fluorescent and 36 W CFL Low Glare Light Fittings:

Recessed mounted, modular fluorescent lighting fixture made of CRCA Sheet steel powder coated (white) housing, electro chemically brightened and anodised reflector, three dimensional cross louvers with concave contours, fresnel top at louver saddle to increase efficiency. The luminance of <200 cd/M2 at 63 degree viewing angle in all directions so as to confirm Cat-2 classification of CIBSELG3

##### Highbay Industrial Fittings:

Industrial Highbay luminaries shall be provided with pressure die cast housing along with all accessories, orthocyclically woundopien construction ballast, capacitor & semi parallel ignitor connected to terminal block and mounted on the gear plate. The gear shall have side entry for ease in maintenance. The spun aluminium reflector is suitable for narrows well as wide beam distribution as specified in schedule of quantities. The luminaire will be suitable for metal halide lamp HPI BU + 250 W which has 25500 lumens or similar 400W lamp and 2.5 minutes restrike time (when operate with son gear).

##### Accessories for Light Fittings - Reflectors:

The reflectors shall be made of CRCA sheet steel/ aluminium/ Silvered glass/ Chromium plated sheet copper as specified. The thickness of reflectors shall be as per relevant standards. Reflectors made of steel shall have stove enameled/ vitreous enameled/ epoxy coating finish. Aluminium used for reflectors shall be anodized/ epoxy stove enameled/ mirror polished. The finish for the reflector shall be as specified. The reflectors shall be free from scratches/ blisters and shall have a smooth and glossy surface having optimum light reflecting coefficient. Reflectors shall be readily remova- ble from the housing for cleaning and maintenance without use of tools.

##### Lamps:

**TLD**

Lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 5 mg. The lamp shall have minimum lumen maintenance of 85 and CRI of 85. The lamp must comply to ROSH (Restriction of Hazardous substances) and covered by WEEE. Lamp should be fully re-cyclable. The lamp should be low on maintenance with life of 40 K hours in case of electromagnetic ballast and 65 K hours in case of HF ballast upto 10% failure. The discharge glass shall be lead free.

TLD Lamps shall be minimum tri-phosphor type and have bi-pin bases. Colour spectrum of light shall be equivalent to “PHILIPS color 84 or color 86 color 82 or “OSRAM color 21 or color 11 or color 41 (as required at site)”.

The fluorescent Tubes (TLD) should have cool daylight colour designation. But Architects reserve the right to prescribe either Cool Daylight or Bright White or Incandescent Colour Designations for TLD. NO extra payment will be made over the quoted rate of bidder for this. The 36 W fluorescent tubes will have Nominal Luminous Flux of not less than 3350 lumens whether so mentioned in the Schedule of Quantities or not.

##### T 5 – High Efficiency ECO-Friendly Lamps

T-5 lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 3 mg. lamp should have lowest CO2 emission compared to any other comparable light source (40% less than a TL-D

standard lamp, 26% less than TL-D/ 80). T-5 lamp shall be 100% lead free. T-5 lamp shall be designed for operation with electronic gear and well suited for dimming. Maximum lumen output to be reached at approx 35oC in free burning position. T-5 lamp can be ignited from -15oC to + 50oC. Lamp should be fully recyclable and must comply to ROSH (Restriction of Hazardous substances) and shall be covered by WEEE. T-5 shall have 16 mm in diameter service life of TL-5 lamp should be 10% more than TL-D lamps. T-5 lamp shall have lumen efficacy of up to 104 Lumens/ W and shall have excellent colour rendering to En 12464 (Ra 80 to 89).

Compact fluorescent lamp shall have same luminous flux and power consumption as fluorescent tubes but less than half the length and more compact than U-shaped and circulator lamps. CFL shall be suitable for use with conventional control gear & standers and for HF electronic control gear. CFL lamp shall be non integral type of OSRAM/ GE/ PHILIPS/ Havells Sylvania only.

##### High Frequency Electronic Ballast:

High frequency electronic ballast shall be used with fluorescent/ Compact Fluorescent Lamps wherever specified in the schedule of quantities. High frequency electronic ballast shall comply to the following:

* IEC 927, IEC 928 for ≤10% total harmonic distortion.
* EMI/ RFI – Confirming to FCC/ VDE Class A/B.
* Line Transient as per IEEE C62.41.
* Ballast Crest Factor C1.7%.
* No Stroboscopic Effect
* Constant Wattage/ Light output between 240 V ± 10%.
* Circuit protection for surge current and inrush current.
* Short circuits, open lamp protection
* PF > 0.99 for fluorescent/ T5 lamp and 0.95 for CFL.
* Deactivated lamp protection
* Suitable for use with single and twin lamps
* RFI < 30 MHz EN 55015
* Total Harmonic Distortion (THD) ≤10%
* Immunity to interference EN 61547
* Safety EN 60928/ IEC 928/ IS 13021 (Part I)
* Performance EN 60929/ IEC 929/ IS 13021 (Part II)
* Vibrations & Bump tests IEC 68-2-6 FC IEC 9001
* Quality Standard ISO 9001
* Environmental Standard ISO 14001
* DC Operation EN 60924
* Emergency Lighting Operation VDE 0108 Total System consumption (lamps + ballast) for

1 x 36 W TLD, shall not exceed 36 W 1 x 28 W T-5, shall not exceed 28 W 1 x 35 W T-5, shall not exceed 35 W 1 x 14 W T-5, shall not exceed 14 W 1 x 18 W CFL, shall not exceed 18 W 1 x 36 W CFL, shall not exceed 36 W

##### Lighting Control Equipment:

**2.4.1 General:**

The lighting control system shall be centralized or decentralized based on a project requirement every device should be microprocessor based, addressable entity

##### Light Level Sensor

The Light Level Sensor shall be capable of measuring ambient light levels in the range of 20 to 3000 lux (40 lux to 1600 lux controllable).

The ambient light level shall be measured by the Light Level Sensor and output devices (such as Dimmer Units) shall be controlled to maintain constant luminance in a given area, under varying conditions.

The target luminance level as well as the Margin shall be set using the control system Installation Software.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The field of View of the light level sensor shall be 180 degrees.

The Supply Voltage to each light level sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required.

The light level sensor shall have an operating temperature range of 0-50 Degree C.

##### Temperature Sensor:

The Temperature Sensor shall be suitable for measuring ambient temperature and issuing on or off commands to one (1) group address for heating or cooling purposes. The unit shall measure in the range 0 - 50 degree C with selectable offset (dead-band) within the installation software

The Temperature Sensor shall have the ability to change its target temperature to a different point (and to reset the target) by receiving bus commands from another system devices.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Supply Voltage to each Temperature Sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required.

##### PIR Occupancy Sensor:

The PIR Occupancy Sensor shall detect passive infrared energy for control of any number of independent electrical loads. The light level shall be adjustable from the front of the unit and shall be used to disable the Occupancy Sensor. Timer settings shall be adjustable from 1 second to 18 hours, in one-second increments. A weatherproof version shall be available for outdoor or industrial use.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Supply Voltage to each PIR Sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required for the unit to operate.

The unit shall have suitable operating temperatures between 0-50 Degree C.

The unit shall be suitable for wall or ceiling mounting, up to mounting heights of 2.4m.

The Indoor unit shall have a field of view of 90 degrees. The outdoor unit shall have a field of view of 110 degrees.

The Indoor unit shall have an effective detection area of 6m x 6m. The outdoor unit shall have an effective detection area of 18m radius x 110 degrees.

The Indoor unit shall have 12 overlapping detection zones. The outdoor unit shall have 18 long range, 16 intermediate range, 10 short range and 4 ultra short-range detection zones.

##### Ultrasonic Occupancy Sensor:

The unit shall be an active device utilizing Doppler wave technology as its means of detection. The unit shall include two air transducers to provide volumetric occupancy detection.

The unit shall be suitable for occupancy detection of larger areas, typically 12m x 12m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit will have easily accessible sensitivity adjustment that can be used to accommodate various room sizes.

The unit will have an indicator LED for walk-testing the unit.

The unit shall be ceiling mounted and a 360-degree field of view. The unit shall utilize an ultrasonic frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50 Degree C.

##### Combined Technology Ultrasonic/ PIR Occupancy Sensor:

The unit shall consist of two air transducers and four PIR detectors with a special lens to provide both volumetric and line of sight detection.

The unit shall be suitable for occupancy detection of larger areas, typically 15m x 15m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit shall be ceiling mounted and a 360-degree field of view.

The unit will have easily accessible sensitivity adjustment that can be used to accommodate various room sizes.

The unit will employ programmable walk-testing LED indicators: Red LED for Passive Infrared and Green LED for Ultrasonic modes.

The unit shall utilize an ultrasonic frequency of 32.7 kHz.

##### Ultrasonic Occupancy Sensor for Corridors and Hallways:

The unit shall be suitable for occupancy detection of Corridors and Hallways, typically up to 4.6m x 30m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit shall be ceiling mounted and a 360 degree field of view. The unit will have an indicator LED for walk-testing the unit.

The unit shall utilize an ultrasonic frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50 Degree C.

##### Lighting control modules for On/ Off switching shall be:

DIN rail mounted consisting of two (2), four (4) or eight (8) or (12) individually programmable integral relays (contactors). The relay shall guarantee a life of >100000 switch operations as per IEC 60947. Relay modules requiring external 220V supply in addition to bus connection shall not be acceptable.

The output states of each of these relays shall be displayed on the front via true mechanical indication. LED status indicators shall not be acceptable. Each of these relays shall be latch-on type with manual operation (override) possible even without power to the system & without having to remove the cover of the control module.

In the event of power failure or bus wiring failure or control module failure, each of the relays shall attain a pre-programmed fail-safe position (‘On’, ‘off’ or ‘as it is Last status’) at the time of commissioning.

The actuators shall be with integrated current detection feature. This functionality shall allow for the monitoring of the load current and operating hours for load management. It shall be possible to set threshold values of the current in order to detect any lamp failures for facilities management.

The control modules shall be capable of being programmed with different applications to suit site requirements for e.g. staircase lighting function that switches ‘Off’ the relays after a preprogrammed time from the time it has switched ‘On’. The application for which a relay has been programmed shall apply irrespective of the signal from which it is controlled.

Each of the relays shall be capable of being programmed with its own ‘On’ and ‘Off’ delays that shall be applicable irrespective of the signal from which the relays are controlled.

The control modules shall receive its operating power supply from the same bus cable without any other power supply. It should not operate on any 220/ 240 V AC supply to avoid possible fire hazards. Relay modules with additional power supply to feed other devices in the network shall not be acceptable.

There shall be DIN rail mounted Dimmer modules to allow for dimming of the related lighting loads. The Dimmer modules shall be shall be selected in accordance with the type of light fittings to allow dimming of all type of light

##### Wall mounted motion sensor:

Sensor angle – 180°, mounting height ~ 1.1 m.

Range: frontally up to 12 m, laterally up to 8 m (upon tangential approach). Mounting height: (1.1-2.5 m), providing a larger detection zone (max. 10 x 15 m).

##### Ceiling mounted Presence detector:

The sensor shall be able to control up to 29 different EIB group addresses Sensor angle 360°.

Detection range at 2.50 m mounting height: 6 m in dia. at a height of 1 m

Adjustable brightness 5 to 1000 Lx

Product standard EN 60669-2-1

##### Wall/ Ceiling mounted motion sensor:

Surveillance zone: 220° horizontal

Maximum range: approximately 16 m

(at installation height of 2.5 m and horizontal lignment)

Surveillance density: 92 sectors/ 368 switching segments n Dusk brightness sensor: 0.5 – 1000 lux

Delay time: 10 sec – 32 min Slewing range

Horizontal: +- 30°

Vertical: 90° upward; 40° downward Operating temperature range -25 °C to 55

#### MEDIUM VOLTAGE 1.1 KV GRADE XLPE/ PVC CABLES:

##### General:

The MV cables shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, Specifications, relevant Standard Specifications and cable manufacturer's instruction.

##### Material:

The MV cables shall be cross linked polyethylene (XLPE) insulated PVC inner sheathed and HR PVC/ FRLS PVC outer sheath of 1100 volts grade as asked for in the schedule of quantities. Cables upto 6 sq.mm shall be with copper conductor and 10 sq.mm and above shall be with aluminium conductor.

##### Technical Requirements:

* + 1. All XLPE Aluminium/ Copper Power cables shall be 1100 Volts grade, multi core constructed as per IS : 7098 Part-I of 1988 as follows:
       1. Stranded Aluminium/ Copper conductor in case of 10 sq.mm. and above whereas solid conductor in case of 10 sq.mm. and below.
       2. Cores laid up
       3. The inner sheath should be bonded over with thermo-plastic material for protection against mechanical and electrical damage.
       4. Armoring should be provided over the inner sheath to guard against mechanical damage. Armouring should be Galvanized steel wires or galvanized steel strips. (In single core cables used in A.C. system armouring should be non-magnetic hard aluminium Wires/ Strips. Round steel wires

should be used where diameter over the inner sheath does not exceed 13 mm; above 13 mm flat steel armour should be used. Round wire of different sizes should be provided against specific request.)

* + - 1. The outer sheath should be specially formulated heat resistant black PVC compound conforming to the requirement of type ST2 of IS: 5831-1984 extruded to form the outer sheath.
    1. Conductor shall be of electrolytic Aluminium/ Copper conforming to IS: 8130 and are compact circular or compact shaped.
    2. Insulation shall be of XLPE type as per latest IS general purpose insulation for maximum rated conductor temperature 70 degree centigrade.
    3. In Inner sheath laid up cores shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.
    4. Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only.
    5. Armouring shall be of galvanised steel wire/ flat.
    6. Repaired cables shall not be used.
    7. Current ratings of the cables shall be as per IS: 3961.

3.3.9. The XLPE insulated cables shall conform to latest revision of IS and shall be read along with these specifications. The Conductor shall be stranded Aluminium/ Copper circular/ sector shaped and compacted. In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation.

* + 1. The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
    2. Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.
    3. Cables shall be supplied in non returnable wooden drums as per IS: 10418.

Both ends of the cables shall be properly sealed with PVC/ Rubber caps so as to eliminate ingress of water during transportation, storage and erection.

* + 1. The product should be coded as per IS: 7098 Part-I as follows: Aluminium Conductor A

XLPE Insulation 2X

Steel round wire armour W

Steel strip armour F

Steel Double round wire armour WW

Steel Double strip armour FF

Non-magnetic (Al.) round wire armour Wa

Non-magnetic (Al.) strip armour Fa

PVC outer sheath Y

##### Inspection:

All cables shall be inspected by the contractor upon receipt at site and checked for any damage during transit.

##### Joints in Cables

The Contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoid cable jointing. This apportioning shall be got approved by the Owner’s site representative before the cables are cut to lengths. Where joints are unavoidable heat shrinkable type joints shall be made. The location of such joints shall be got approved from the Owner’s site representative and shall be identified through a marker.

##### Jointing Boxes for Cables

Cable joint boxes shall be installed with heat shrinkable sleeve and of appropriate size, suitable for XLPE armoured cables of particular voltage rating.

##### Jointing of Cables

All cable joints shall be made in suitable, approved cable joint boxes and the filling in of compound shall be done in accordance with manufactures' instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resin.

All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commence. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and by using of spreaders of approved size and pattern. The joints shall be completely topped up with epoxy compound so as to ensure that the box is properly filled.

##### Cable End Terminations

Cable end termination shall be done in cable terminal box using crimping sockets and proper size of glands of double compression type

##### Bonding of Cables

Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an approved type of armour clamp and gland. The clamps must grip the armouring firmly to the gland or casing, so that no undue stress is passed on to the cable conductors.

##### Cable Installation

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks.

##### Laying of Cables on Cable Trays:

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

All cables passing through holes in floor or walls shall be sealed with fire retardant Sealant and shall be painted with fire retardant paint upto one meter on all joints, terminations and both sides of the wall crossings by “VIPER CABLE RETARD”.

##### Laying of Cables in Ground:

The width of trench for laying single cable shall be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench shall be

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

**Excavation of trenches:** The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided. Where gradients and changes in depth are unavoidable, these shall be gradual. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench shall be levelled and shall be made free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth. Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum shall be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch. However, where this is not possible the remainder of the cable shall be removed by `Flaking’ i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line. Cable laid in trenches in a single tier formation shall have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. Finally the cables shall be protected by second class bricks before back filling the trench. The buried depth of uppermost layer of cable shall not be less than 750mm.

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

##### Cables inside Building:

Cables inside buildings shall be laid on the cable trays. All cables passing through walls shall run through GI Pipes sleeves of adequate diameter 50 mm apart maintaining the relative position over the entire length.

##### Route Marker:

Route marker shall be provided along straight runs of the cables not exceeding 30 meters also for change in the direction of the cable route and underground joints.

Route marker shall be of cast iron painted with aluminum paint. The size of marker shall be 100

mm dia with “Cable” and voltage grade inscribed on it.

##### Cable Trays:

Ladder and perforated type Cable Trays shall be of Hot dip Galvanized type and factory fabricated out of CRCA sheet with standard accessories like tee, bends, couplers etc. for different loads and number and size of cables as given below :

Cable trays shall be galvanized as per Specification given under 3.14.

1. 1500 mm wide

Runners 25 x 100 x 25 x 3 mm

Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C

Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

1. 1200 mm wide

Runners 25 x 100 x 25 x 3 mm

Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C

Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

1. 1000 mm wide

Runners 25 x 100 x 25 x 3 mm

Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C

Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

1. 750 mm wide

Runners 20 x 75 x 20 x 2.5 mm

Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C

Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

1. Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.
   1. 600 x 40 x 40 x 2 mm thick
   2. 450 x 40 x 40 x 2 mm thick
   3. 300 x 40 x 40 x 2 mm thick
   4. 150 x 40 x 40 x 2 mm thick

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

##### Specification for Hot Dip Galvanizing Process:

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

##### General Requirements Quality of Zinc

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

##### Coating Requirement:

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

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats/ wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

##### Fire retardant Cable Paint & Fire Barrier:

The fire retardant paint/ barrier shall be listed by independent test agencies such as UL, FM or OPL and be tested to, and pass the criteria of ASTM E 814 (UL1479) standard test method for fire test through- penetration fire stops and ASTM E 1996 (UL 2079) standard test method for fire resistive joint system.

##### Fire retardant cable Paint:

The Fire resistant cable coating/ painting shall be intumescent/ ablative, water based compound, the coating shall expand up to 10 times, supplied in a manufacturer seal container indicating manufacturing and expiry dates. The coating material shall be non- toxic, asbestos free, & halogen free and shall have good mechanical strength. The colour of paint shall be white and density of coating shall be 1.3kg/ltr, coating shall have a snap time of 30 minutes, the expansion shall begin at 230 deg.C and it shall have a oxygen index of 41%.

Coating shall be applied by ordinary paint brush after cleaning the cables of dust and oil deposition. A minimum textured finish of 3 mm wet film thickness shall be achieved by applying the material in 2-3 layers leaving intervals of 2 to 8 hours depending upon the moisture and thickness, moisture and temperature hours between each coat.

##### Fire Barrier sheet for floor and wall sealing:

The framing & fixing part of fire barrier sheet shall be very simple & directly fixed around walls & floors by help of anchored bolts & washer. For 2 hour fire rating the fire barrier sheet shall be minimum 7.62 mm thick and shall be cut as per the profile of penetration and opening. The small gap left around the penetration shall be closed with fire rated soft & mouldable putty. Fire barrier must be design on the intumescent technology to seal larger penetration through the fire rated walls & floors. Fire barrier must be a composite construction with the quality incorporated with organic/ inorganic fire resistive elastomeric sheet with specific gravity of 1.6 gm/ cubic centimeter.

##### Testing of Cables:

Cables shall be tested at works for all routine tests as per IS including the following tests before being dispatched to site by the project team.

1. Insulation Resistance Test.
2. Continuity resistance test.
3. Sheathing continuity test.
4. Earth test. (in armoured cables)
5. Hi Pot Test.

Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Owner’s site representative.

1. Insulation Resistance Test (Sectional and overall)
2. Continuity resistance test.
3. Sheathing continuity test.
4. Earth test.

All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Owner’s site representative, results will be noted and signed by all present and record be maintained.

##### Floor Cable Trunking

General

1. Trunking and fittings shall comply with BS 2989 or Indian Standard of IS277 with a GI coating thickness of 275GSM.
2. Trunking shall be top accessed. Inverted trunking is not acceptable.
3. All multi-compartment trunking systems shall maintain the stated segregation throughout, including all accessories.
4. Trunking shall be manufactured using pregalvanised sheet steel. Trunking shall be spot welded & arc welded throughout its length for better impact resistant and to prevent concrete seepage during installation. The trunking shall normally be supplied in 2500mm lengths with a material thickness of 1.6mm. Lengths of trunking shall be coupled together by means of joint sleeves, made of pre galvanized GI with 275 GSM GI coating. At each joint in the trunking, continuity shall be maintained by means of copper links, not less than 25 x 3 mm to achieve an acceptable earth loop impedance level in compliance with BS 2989, fixed with brass nuts, bolts and serrated washers. Removal of any lid no matter how it is fitted shall not affect the earth continuity of the trunking. LSZH copper cable link with cable lugs may be used, if the proper connection method is provided to avoid long term corrosion and electrolytic action. The LSZH cable shall have an equivalent cross sectional area to the copper links. Bonding link shall be fixed on external surfaces.
5. Manufacturer’s standard fittings shall be used for all connections and changes of direction. All vertical bends, Crossover boxes, access outlets, and junction boxes shall be of the same manufacturer as the trunking. Trunking shall not be cut or bent to form bends, flanges or attachments. Gusset bends shall be used wherever necessary to provide sufficient bending radius for the cables. Site fabricated items shall not be accepted.
6. The minimum size shall be 50mm by 40mm with single compartment. The maximum recommended size for the trunking is upto 300mm by 40mm with triple compartments.
7. All inside edges of trunking shall be smooth and provision shall be made to prevent abrasion at bends.
8. Cable retaining straps supplied by the trunking manufacturer shall be fitted at intervals not exceeding 1m. Where trunking passes through walls, floors and ceilings, proprietary fire barriers shall be installed in the trunking. The fire barrier shall have a rating not less than that of the original construction of the opening.

Trunking shall be adequately supported throughout its length. Trunking support and channel shall be quick-fixing type and shall be such as to space the trunking a minimum of 13mm from any part of the wall or bulkhead.

1. A minimum of two fixings shall be provided between joints in the trunking except where the distance between is less than the maximum spacing.
2. Where trunking is cut or drilled, the cut edges of the trunking shall be smoothed to prevent abrasion of the cables and shall be painted with anti-corrosion paint like aluminium coating, to the same colour as the adjacent surfaces, such painting to be carried out as the work proceeds. In no circumstances will rough screw edges and nuts be allowed in the interior of the trunking.
3. Flush or buried trunking and under floor metal ducts shall comply with BS 2989.
4. The space factor for cables installed in trunking shall not exceed 35% as per IEE regulations.
5. All lengths of vertical run trunking in excess of 3000mm shall contain cable supports made of insulating, non-hygroscopic, non-combustible material. The spacing between such supports shall not exceed 1800mm. An additional support shall be provided at the top of all

vertical runs exceeding 3000mm, to support the weight of the cable and distribute the cables within the trunking to prevent undue compression of the installation.

1. Where trunking crosses expansion joints, a trunking fitting shall be used which shall allow for expansion and maintain earth continuity.
2. Suitable cutout on underfloor trunking at ticket barriers shall be provided to suit Automatic Fare Collection System Contractor’s requirement. The cutout shall not have a sharp edge or abrasive effect on cables. The location and route for the cutout and under floor trunking shall be according to Working Drawings.
3. Trunking installed externally shall be manufactured from galvanized sheet steel in accordance with BS 2989 protection Class 3, or other international standards. Trunking installed internally shall be of Class 2.
4. Partitions or dividers shall be of the same material and finish as the trunking. The method of fixing shall not cause any long-term corrosion or electrolytic action.
5. Connections to multiple boxes, switchgear and distribution boards shall be made with multi compartment vertical access boxes. Expansion joints in long continuous runs shall be provided as recommended by the manufacturer.

##### ACCESS OUTLETS

* Access Outlets are made of very high quality materials to withstand heavy load and corrosion.
* Manufactured from high-pressure die cast material for strength &durability.
* The trap frame & trap are made of flame retardant Engineering Plastic - ABS & Polyamide ratchet for strength & durability.
* The Trap Frame can be easily removed by pulling either one of the Nylon Bars to detach & remove the unit for servicing or installation of accessories to save installation & servicing time.
* Patented screw less ratchet bar level adjusting system to match with screed/ floor height. The trap lid is self-adjustable to any floor finish thickness.
* Trap cover must be reinforced with a 2.0mm thick pre-galvanized steel plate to provide rigidity & added strength. Trap lid to have a screw less knob-hinged design for quick mounting on to the frame requiring minimum maintenance.
* The Trap cover must have 8 mm recessed for installation of carpet and tiles.
* Trap trim design to protect carpet from damages and give the floor area added aesthetics.
* Trap lid should be made of Electrostatic Polyester Epoxy Coating to provide excellent and enhanced protection on visible parts against chemical or saline corrosion.
* Strong and durable trap lifting handle on the trap cover is made of similar color material and has special design for easy lifting, even with large fingers.
* Cables are guided by Cable Retainers through generous cable outlet which open automatically and lock into position when cables are present.
* Trap cover of Access box should be retained by Cable Grommets with high quality durable foam to prevent the cable damage from exit position & also prevent ingress of dust when closed.
* Access Outlet should carry service plates for providing services i.e.: Power, Data & Telecom. The Access outlets must accommodate to have three compartments to run Mains Voltage & Extra Low Voltage cables.
* The system must have Positive Double Earthing connections.
* Earth wire connector should be provided in all the boxes, and complies with the requirement of current IEE regulation.
* Access outlets are tested to a load bearing of 2 tons on the trap lid for heavy traffic areas
* Four side blanks are made with removable perforations to suit ducts installation.
* Standards & Approvals – The system must comply to the relevant specification & IEC 61084 standards.

##### CROSSOVERS/ JUNCTION BOXES

* Cross Overs/ Junction boxes are made of very high quality materials to withstand heavy load and corrosion.
* Manufactured from high-pressure die cast material for strength &durability.
* The trap lid is self-adjustable to any floor finish thickness using the leveling screws on all the four corners.
* The Trap cover is made of 2.0mm thick pre-galvanized steel plate to provide rigidity & added strength.
* The Trap covers to have flexibility for quick mounting on to the base box requiring minimum maintenance.
* The Trap cover must have 8mm recessed for installation of carpet and tiles.
* The Flyover units, trapframe and traps should be made of Electrostatic Polyester Epoxy Coating to provide excellent and enhanced protection on visible parts against chemical or saline corrosion.
* The Cross Overs should carry fly-over made of Electrostatic Polyester Epoxy Coating for cables passage to ensure segregation of service
* Crossovers are tested to a load bearing of 3.6 tons on the trap lid for heavy traffic areas
* The Cross Overs should have provision to Power, Data & Telecom services.
* The system must accommodate to run Mains Voltage & Extra Low Voltage cables.
* The trap cover screws must be made from Stainless Steel for extra protection.
* The system must have Positive Double Earthing connections.
* Earth wire connector should be provided in all the boxes, and complies with the requirement of current IEE regulation.
* The complete system must have excellent protection against rust.
* Four side blanks are made with removable perforations to suit ducts installation of upto 38-mm height.
* The one-piece base frame design ensures minimum openings to prevent concrete seepage into the box during casting of concrete or screeding.
* Standards & Approvals – The system must comply with the relevant specification & IEC 61084 standards.

##### VERTICAL ACCESS BOXES

* Vertical access boxes are made of very high quality materials to withstand heavy load and corrosion.
* Vertical access boxes facilitate the connectivity of floor raceways to the equipments on the wall like the distribution boards, so the product should be designed as “L” shaped
* The Vertical access boxes should have provision to carry Power, Data & Telecom services
* The vertical access boxes should have the duct entry knockouts of upto 38mm and also provision for carrying the conduits to the wall

The vertical access boxes are made of electrostatic polyester epoxy coating to prevent the rust accumulation

#### 4(A) DISTRIBUTION PANELS/ BOARDS:

Main Distribution Panels, Sub-Distribution Panels and Final Distribution shall be covered under this section. Panels/ Boards shall be suitable for operation on 3 Phase/ single phase, 415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All Distribution panels shall be CPRI tested design and manufactured by a approved manufacturer. **CPRI certificate shall be made available.**

Distribution panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

##### Construction Features:

Distribution panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting/ wall mounting type and shall be form 3b construction. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum **operating** clearance of 275 mm shall be provided between the floor of Distribution panels and the lowest operating height.

Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Feeders shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/ conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

##### Bus Bar Connections:

Bus bar and interconnections shall be of high conductivity electrolytic grade aluminium/ copper as indicated in the bill of quantities complying with requirement of IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and

short circuit current and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper/ aluminium strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum current density for the busbars shall be 0.8 A/sq.mm for aluminium and **1.4** A/sq.mm for copper busbars.

##### Maximum allowable temperature for the Bus bar to be restricted to 85 deg C

* + 1. **Temperature - Rise Limit**

Unless otherwise specified, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS: 8623 (Part-2) 1993.

All main distribution panels and sub distribution panels shall be provided with MCCB of appropriate capacity as per Single Line Diagram. All final Distribution boards shall be provided with Miniature Circuit Breakers. Final Single Phase Distribution boards shall be connected to the incoming supply through double pole MCB units & earth leakage circuit breakers. All wiring for final distribution boards shall be concealed behind 5 mm thick bakelite sheet or MS sheet cover. All Distribution boards shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

##### Cable Compartments:

Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/ bottom. Adequate supports shall be provided in cable compartment to support cables.

##### Air Circuit Breakers (ACB):

* + 1. The ACB shall conform to the requirements of IEC 60947-2/ IS 13947-2 and shall be type tested & certified for compliance to standards from–CPRI, ERDA/ any accredited international lab. The circuit breaker shall be suitable for 415 V + 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" “TRIP” indications.

The ACB shall be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity (Icu) and short circuit withstand values (Icw) for 1 sec.

Circuit breakers shall be designed to ‘close' and `trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/ OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open. Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker.

Rated insulation voltage shall be 1000 volts AC.

##### Cradle:

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/ rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle. Racking Interlock in Connected/ Test/ Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the

breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions. The following safety features shall be incorporated:

* + - 1. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.
      2. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.
      3. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.
      4. All Switchgear module front covers shall have provision for locking.
      5. Switchgear operating handles shall be provided with arrangement for locking in

‘OFF’ position.

##### Protections:

The breaker should be equipped with micro-controller based, communicable type release with RS 485 port for communication to offer accurate and versatile protection

with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones:

* Long time protection.
* Short time protection with intentional delay.
* Instantaneous protection.
* Ground fault protection.

The protection release shall generally have following features and settings **however for exact requirement of protection releases, reference shall be made to SOQ:**

##### True RMS Sensing:

The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

##### Thermal Memory:

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/ Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

##### Defined time-current characteristics:

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

##### Trip Indication:

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

##### Self powered:

The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation.

##### Zone Selective Interlocking:

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimises the damage to the system. To implement ZSI manufacturer should supply all related equipment like power supply, wiring etc.

On-Line change of settings should be possible. It should be possible to carry out testing of release without tripping the breaker.

* + - 1. The release shall meet the EMI/ EMC requirements.
      2. The setting range of release shall be generally as follows:

|  |  |  |
| --- | --- | --- |
|  | **SETTING RANGE OF RELEASE** | |
| **Type of** |  |  |

|  |  |  |
| --- | --- | --- |
| **Protection** | **PICK-UP CURRENT** | **TIME DELAY** |
|  |  |  |
| Long Time | 0.4 to 1.0 times In (Ir) | 0.5 to 30 sec at 6 Ir |
|  | Steps: 0.4, 0.5, 0.55, 0.60,  0.65, 0.70, 0.75, 0.80, 0.85,  0.90, 0.95, 1.00. | Steps: 0.5,1, 2,4, 6,  8,12,18,24 and 30 secs |
|  | Operating Limit: 1.05 to 1.2 times Ir | Tolerance: Corresponding to  ±10% of current. |

|  |  |  |
| --- | --- | --- |
| Short Time | 2 to 10 times Ir  Steps: 2,3,4,5,6,7,8,9 & 10  Tolerance: ±10% | 20 ms to 600 ms  Steps: 20,60,100,160,200,260,300  400,500 and 600 ms  Tolerance: ±10% or 20ms whichever is higher |
| Instantaneous | 2 to 12 times In  Steps: 2,3,4,6,8,10,12  Tolerance: ±10% |  |
| Ground Fault | 0.2 to 0.6 time In  Steps: 0.2,0.3,0.4,0.5,0.6  Tolerance: ±10% | 100 ms to 400 ms  Steps: 100,200,300,400ms  Tolerance: +10% or 20 ms whichever is higher. |

All **incomer** ACBs shall have following additional protections other than mentioned above.

* Earth Fault protection
* Trip Circuit supervision with PS class CT’s.

The release should provide local indication of actual %age loading at any instant. The release of incoming breakers should provide comprehensive metering with the following parameters

* Phase currents (running, avg & max) – All parameters in single window.
* Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.
* Release should be self powered.
* Release should have facility to select different type of IDMTL protection (DT, SIT, VIT, EIT, HVF) for better co-ordination with HT Breaker/ Fuse.

##### All O/G ACBs shall have following functions. Protection:

* The ACB control unit shall offer the following protection functions as standard: Long-time (LT) protection with an adjustable current setting and time delay;
* Short-time (ST) protection with an adjustable pick-up and time delay;
* Instantaneous (INST) protection with an adjustable pick-up and an OFF Position.
* Current and time delay setting shall be indicated in amperes and seconds respectively on a digital display.
* Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

##### Measurements:

* An ammeter with a digital display shall indicate the true rms values of the currents for each phase. Release shall acknowledge the current & time delay settings done by user on the LCD display.
* A LED bargraph shall simultaneously display the load level on the three phases.
* A maximeter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.

##### Safety Features:

1. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
2. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.
3. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.
4. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions. MCB for protection circuit and measuring instrument circuits.
5. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.
6. Draw out breakers should not close unless in distinct Service/ Test/ Isolated positions.
7. The insulation material used shall conform to Glow wire test as per IEC60695.
8. The ACB shall provide in built electrical and mechanical anti-pumping.
9. All EDO ACB`s Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

##### Moulded Case Circuit Breaker (MCCB)

The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ. MCCB shall comply with the requirements of the relevant standards IS13947–Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI/ ERDA or any accredited international lab.

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses

The breaking capacity of MCCB shall be as specified in the schedule of quantities. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCBs for motor application should be selected in line with Type-2 Co-ordination as per IEC- 60947-2, 1989/ IS 13947-2. The breaker as supplied with ROM should meet IP54 degree of protection.

##### Current Limiting & Coordination:

* The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. **The manufacturer shall provide both the discrimination tables and let-through energy curves for all.**

##### Protection Functions:

* MCCBs with ratings up to 200 A shall be equipped with Thermal-magnetic (**adjustable** thermal for overload and **fixed** magnetic for short-circuit protection) trip units.
* Microprocessor MCCBs with ratings 250A and above shall be equipped with microprocessor based trip units.
* Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings.
* Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.)
* Protection settings shall apply to all poles of circuit breaker.
* All Microprocessor components shall withstand temperatures up to 125 °C

##### Testing:

* + - 1. Original test certificate of the MCCB as per IEC 60947-1 &2 or IS13947 shall be furnished.
      2. Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

##### Interlocking:

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

* + - 1. Handle interlock to prevent unnecessary manipulations of the breaker.
      2. Door interlock to prevent the door being opened when the breaker is in ON position.
      3. Defeat-interlocking device to open the door even if the breaker is in ON position.
         * The MCCB shall be current limiting type and comprise of quick make– Break switching mechanism. MCCBs shall be capable of defined

variable overload adjustment. All MCCBs rated 250 Amps and above shall have adjustable over load & short circuit pick-up and 200Amps and below shall have adjustable overload and fixed short Circuit Trip Units.

* + - * + All MCCB in Main LT Panel & Incomer of MDBs shall be with adjustable Overload, Short circuit and earth fault protection with time delay.
        + The trip command shall override all other commands.

##### Motor Protection Circuit Breaker (MPCB):

Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1, 2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-

2 N°14.

The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4.MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to satandrd IEC 60947-2 and shall have a rated impulse withstand voltage (Uimp) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating.

Power supply shall be from the top or from the bottom.In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the “isolated” position.

The motor circuit breakers shall be equipped with a “PUSH TO TRIP” device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co- ordination of the protective devices conforming to IEC 60947-4-1.Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory). The motor circuit breakers, depending on the type, could be equipped with a door- mounted operator which shall allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (- 20°C to +60°C)

##### Miniature Circuit Breaker (MCB):

Miniature Circuit Breaker shall comply with IS-8828-1996/ IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B, C, D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/ IEC and the manufacturer shall publish the values.

MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.

##### Coordination Study in LV Network:

LV Switchgear Manufacturer shall submit coordinated & Discriminated solution for LV Network protection devices i.e. **ACB, MCCB, MPCB &** MCB for all Incoming and outgoing devices for all Panels/ DB`s as per BOQ with the help of published discrimination tables. Total discrimination shall be provided up to the short circuit breaking capacity of most downstream circuit Breakers.

##### Residual Current Circuit Breaker Current Operated Type (RCCB):

1. **System of Operation:**

Residual Current Circuit Breaker shall confirm to IEC 61008.RCCB shall work on the principle of core balance transformer. The incoming shall pass through the torroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage, current sensitivity shall be of 30 mA at 240/415 volts AC and shall have a minimum of 20,000 electrical operations.

##### Mechanical Operation:

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing/ opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

##### Neutral Advance Feature:

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact first before the phases; and at the time of opening, the neutral shall breaks last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

##### Testing Provision:

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB/ RCCB and the operating handle shall move to the "OFF" position.

##### Earthing:

Earthing shall be provided as per IS: 3043-1987.

##### Painting:

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with electrostatic paint

(Powder coating). The shade of colour of panel inside/ outside shall be as per BOQ confirming to IS Code No.5.

##### Labels:

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

##### Meters:

1. All voltmeters and indicating lamps shall be through MCB’s.
2. Meters and indicating instruments shall be flush type.
3. All CT’s connection for meters shall be through Test Terminal Block (TTB).
4. CT ratio and burdens shall be as specified on the Single line diagram.

##### Current Transformers:

Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

##### Potential Free Contacts:

Potential free contacts shall be provided for connection to Building Automation System in panels indicated in Schedule of Quantities.

##### Indicating Panel:

All meters and indicating instruments shall be in accordance with relevant Indian Standards. Meters shall be flush mounted type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/ MPCB as per relevant fault level and toggle switch.

##### Testing:

Testing of panels shall be as per following codes:

1. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.
2. IS: 13947: 1993 Degree of protection.
3. IS: 5578 & 11353: 1985 Arrangement of bus bars.

##### Wiring:

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

##### Anti-Condensation Space Heaters:

1 No. 100 W, 240 volts, single phase, 50 Hz AC Anti Condensation space heaters controlled by thermostat and protected by 6 amps MCB’s or MPCB’s as per fault level at the panel shall be provided in each vertical section of main LT panel and 1 No. 60 watt Anti Condensation space

heater with thermostat shall be provided in each cable alley of main distribution boards and sub distribution boards.

##### Installation:

Installation of all LT panels shall include but not limited to the following to complete the installation, testing and commissioning:

1. Transporting materials from stores to exact location of installation.
2. Supply and installation of required base frame made of MS angle or channel sections and duly painted with black paint.
3. Positioning, aligning, fixing, assembling, and installation of LT panel issued free of cost by Client after carrying out proper cleaning and inspection.
4. Site supervision, testing for proper functioning/ operation, and pre-commissioning tests.

##### Commissioning and onsite Testing:

1. All switchboards shall be tested for dielectric test with 1000V megger.
2. All earth connections shall be checked for continuity.
3. All busbar connections shall be checked and tightened properly.
4. All cable terminations and terminal shrouding shall be checked if they are properly done.
5. The operation of protective devices shall be tested by secondary injection test.
6. The operation of circuit breaker shall be tested for all interlocks.
7. Functional test shall be done for all ACBs, MCCBs and other components.
8. Indicating lamps and meters shall be checked for proper working.

#### 4(B) FINAL DISTRIBUTION BOARDS (FDB’s):

Final Distribution Boards (FDBs) shall be suitable for operation on 3 Phase/ single phase, 415/240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum di-electric strength of 2.5 KV/ Sec. All Distribution Boards shall manufactured by a manufacturer listed in Appendix-I.

FDB’s shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and

shall be as per IS-13947-1993.

##### Construction Features:

FDB’s shall be made out of 1.6 mm thick high quality CRCA sheet steel and shall be pre- treated and powder coated sheet steel used in the construction of FDB shall be folded and braced as necessary to provide a rigid support for all component. FDB shall be suitable for indoor/ outdoor installation, wall mounting free standing type, in double door construction. The Final Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement. All removable/ hinged doors and covers shall be grounded by 4.0 sqm tinned stranded copper connectors. Final Distribution Boards shall be suitable for the climatic conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of FDBs.

Knockout holes of appropriate size and number shall be provided in the FDB’s in conformity with the location of cable/ conduit connections. Detachable sheet steel gland plates shall be provided at the top/ bottom to make holes for additional cable entry at site if required.

##### Final Distribution Boards shall comprises of the following:

A panel for mounting where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.

Installation accessories shall be part of the DB for fixing conductor and rails for mounting MCB’s and RCCB’s etc. neutral bus bars & earthing bus bars required in the circuit. All busbars in the FDB shall be insulated type.

Service cable/ interconnection shall be part of the Distribution Boards.

The board shall be installed at a height such that the operating is within reach of the normal human height i.e. 1.2 to 1.8 meters from finish floor level.

Degree of protection shall be IP-52 for indoor application, IP-54 for kitchen & laundry and IP-55 for outdoor application.

All three phase distribution boards shall have 4 rows and single phase distribution boards shall

have single rows for housing of MCB’s and RCCB’s unless noted otherwise. Phase segregation to be maintained in all three phase distribution boards. Earthing shall be provided in each FDB’s.

##### Miniature Circuit Breaker (MCB):

For specifications refer Section 4A, clause 4.7

##### Residual Current Circuit Breaker Current Operated Type (RCCB):

For specifications refer Section 4A, clause 4.8

##### Earthing:

Earthing shall be provided as per IS: 3043-1987.

##### Painting:

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/ outside shall be of Siemens gray paint shade no. RAL-7032 of IS Code No.5.

##### Labels:

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

##### Testing:

Testing of panels shall be as per following codes:

* + 1. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.
    2. IS: 13947: 1993 Degree of protection

##### Wiring:

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

#### POWER FACTOR CORRECTION SYSTEM:

##### Power Factor Correction System With Detuned Filter: Scope:

Design, manufacture, supply, erection, testing and commissioning of Indoor type power correction capacitor banks for power factor improvement as per specification given below:

##### Standard:

Unless otherwise stated below, the capacitor shall comply with the following standards (and their latest amendments): IS 13340-1993, IS 13341-1992, IEC 60831-1+2

##### Rating:

50 KVAR (or less) capacitor units as specified in the BOQ shall be used to form a bank of capacitors of desired capacity.

##### Enclosure:

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shade/s to match the colour of the other panels. The thickness of powder coating should be minimum 60-80 microns.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors. The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

##### APFC Relay/ Controller:

Microprocessor based APFC relay (Intelligent VAr controller) shall have dual sensing so that on generator supply it can suitably switch to desired power factor and automatically switch ON/ OFF the capacitor unit or stage to achieve the preset target PF. The controller shall have the following features:

* + - Controller shall provide thyristorized output of 8/16 stage.
    - Digital settings of parameters like PF, Switching time delay, Step limit etc.
    - LCD Display displaying PF/V/I/KVA/KW/KVAR temp./ Harmonics (THD and Individual for Voltage and Current)
    - Indication of PF, preset parameters, Contactors switching operation and capacitors operating life.
    - Minimum threshold setting of 1% of CT current.
    - No-volt release.
    - Protective shut down in case of harmonic overload.
    - Shall have data logging for all Electrical parameter for 2 months.
    - Shall have RS 232 interface.
    - Output command shall have maximum 16 outputs.
    - Indication for Failure to achieve the target PF, Harmonic overloading, Step failure etc.

##### Construction:

Each basic unit of mixed dielectric extra low loss/ All Poly Propylene (APP)/ MPP Gas Filled, filled with inert gas capacitor shall be built with a number of elements. These elements shall be combination of capacitor tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable impregnant or Film Foil capacitor manufactured using Poly propylene film placed between 2 layers of metal foil and winding or shall have wave cut MPP design. The elements shall be connected to the external bus bars through these leads in a series parallel connection to form a three phase unit.

The capacitor units shall be floor mounting type using minimum floor space. The container of capacitors shall be made out of 2 mm thick M S sheet steel of polyster paint coated finish/ cylindrical Aluminium can. Each standard unit shall be provided with internal fuses (operation co-ordinated with case-rupture characteristics to avoid rusting).

Total Harmonic Distortion (THD) of up to 5% on voltage and current waveforms shall not affect the life of capacitors. 440±10% variation in line voltage shall not affect the life of the capacitors.

##### Capacitors:

* + - Capacitor shall be 525 V and output shall be increased considering reactor suitability.
    - General specifications: 3 phase, delta connected, 50 Hz.
    - Capacitor shall be ISI marked.
    - Voltage: Shall be designed for minimum **520V** and shall withstand system over voltage, increased voltage due to series reactor and harmonics.
    - Capacitor type: Super heavy duty with double side metallised capacitor tissue paper. Oil impregnated and self-healing type with bi-axially oriented polypropylene film shall be fitted with pressure sensitive disconnector in each individual capacitor cell.

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Or Gas filled type, MPP design, with wave cut technology with PSD for individual cell.

* + - Overvoltage +10% (12h/ 24h), + 15% (30m/ 24h), + 20% (5m), + 30% (1m) as per Clause 6.1 of IS 13340-1993.
    - Overcurrent: 2.5 x In
    - Peak Inrush current withstand : 350 x In
    - Total watt-losses excluding discharge resistors: < 0.45 W/ kVAR.
    - Temperature category: -25 deg.C to 70 deg.C or at D Class.
    - Capacitor shall be self-heating type and oil impregnated for longer life. The impregnant shall be non-PCB, biodegradable type, must be properly treated and de-gasified, so as not to have any degeneration properties and shall be non-oxidizing/ inert gas.
    - The design shall be modular for simple mechanical assembly, no extra accessories/ metal parts to be required. Unit must be free standing with an IP 41 protection level.

##### Switching Module:

Electronic Thyristor switching module shall be capable of voltage peak withstand capacity of upto 2400 Vpk. It shall be enclosed in separate enclosure with heat sink for it’s cool Operation. This enclosure shall be produced out of enclosure containing filter bank. This shall be capable to switch capacitor within 60 millisecond and reaction time shall be 5 milliseconds. Thyristor shall be connected with superfast electronic fuses with each step and capacitor shall be connected with fast discharge resistances. Total losses shall not be more than 3 watt/ KVAR.

##### Terminals:

Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminum conductor armoured cables as specified. Or Sigut terminal shall be preferable.

##### Earthing:

Two separate earthing terminals shall be provided for earth connection of each bank.

##### Low Voltage Filter Reactor:

Filter reactor shall be series type having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 76. The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature class H operation. The reactor coils shall be wound with high grade aluminum/ copper and termination shall be provided with suitably designed copper bars.

##### Testing:

The reactor shall be tested `using a separate source voltage test of 3 KV (coil to core) for one minute as per IEC 76/3. The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuit in case of high operating temperature.

##### Series Reactor:

**Application:**

LV Harmonic Filters shall be used with harmonic filter duty power capacitors to mitigate harmonics, improve power factor and avoid electrical resonance in LV electrical networks.

##### Construction, Testing & Protection:

The low voltage filter reactor shall be series type having a three phase, iron core construction suitable for indoor use (IP 00). The reactor shall be air cooled and the layout shall be in accordance with IEC 60289/ IS-5553.

The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature Class H (T60/H) operation.

The reactor shall be tested using a separate source voltage test of 3.0kV (coil to core) for 1 minute as per IEC/ IS standards.

The permitted tolerance of inductance shall be ±5% of rated inductance value.

Reactor tuning factor shall be 5.67% and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

The limit of linearity of inductance of the filter reactor shall be as follows 2.08  with L = 0.95 LN

The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuits in case of high operating temperatures.

##### Switchgear & Protection:

Incomer switchgear shall be TP&N breaker appropriate rating (**minimum 1.8 times** the normal current to take care of inrush switching current). Suitable contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection.

Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures upto 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

##### Control Circuit & General Protection:

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset).

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Inspection terminal strip, number ferruling, labeling etc. shall be provided. 440 V caution board on the panel shall be provided.

##### Testing:

The capacitor bank shall be subject to tests as specified in relevant Indian Standards at the factory and the test certificates shall be furnished in quadruplicate.

##### Installation:

Capacitors banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards.

All interconnections in the control panel shall be checked before commissioning.

Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.

Insulation matting as per IS-15652 of an approved make platform shall be provided in front of the full length of the capacitor bank and control panel.

##### Testing & Commissioning:

Insulation resistance shall be tested with a 1000 volts meagger between phases and phase to earth.

Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute.

Each discharge resistor shall be tested for its working.

#### EARTHING:

##### Earthing:

The system shall be TNS with four wire supply system (R, Y, B, N and 2 Nos. E) brought from the main LT Panel. All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, ducts, cable trays, stair case railing etc shall be bonded to earth.

All earthing shall be in conformity with IS: 3043 1987, and the basic system of earthing shall be TNS.

##### Earthing Conductors:

Earthing conductors shall be of copper/ GI as mentioned in schedule of quantities and shall be protected against mechanical injury and corrosion.

##### Sizing of Earthing Conductors:

The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits upto 15 amps shall be earthed with PVC insulated copper wire.

##### Connection of Earthing Conductors:

Main earthing conductors shall be taken from the earth connections at the main LT panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed in case of copper and by welding bolting in case of GI, wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed.

The installation shall be complete in all respects for efficient and trouble free service. All work shall be carried out in a first class quality and neat workmanship. Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during their installation. All exposed ground conductors run shall be taken in a neat manner horizontal, vertical and parallel to the building walls or columns and shall not be laid haphazardly. All connections to the grounding grid shall be made with **earthing** strip welded to grid and bolted at equipment ends.

##### Prohibited Connections:

Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system

conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main LT panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 1 ohm. All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in G I pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in case of copper and by welding/ bolting in case of GI in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

##### Earthing:

**The following must always be ensured in earthing system:**

All earths must be interconnected at the earth pits. This includes generator neutrals, transformer neutrals, transformer body, lightning protection system earths, UPS earths etc.

Extraneous conductive parts such as gas pipes, other service pipes and ducting risers and pipes of fire protection equipment and exposed metallic parts of the building structure.

* 1. The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located before starting the installation.

##### Resistance to Earth:

The resistance of earthing system shall not exceed 1 ohm.

##### Specification for Hot Dip Galvanizing Process: General Requirements

**Quality of Zinc:**

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

##### Coating Requirement:

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

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats/ wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing. Jointing of earthing tape shall be by welding. All joints and cut ends shall be properly painted with aluminium paint.

##### (Note: Please specify only one type as per project requirement)

* 1. **Earthing Electrode: Conventional Plate electrode: Copper Earth Electrode:**

Earthing electrode shall be 600 x 600 x 3.15 mm thick tined copper plate electrode, with 2 Nos 50 x 6 mm copper strips from earth plate electrode to inspection chamber, 50 mm dia medium class GI pipe, CI funnel with 20 gauge GI wire mesh, masonry chamber 1000 x 500 mm with concrete base CI heavy duty/ chequered plate manhole cover with frame painted with bitumastic paint and packing with mixture of charcoal and common salt around plate electrode including digging of pit upto permanent moisture level and as per soil condition but not less than 3 meters and back filling as required.

##### GI Earth Electrode:

Earthing electrode shall be 600 x 600 x 6.3 mm thick GI plate electrode, with 2 nos. 50 X 6 mm GI strips from earth plate electrode to inspection chamber, 50 mm dia medium class GI pipe, CI funnel with 20 gauge GI wire mesh, masonry chamber 1000 X 500 mm with concrete base CI manhole cover with frame painted with bitumastic paint and packing with mixture of charcoal and common salt around plate electrode including digging of pit upto permanent moisture level but not less than 3 meters and back filling as required.

##### Maintenance free Earthing Electrode System/ Chemical Earthing (Optional):

In maintenance free earthing copper bonded earthing rod electrode shall be of 14.35 mm in diameter and 3 meter length. The rod shall be placed in a 150 mm dia an augured hole in the ground and then surrounded by ground enhancement material in either a dry form or pre mixed in slurry. Once set, ground enhancement material becomes hard and as such holds positively to the rod as well as surrounding ground.

Earth rod offered shall have passed the test required of BS7430/ ANSI/ UL467 and confirm to the adhesion of the copper coating to the steel core (Design feature that prevents the ingress of moister and subsequently the integrity of the rod.

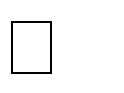
Minimum 0.25 mm thickness of copper shall be deposited over the steel core as per BS 7430/ UL 467. Average life of the ground rod shall be 30 years in most soil.

Ground enhancement material shall be as per IEEE-80 clause 14.5d with a resistivity of less than 0.12 ohm-meter. The ground enhancement material shall be permanent and not leach any chemicals in to the ground. The pH value of the ground enhancement material shall be 6.9 to

7.2 of 100 gm/ lit @ 20 deg.C.

Minimum 30 Kg of ground enhancement material shall provided for each earth electrode.

Inspection chamber shall be of 400 x 500 mm with concrete base CI manhole cover with frame painted with bitumastic paint. 2 Nos. of 50 x 6 mm cross section & 300 mm long copper strip to be clamped with copper claded rod electrode have sufficient nos (But not less than 4 Nos.) of

10 mm GI nuts & bolts for connection to the equipment/ interconnection to the other pits to form equi-potential bonding.

##### Earth for UPS/ Low volt/ Servers:

Clean earth shall be used for earthing UPS/ Low volt/ Server systems and shall be separate from safety earthing. Separate earthing electrode shall be provided in the ground and from this electrode, single core copper cable of required size shall be taken as earth conductor to be laid in the vertical shaft. This cable shall be terminated on each floor in a earth terminal box located in the shaft. The earth terminal box shall have 50x6mm copper busbar mounted on insulators. The busbar shall have facility to terminate the incoming earth cable as well as required number of outgoing earth conductors.

#### LIGHTNING PROTECTION SYSTEM:

##### Lightening Protection System ESE Advanced Lightning Protection System (Based on NFC17-102):

**Scope:**

The work to be done under this section comprises the supply & installation necessary for the complete installation of the lightning protection system.

The design of the components shall be traceable to field research, laboratory testing, fundamental analysis, and statistical levels of the lightning event.

The design of the components shall be traceable to long term practical field studies laboratory testing, fundamental scientific principles and statistical levels of the lightning event as documented in international standard.

The lightning protection system should complies in accordance with NFC 17-102 standard and

shall be installed strictly to the manufacturer’s instructions.

The advanced lightning protection system shall include components as follows: ESE Air terminal

Mechanical supports Down-conductors

Performance Recording Equipment A low impedance Grounding system.

##### Standards:

Complete installation shall be engineering and constructed in accordance with the latest revision of the following:

* + - NFC-17-102
    - IEC 61204

The details of the lightning protection system shall also confirm to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this specification and drawings, whichever is more stringent and acceptable to the engineer.

##### Air Terminal:

The air termination shall be of the type that responds dynamically to the appearance of a lightning down leader by creating free electrons between outer surfaces and an earthed central finial rod.

The Air terminal should work under **Early Streamer Emission (ESE) Technology** and the attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics.

The Lightning conductor should deliver a unique gain time in efficiency, anticipating the natural formation of an upward leader. The air terminal generates a leader that propagates rapidly to capture the Lighting stroke and conduct it towards the ground.

Arcing is not to be continuous and shall only occur during the progress of the lightning leader.

The air termination shall not cause high frequency radio interference except during the millisecond intervals associated with the progress of the lightning leader and during the main return strike of lightning events in the region.

The materials of the air termination shall be non-corroding in normal atmosphere.

The air termination shall not be dependent upon batteries or external power supplies for any part of its operation.

The Height of the air terminal support mast should be minimum 2mts and the height will be increased as per the coverage design.

The support shall be securely installed and guy wires shall be used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

##### Down Conductor:

The down conductor should be used 25 x 3 mm copper strip. Two down conductors shall be used in case of the structure height is above 28mts and both should be connected with maintenance-free Grounding system.

The main copper conductor shall be connected directly to the air termination.

The down conductor shall be installed in accordance with the manufacturer’s instructions and

should not be subject to sharper bends.

The down conductor must be kept in constant physical contact with the structure via conductive mounting clamps.

##### Lightning Flash Counter:

Each protection system shall be supplied with Lightning strike counter. The counter shall have a register that activates one count for every discharge where the peak current exceeds 400A at the 8/20us standard.

The lightning flash counter shall be robust and easy to install. The counter shall operate from the energy of the lightning discharge and should not work on external or battery power to operate.

The lightning flash counter shall be installed to the manufacturer’s instructions in a readily accessible manner (always 2mts above the Ground) so that reading can be taken at regular intervals. It shall be positioned such that its operating temperature is within the range -20'C to + 60'C.

##### Grounding System:

The Lightning arrestor grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the specifying engineer or manufacturer of the lightning protection system.

Grounding will be done by copper bonded steel core ground rods especially designed for electrical grounding.

Bonding of the grounding system to metallic parts of the building, the structural reinforcing steel of the building to arriving services is recommended.

Electrically conductive, non soluble TEREC Powder should be used to achieve low ground resistance. Provided the materials are mixed and installed strictly in accordance with the manufacturer's instructions.

##### Lightning and Surge Voltage Protection: Scope:

The work required under this section shall include all material, labour and auxiliaries required to furnish and install complete Surge Protection Devices at main LT Panel incoming feeders (Stage I/ Class B) & Distribution Boards (Stage II/ Class C) for the protection of Building electrical and Electronics system from the effect of Lightning discharges, line induced transient surge voltage or switching surges as per the details mentioned in the BOQ.

##### Codes & Standards:

The following standards & publications as referred in the various parts of this Specification shall apply.

IEC-61643-11, IEC-61643-12 IEC 60 364 – 5 – 5 53

IEC 62 305 - 4

##### Product Specifications:

**Surge Protector at Stage I/ Class B (LT Panel Protector):**

The Surge Protection Device (SPD) manufacturer shall offer a complete line of Surge Protection Devices to support the requirements for Main LT Panel Incoming feeders. The surge protector at this stage shall be provided to protect the down stream electrical and electronics against any lightning discharges surges that may enter into the system through Mains panel.

The Protection unit shall be based on single arc spark gap technology and shall be able to withstand 10/350 microsecond surge currents associated with external lightning discharges.

##### Protection Network Configuration:

The work required under this section consists of furnishing, installing and connecting SPD device as specified and as asked for in BOQ. The SPD device shall be installed in a NETWORK configuration, consisting of one set of SPD panel device at the service entrance of switchboard. All SPD device in this network configuration shall be of same manufacturer. All SPD device shall be modular, mountable on 35 mm DIN rail.

Unit status indicator shall be provided to indicate the status of complete Protection unit.

Protection shall be manufactured for the specific type and voltage of the electrical Service and shall provide clamping for both normal (L-N) and common (N-G) mode operation.

Protection shall be manufactured to withstand a maximum continuous operating voltage of not less than 115% of normal RMS Line voltage of 240 V.

The Protection shall be provided with safety MCB’s to be connected in series between Line/s to neutral & neutral to earth as per the TNS configuration of wiring. It shall be testable on line for routine maintenance, module failure and in order to prevent catastrophic failure modes.

Protection shall be a fail-safe type device, shall have a follow through current quenching capacity upto 25 KA r.m.s., shall have repeated surge capability state, shall be self restoring and be fully automatic in all mode of operation.

Protection shall comply with IEC 61643 and shall be approved for the location in which they are listed.

Protection shall have an operating temperature ranges from -20oC to 60oC.

##### Protection Criteria:

The maximum continuous operating voltage (Rated Voltage) for SPD devices connected to phase-neutral shall not be less than the values shown in table:

|  |  |
| --- | --- |
| Nominal Voltage Rating per phase | Maximum Continuous Operating Voltage |
| (Vrms) | (Vrms) |
| 240 | 320 |

Listing

The surge protective device and associated hardware must comply with IEC 61643-11.

The Protection voltage of the complete rail mount surge protective device shall be type test to the figures as indicated in table below, which must not exceed the values shown.

|  |  |
| --- | --- |
| Service Voltage/ per phase | Protection Voltage @ In (Nominal discharge current)/ Protection Level |
| 240 V | < 2.5 k V (between Line to Neutral)  1.5 kV (between Neutral to Earth) |

Surge protective device application at Low Voltage AC main LT Panel incoming feeder surge impulse current withstanding capacity as shown in table below.

|  |  |
| --- | --- |
| Application Panel Location | Max. Single Withstand Surge Current  (of 10/350 μs Impulse) |
| Service Entrance (Main LT Panel) | 25 KA, 10/350μs (between Line to Neutral 100 KA, 10/350 (between neutral to Earth) |

Compliance to this specification must be provided in the form of a certificate from an independent testing laboratory.

Response time of stage-I class –B arrester should not be < 100 ns.

##### Surge protector at Stage II/ Class C (Final Distribution Board Protector):

The surge Protection manufacturer shall offer a complete line of surge Protection product to support the requirements for the Distribution Board. The surge protector at this stage shall be provided to protect the down stream electrical and electronics against any induced switching surges that may be passed on to the down stream electrical & electronic system.

The Protection unit shall be based on Single High Capacity Metal Oxide Varistors (MOV), capable of handling 8/20 μs surges and shall be able to give an indication in the event module failure and be pluggable to facilitate the in-service replacement without distributing the lines. One extra set of replacement module shall be furnished to the job site.

**Protection Network Configuration**. The work required under this section consists of furnishing, installing and connecting SPD device as specified and as shown in the drawings. The SPD device shall be installed in a NETWORK configuration, consist of one set of SPD panel device at the service entrance of switchboard. All SPD device in this network configuration shall be of same manufacturer. All SPD device shall be modular, mountable on 35 mm DIN rail and be field replaceable without interruption of electrical distribution circuit.

Unit status indicator shall be provided to indicate the status of complete Protection unit on the product as well as provision for remote indication must be provided.

Protection shall be manufactured for the specific type and voltage of the electrical Service and shll provide clamping for both normal (L-N) and common (N-G) mode operation.

Protection shall be manufactured to withstand a maximum continuous operating voltage of not less than 115% of normal RMS Line voltage of 240 VAC.

The Protection shall be provided with internal safety fusing if required, to be connected in parallel between Line/s to neutral & neutral to earth as per the TNS configuration of wiring. It shall be testable on line for routine maintenance, module failure and in order to prevent catastrophic failure modes.

Protection shall be a fail-safe type device, shall have no follow through current shall have repeated surge capability, shall be solid state, shall be self restoring and be fully automatic in all mode of operation. It shall have thermal disconnection and indication against overloading of the device.

Protection shall comply with IEC 61643 standards.

Protection shall have an operating temperature ranges from -20oC to + 60oC.

##### Protection Criteria:

The maximum continuous operating voltage (Rated voltage) for SPD devices connected to phase-neutral shall not be less than the values as shown in table below:

|  |  |
| --- | --- |
| Nominal Voltage Rating per phase | Maximum Continuous Operating Voltage |
| (Vrms) | (Vrms) |
| 120 | 150 |
| 240 | 320 |
| 350 | 440 |
| 480 | 600 |

##### Listing:

The surge protective device and associated hardware must comply with IEC 61643-11.

The Protection voltage of the complete rail mount surge protective device shall ble type test to the figures as indicated in table below, which must not exceed the values shown.

|  |  |
| --- | --- |
| Service Voltage/ per phase | Protection Voltage @ In (Nominal discharge current)/ Protection Level |
| 240 V | 1500 V |

##### Nominal Withstand Surge Current

Surge Protective device (including all fusing and over current protection) for application at sub- Distribution Panels shall have a Nominal surge current withstand capacity as shown in table below. The failure or operation of any fuse/ over – current device during the test is not permissible.

|  |  |
| --- | --- |
| Application Panel Location | Max. Single Withstand Surge Current Of 8/20 µs Impulse) |
| Sub-Distribution Panel | 10KA for 8/ 20 μs (between Line to |
| Final Distribution Board | Neutral) |
|  | 25 KA for 10/350 μs (between |
|  | Neutral to Earth) |

Compliance to this specification must be provided in the form of a certificate from an independent testing laboratory.

Response time of Class C arrestor should not be <25 ns.

#### FIRE PROTECTION SEALING:

##### FIRE PILLOWS:

All electrical & service openings in fire rated walls & floors are to be properly fire stopped with FIRE PILLOWS or equivalent packed tight into openings. Any possible gaps (eg: near cables) shall be sealed with acrylic intumescent of silicon based materials of putty consistency with excellent adhesive and fire resistance properties. All to be installed in accordance with the manufacturer’s instructions to meet the performance criteria in accordance with the BS 476 Part20.

##### FIRE RATED MORTAR

**120 minutes Fire Resistance, Fire Stopping with light weight hydraulic Cement**

Fire-seal cement of light weight hydraulic cement composite in accordance with BS 476 part 20 – Fire cement, a white powder, shall be packed in bags dlended ready for mixing with 12-16 lts of water. 20kg of powder will produce appro. 25 lts of mix which will fill an area of 0.812 sqmt 40mm deep (1.7bags 40mm deep) for 120 minutes Fire resistance.

All the joints are filled with acrylic intumescent of silicon based materials of putty consistency with excellent adhesive and fire resistance properties.

##### BULKHEAD SEALER SYSTEM

2 hours fire rated Bulkhead Sealer as per AS 1530 : Part 4 and BS : 476 Part 20 to seal the opening required to the passage of cables through walls/ slabs – Comprising of two layers of 50mm thick 120kg density rock wool panels tightly sealed and coated with 2 coat of Bulkhead Sealer. The layer of coating is also extended to 50mm into the adjoining wall/ slabs and 100mm on cables to achieve 2 hours fire rating as per BS: 476 Part – 20).

##### FIRE RETARDANT COATING:

Bulkhead Sealer Coating Over Cables as per BS 476: Part 4, 6 & 7.

#### TESTING:

##### General:

At the completion of the work, the contractor shall carry out the pre-commissioning as well as commissioning checks as given below on the entire installation and records be maintained for reference of any statutory authority, Client or their representatives.

##### Pre - Commissioning Checks:

Note - Pre- Commissioning checks are to be carried out by Electrical contractor in presence of Project Management Team.

|  |  |  |
| --- | --- | --- |
| **Sr.**  **No.** | **Component** | **Points to be checked** |
| 1 | Wires | * Correct identification of each wire by continuity check and providing correct ferrules as per approved drawings. * Correct colour coding and correct connection by proper copper lugs. * Wires are dressed and bunched properly. * Connections are properly tightened. * Not more than two wires are connected on any one side of terminal. * IR values of the circuit are measured and recorded. |
| 2 | Switch boxes & Receptacles | * Wires are connected properly as per wiring diagram. * Correct colour coding and correct connection by proper copper lugs is done. * Wires are dressed and bunched properly. * Connections are properly tightened. * Not more than two wires are connected on any one side of terminal. * Earthing connection is made properly. * Functional check is OK * IR values of the circuit are measured and recorded. |
| 3 | Panels | * External cables are glanded properly. * Wires are connected properly as per wiring diagram. * Correct colour coding and correct connection by proper copper lugs is done. * Wires are dressed and bunched properly. * Connections are properly tightened. * Not more than two wires are connected on any one side of terminal. * Two Earthing connections are made properly. * Functional check is OK * IR values of the circuit are measured and recorded. * Check proper mechanical operations of circuit breaking devices including alignment of trolley for drawout type device. * Check contact alignment. And proper sequence of closing and opening of main and arcing contacts. * Check electrical relays, meters & controls for correct wiring. * Check polarity and connections of all instrument transformers. |
| 4 | Light fittings | * Correct colour coding and correct connection by proper copper lugs is done. |

|  |  |  |
| --- | --- | --- |
|  |  | * Connections are properly tightened. * Not more than two wires are connected on any one side of terminal. * Earthing connection is made properly. * IR values of the circuit are measured and recorded. |
| 5 | Lighting Poles | * Concrete foundation is firmly set and cured. * Correct colour coding and correct connection by proper copper lugs is done. * Connections are properly tightened. * Not more than two wires are connected on any one side of terminal. * Earthing connection is made properly. |
| 6 | Cables | * Cable identification tags are provided at both ends. * Cable entry in all equipment is through proper sized glands. * Cable termination is made by proper crimping type lugs. * Connections are properly tightened. * Not more than two conductors are connected on any one side of terminal. * IR values of the circuit are measured and recorded. |
| 7 | Earthing | * The resistance value of each earth electrode are measured and recorded. * Total resistance of earthing system should be as per the design value and in any case, shall not be more than 1 Ohm as per IS-3043. * Continuity test for earth continuity conductors with ELV tester. |
| 9 | DG set | * Check equipment for free movement of rotor, end play, lubrication and any other mechanical defects. * Check commutators, slip ring, brushes, brush holders etc. for satisfactory conditions. * Check insulation test of alternator between windings and ground. Use 500V megger for LV and 1000V megger for HT alternator. * Check if starting batteries are fully charged and properly connected. |

##### Commissioning Checks:

Note –Commissioning checks are to be made in following sequence starting from Transformer/ DG to main panel to last light fitting. All results of testing and observations are to be preserved for record and reference by any statutory authority.

|  |  |  |
| --- | --- | --- |
| 1. | DG set | A. Voltage and frequency test   * Ensure that voltage and frequency is developed at no load as per required specification.   B. AMF Panel   * Check that Dg start signal is given when main power fails. * Check that DG stop signal is given when main power is restored. * Check that ACB close signal is given when DG develops full voltage and frequency.   C. Check proper functioning of,   * Lub. Oil temperature gauge |

|  |  |  |
| --- | --- | --- |
|  |  | * Water temperature gauge * Hour meter with RPM indicator * Battery charging ammeter   **D. Ensure that neutral earthing switch, wherever provided is in closed position.**  E. ensure that all protective relays in AMF and LT panels are set properly.  **F, All rectification points are attended and correctly rectified**  G. First switch on the DG set on NO load and keep for 15-20 minutes  H. Slowly one by one switch on the loads |
| 2. | Main LT panel | * All rectification points are attended and correctly rectified. * Incoming line voltage is correct as per panel incoming meter or checked by tong tester. * Energize only control circuits and carry out closing and tripping operations (where AC supply is derived from main supply and used for operation, the switch gear bus may be energized). * Check operation of electrical interlocks. * Check tripping of breaker by manual operation of relay. * Check operation of mechanical closing and tripping devices. * If incoming line voltage is correct, switch on out going feeder one by one and note that each one is kept ON for 5 – 10 minutes without any problem. |

|  |  |  |
| --- | --- | --- |
| 4 | Switch boxes & Receptacles | * All rectification points are attended and correctly rectified. * Check the voltage with test lamp. * Switch on the circuit. |
| 5 | Lighting Panels | * All rectification points are attended and correctly rectified. * Incoming line voltage is correct as per panel incoming meter or checked by tong tester. * If incoming line voltage is correct, switch on out going feeder one by one and note that each one is kept ON for 5 – 10 minutes without any problem. |
| 6 | Light fittings | * All rectification points are attended and correctly rectified. * Switch on the circuit. |
| 7 | Lighting Poles | * All rectification points are attended and correctly rectified. * Check the voltage with test lamp. * Switch on the circuit. |
| 8 | Earthing | * Check if all earth electrodes in earth pits for it’s correct   installation and connection to earth grid.   * Check if all protective conductors from the earth electrodes to grid and from grid up to all electrical equipment are made correctly. * Remove the protective conductor/ grid connection with earth electrode and measure earth electrode resistance by using earth megger. * Repeat above procedure for all electrodes. * Ensure that total earth resistance of the installation is less than 1 - ohms. |

### ELECTRICAL SYSTEM

**INDEX**

**APPENDIX - III**

**LIST OF APPROVED MAKES**

|  |  |  |
| --- | --- | --- |
| **S.**  **No** | **Materials / Equipment to be installed** | **Manufacturer’s / Vendor’s Name** |
| **A.** | **MEDIUM VOLTAGE EQUIPMENT** |  |
| 1. | Power Distribution Panel and Motor Control Centre & Air Insulated Bus ducts | Jakson. Sudhir Engineering Shivalic Power Controls System Projects & Engineers |
| 2. | Final Distribution Board | ABB Hager (L&T) Havells MDS Legrand Siemens Schneider Electric (MG) |

|  |  |  |
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| 3. | Air Circuit Breaker ( 3/4 Pole ) | ABB (E-Max)  Larsen & Toubro (U Power) Siemens (3 WL)  Schneider Electric (Masterpact NW) And similar equivalent |
| 4. | Moulded Case Circuit Breaker (MCCB) | ABB (T-Max)  Larsen & Toubro (D-Sine) Siemens (3 VL)  Schneider Electric (MG – NS Series)  And similar equivalent |
| 5. | Miniature Circuit Breakers (MCB) | ABB  Legrand Hager L&T Havells  Schneider Electric(Multi-9)  And similar equivalent |
| 6. | Residual Current Circuit Breaker (RCCB) | ABB  MDS Legrand Hager  L&T  Schneider Electric(Multi-9)  And similar equivalent |
| **S.No** | **Materials / Equipment to be installed** | **Manufacturer’s / Vendor’s Name** |
|  | b. Electro\_Magnetic Meters | Secure Conzerv Elmeasure AMTL  equivalent |
|  | c. Digital Dual Source Prepaid Meters with LED Display | Secure Conzerv Elmeasure AMTL  equivalent |

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| 1 | Static Power Meter & Logger (SPML) | Conzerv |
| 5. |  | CG Schlumberger |
|  |  | Larsen & Toubro |
|  |  | Automatic Electric |
|  |  | equivalent |
| 1 | LT Jointing Kit / Termination | Raychem |
| 6. |  | Safe Kit |
|  |  | equivalent |
| 1  7. | PVC insulated copper conductor stranded flexible wires (FRLS) | Finolex Skytone Rajnigandha Batra Henlay |
|  |  | equivalent |
| 1  8. | XLPE / PVC insulated aluminium/coppe conductor armoured MV Cables upto 1100 V grade | CCI  Universal Skytone Polycab equivalent |
| 1 | Cable Glands Double Compression with | Dowell’s (Biller India Pvt. Ltd.) |
| 9. | earthing links | Comet |
|  |  | equivalent |
| 2 | Bimettalic Cable Lug | Dowell’s (Biller India Pvt. Ltd.) |
| 0. |  | Comet |
|  |  | Hax Brass (Copper Alloy India Ltd.) |
|  |  | equivalent |

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| **S. No** | **Materials / Equipment to be installed** | **Manufacturer’s / Vendor’s Name** |
| 21. | Accessories for Mettalic /GI Conduit (ISI approved) | Sharma Sales Corporation Prakash Engineering Works Super Sales Corporation equivalent |
| 22. | PVC Conduit & Accessories (ISI approved) | BEC  Optima D Plast Polypack AKG  equivalent |
| 23. | Switch & Socket | Northwest Schneider (Neo) Anchor (Ave)  ABB  Indo Simon equivalent |
| 24. | Industrial Socket |  |
|  | a. Splash Proof | Clipsal  MDS Legrand Neptune Bals Schneider Electric equivalent |
|  | b. Metal Clad | Havell’s MDS BCH  equivalent |
| 26. | Lighting Fixture |  |
|  | a. LED Light Fixture | Philips Wipro |
|  | b. E x t e r n a l L i g h t i n g F i x t u r e | Philips Wipro |

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| --- | --- | --- |
| **S. No** | **Materials / Equipment to be installed** | **Manufacturer’s / Vendor’s Name** |
|  | c. Aviation Obstruction Light | Bajaj  Binay Opto Actos equivalent |
| 27. | Electronic Ballast for Fluorescent | Philips  Thorn  Wipro (Sigma) Osram  Opal equivalent |
| 28. | Selector Switch, Toggle switch | Salzer (Larsen & Toubro)  Kaycee equivalent |
| 29. | Timer | Schneider Electric (Telemechanique)  ABB  Legrand  Larsen & Toubro GE Power Control Siemens equivalent |
| 30. | Batteries Lead Acid | Exide  Standard equivalent |
| 31. | Sealed Maintenance Free Batteries | Shinkobe (VRLA)  Exide  Hitachi equivalent |
| 32. | Battery Charger | Volstat  Crompton Greaves Chhabi Electricals Caldyne equivalent |
| 33. | Cable Trays (Factory Fabricated) /  Raceways | Profab Engineer  Rico Steel  M M Enterprises Slottco equivalent |
| 34. | Advanced Lightning Protection/ Surge  Protection Devices / Chemical Earthing | LPI  Erico Dehn  ABB – Pulsar Schneider equivalent |

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| --- | --- | --- |
| **S. No** | **Materials / Equipment to be installed** | **Manufacturer’s / Vendor’s Name** |
| 35. | Inverter | Luminous Megatech Microtek  Autopro (Professional Lighting Pvt. Ltd.)  equivalent |
| 36. | MATV System | Swift vision  Cat vision equivalent |
| 37. | UPS | APC  Merlin Gerin  Emerson Network Power Mitsubishi  Powerware equivalent |

1. **VARIABLE REFRIGERANT FLOW SYSTEM**
   1. SCOPE :

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

* 1. TYPE :

Unit shall be air cooled, variable refrigerant volume air conditioner consisting of one outdoor unit and multiple indoor units. Each indoor unit having capability to cool independently for the requirement of the rooms. All indoor units shall be provided with isolation valves so that a particular unit can be isolated and removed for servicing, while system keeps functioning in normal way.

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

* + - Ceiling mounted cassette type.
    - Ceiling mounted duct able type.
    - Wall mounted Hi-Wall type.
    - Floor mounted type.

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

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

Both indoor unit and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivery at site.

* 1. OUT DOOR UNIT :

The outdoor unit shall be factory assembled, weather proof casing constructed from heavy gauge mild steel panels with powder coated finish.

All outdoor units above 5 HP rating shall have minimum two number scroll compressors.

In case of outdoor units with multiple compressor, the operation shall not be disrupted with failure of any compressor.

The noise level shall not be more than 60 dB (A) at normal operation measured horizontally 1m away and 1.5 m above ground level.

The outdoor unit shall be modular in design with possible future expansions. The unit shall be provided with microprocessor control panel.

* 1. COMPRESSOR :

The compressor shall be high efficiency scroll type and capable for capacitycontrolling. It shall change the speed / refrigerant mass flow rate in accordance to the variation in cooling load requirement. Refrigerant mass flow rate can be changed by speed modulation of compressor / mechanical control system. System shall incorporate liquid sub-cooling mechanism with liquid injection at intermediate pressure.

The inverter if used, shall be IGBT (insulated gate bipolar transistor) type for efficient and quiet operation.

All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated. Forced lubrication may also be employed.

Oil heater shall be provided in the compressor casing.

* 1. HEAT EXCHANGER :

The Heat Exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fan coil and larger surface area.

The fins shall have anticorrosion treatment for Heat Exchanger Coil. The treatment shall be suitable for areas of high pollution, moisture and salt laden air.

The casings, fans, motors etc. shall also be with anticorrosion treatment as a standard features.

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

* 1. REFRIGERANT CIRCUIT :

The Refrigerant Circuit shall include anliquid receiver /accumulator, liquid & gas shut off valves and a solenoid valve. All necessary safety devices shall be provided to ensure the safety operation of the system..

* 1. SAFETY DEVICES :

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

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

* 1. PIPING :

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

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

Insulation of cold lines shall be carried out with Armaflex / K-Flex insulation sheets and tubes of appropriate thickness so that condensation does not occur.

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

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

* 1. OIL RECOVERY SYSTEM :

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

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

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

* 1. INDOOR UNITS :

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

Units shall have DX coils with copper tubes and bonded aluminium fins for highly efficient heat transfer. Units shall have Centrifugal fans for adequate amount of Air circulation and low Noise.

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

All components of Units are easily accessible for connection, repairs and maintenance. Units shall have very low noise.

All units with Factory manufactured Units, Grills shall have auto swing feature for proper Air distribution. All unit shall be controlled by electronic Expansion Valves only.

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

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

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

Anticorrosion treatment for avoiding corrosion of coils.

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

Cooling coil and refrigeration parameters shall be designed in such a way that supply air temperature shall not be less than 20C or 10C above room dew point temp, whichever is more. Contractor shall guarantee inside conditions with selected supply air temperature.

* 1. CEILING MOUNTED CASSETTE TYPE UNIT (MULTI-FLOW TYPE) :

The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated galvanized steel. The body shall be light in weight and shall be possible to suspend from four corners.

Unit shall have a external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grille in centre.

Each unit shall have high lift drain pump, fresh air intake provision (if specified), low gas level detection system and very low operating sound.

* 1. CEILING MOUNTED DUCTABLE TYPE UNIT :

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

* 1. HIGH WALL MOUNTED UNITS :

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

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

1.2. FLOOR MOUNTED UNITS :

The unit shall be suitable for floor mounting. The unit shall include, pre-filter fan section, DX. Coil section. The housing of unit shall be light weight powder coated galvanised / anodisedaluminium panels. Unit shall have an attractive external casing with supply & return air grilles.

* 1. CENTRAL REMOTE CONTROLLER (OPTION IF SPECIFIED IN BOQ) :

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

The controller shall be able to control upto min. 64 zones of 64 group (each group consisting of max. 16 units) or 128 nos. of indoor units with the following functions.

* Temperature setting for each zone, or group, or indoor unit.
* On/Off as a zone or individual unit.
* Indication of operating condition.
* Select ON of all operation modes for each zone..
* The controller shall have wide screen liquid crystal display and shall be wired by a non polar 2 wire transmission cable to a distance of 1000m away from the indoor unit.
* The controller shall be integrated to BAS system thru software for monitoring & controlling of all above parameters including start/ stop of each indoor / out door unit. All necessary interface cards / units should be supplied as a part of the system to integrate to the BAS Software.
  1. UNIFIELD ON/OFF CONTROLLER (OPTION IF SPECIFIED IN BOQ) : Unified ON / OFF controller shall be supplied as an optional accessory.

The controller shall be able to control minimum 2 groups (each group containing maximum 16 indoor units) or 128 nos. of indoor units with the following functions.

* + - On / Off as a zone or individual unit.
    - Indication of operation condition of each group.
    - Select one of 4 operation modes.

The controller shall be wired by a non-polar 2 wire transmission cable to distance of 1 km away from indoor unit.

The controller shall be integrated to BAS system thru software for monitoring & controlling of all above parameters including start/ stop of each indoor / out door unit. All necessary interface cards / units should be supplied as a part of the system to integrate to the BAS Software.

* 1. CONDENSATE:

25mm diauPVC pipes, 40mm diauPVC headers & fittings shall be usedfor condensate, from Evaporator Unit to drain point. The joints shall be properly sealed so that there is no water leakage. U-trap shall be provided at the end. Additional insulation drain tray shall be provided below the Evaporator Unit, if required.

##### Mounting

All indoor units shall be mounted with Brackets, Hangers etc. with proper size anchor Fasteners.

1.18 ELECTRICAL INSTALLATION :

For Variable Refrigerant flow systems, power will be provided near outdoor unit location. HVAC Contractor to provide suitable distribution panel along with 3-phase power to outdoor units and single phase power to all indoor units fed by these outdoor units. Power / control cabling along with supports shall be included.

### DRY SCRUBBERS

* 1. SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of dry scrubbers comprising of electrostatic sections with auto wash module for use in kitchen exhaust / grease / exhaust air treatment.

* 1. TYPE

The unit shall be CE certified and of the type as indicated on Drawings and identified in Schedule of Quantities.

* 1. CAPACITY

The air-moving capacity of unit shall be as shown on Drawings and in Schedule of Quantities.

* 1. Technical parameters

The unit shall provide efficiency of 90% or better for single pass base on ASHRAE test method at flow rates of 800 – 1300 CFM per module (supported by sample test report by a US laboratory). Multiple units can be joined together for increased volume. The system shall be suitable to connect to fan section with average velocity of 500 FPM across air cleaner.

* 1. Equipment specifications

The unit shall be designed and constructed and supplied by a manufacturer specializing in the research, design and manufacture of products specified in this section with a minimum of three years of documented experience, and capable of issuing complete catalog data on the total product.

* 1. Unit Housing

Housing shall be 16-gauge zinc coated steel construction to protect against rust and corrosion. Each section shall include single door access, located one side of the unit. The access door shall be mounted on steel hinges and secured with adjustable, gasket sealed lever latches allowing for component access and removal. All doors shall be gasketed to prevent air and water leakage. Doors to charged high voltage components shall be equipped with electrical interlocks, for interconnection into the primary power supply, to prevent access when the components are energized. The housing shall be furnished completely assembled for ease of shipment and installation. Between each section, a permanent 1/8” thick gasket shall be installed to prevent leakage. The bottom drain pan under ESP section containing integral washing systems shall be pitched downward 1/4“ per foot minimum toward a 3” NPT drain nipple.

* 1. Base construction:

The sections are to be mounted on a structural C-channel or floor mounting or ceiling suspension. Lifting lugs shall be incorporated in the base channel to allow for rigging, if ordered.

* 1. Finish

The external casing finish shall be a durable industrial grade semi gloss baked-on epoxy ester, not less than 3 mil minimum thickness.

* 1. Cells Wash Module

The Cells Wash module shall incorporate mechanical filtration. The stationary filter from the direction of airflow will be a metal mesh filters with single, gasketed access doors. Wash manifolds and headers are supplied to wash the module during the normal wash cycle.

* 1. Electrostatic Precipitator Module:

The electronic air cleaner shall be the two-stage dual voltage plate type cells, rated at not less than 90% efficiency as per the ASHRAE test standards for dry particulate (supported by sample test report by a US laboratory).The collection cells shall be in Single Pass arrangement to provide for maximum collection efficiency.

* 1. Ionizing collection cell

Ionizing-Collecting cell(s) shall be of one-piece construction 2.23” inches deep in direction of airflow. All support framing, end plates and ionizer ground electrodes shall be 0.090 inch thick aluminum. Both repelling and collector plates shall be 0.020 inch thick aluminum, 9.125 inch deep in direction of airflow and rigidly retained in place with tubular spacers and tie rods. Spacing between plates shall be no less than

0.175 inch. Ionizing electrodes shall be 24 gauge stainless steel spiked design, ionization wires are not acceptable, rigidly supported both vertically and laterally. High voltage support insulators shall be of self- glazing Cordierite ceramic with all surfaces, including center hole, glazed to enhance dielectric strength and retard tracking. Insulators shall be mounted out of the airstream, to reduce contaminant buildup. All high voltage electrical connections within each tier of cells, shall be between cells and automatically made when cells are installed. All electrical connections between unit tiers and high voltage connections between power packs and cells shall be located on the access door end of the cabinet and manually connected for ease of service.

* 1. Power supplies

Power supplies shall be 100% solid state, UL Listed. operate on 200 to 240 VAC, 50 HZ, 1 Phase input and provide a dual high voltage output of (+) 12 to 13 KVDC for the ionizer and (+) 6.0 to 6.5 KVDC for the collector. A regulated output of up to 5.5 MA shall be supplied to maintain the specified collection efficiency. Integrally mounted electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power. The power supply shall operate over a temperature range of -32 degrees F to 20 degrees F, be self-protecting and accommodate an LED light indicating the performance status of the ionizing/collecting cell. High voltage output leads shall be sealed and a bleed resistor incorporated to remove stored electrical charge where the power supply(s) are de-energized. Module of capacity above 3000 CFM shall be equipped with Pulse width modulating (PWM) to maintain the specified collection efficiency by maintaining a constant charge in the event of Low/High Voltage from source thus ensuring that the unit functionality is not affected with these voltage fluctuations. Power Consumption should not be more that 50 watts per ESP cell.

All power supply components shall be designed for ease of mounting and servicing. High voltage power cables shall be of one continuous length, splicing is not acceptable.

* 1. System Controls

Programmable Logic Controller (PLC) shall be housed in a NEMA-12 type enclosure. Controller shall be shipped for remote mounting and must be installed indoors or other means of weather protection provided if installed. Terminals shall be provided to interconnect the system fan and shall sequence the detergent wash, soak, rinse fan force dry and return to operation cycle. All sequence times shall be factory set. Control initiation shall be semiautomatic, push button initiated, or fully automatic by time clock, with semiautomatic push button override.

A remote mounted Sleep Mode Reset Switch (momentary contact push button type) shall be supplied to be installed at the kitchen hood location to re-energize the air cleaning system after the wash system has completed. The switch may optionally be installed on the panel of the ATS control enclosure.

2.2 Automatic Time Clock

The control cabinet shall be furnished with a factory installed and wired 7-day initiator clock with battery backup.

* 1. Water Wash/Detergent System

Detergent wash and rinse will be accomplished with manifolds located on the air entering sides of the (prefilter wash collar if supplied) ionizing/collecting cell tier through spray nozzles delivering a cone shaped pattern. The detergent reservoir, pump, motor and bypass valve shall be provided as a prepackaged assembly with an adjustable detergent volume setting. The detergent pump motor shall be 0.75kW TEFV motor, 220v/50hz/1ph, with pump of positive displacement self priming and deliver not less that 6 GPM at 50 PSIG minimum outlet pressure. Pump motor shall contain built-in overload protection. Main water line strainer and solenoid valves are to be factory furnished with the system. Detergent system shall a 30-gallon tank for remote mounting with initial supply of biodegradable detergent as per unit manufacturer’s recommendations.

* 1. Static Pressure Drops

The pressure drop shall not exceed the following (inches H2O):

ESP Section 0.2”

Metal Mesh prefilter or after filter 0.10”

The ESP section must have both an internal prefilter and an after filter, select and add for each.

External losses for ductwork, exhaust hoods, manufacturing equipment with associated entry losses, kitchen hoods, etc.. must be added with the above internal equipment losses to calculate total fan static pressure required.

* 1. Adsorber Module

The Adsorber Module shall be designed to utilize required number of 23.38” x 23.38” x 2” deep trays that are powder painted for corrosion resistance, may be reused and are secured in a V-bank arrangement on steel slide tracks. Trays shall be charged with 18.25 lbs. of activated carbon granules.

#### FANS

* 1. SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of centrifugal, in- line and propeller type fans and roof mounted units conforming to these Specifications and in accordance with the requirement of Drawings and Schedule of Quantities.

* 1. TYPE

Centrifugal, in-line propeller fans and roof mounted units shall be of the type as indicated on Drawings and identified in Schedule of Quantities.

* 1. CAPACITY

The air-moving capacity of fans shall be as shown on Drawings and in Schedule of Quantities.

* 1. CENTRIFUGAL FAN

Centrifugal fan shall be DWDI / SWSI Class I construction arrangement 3 (i.e. bearings on both the sides) for DWDI fans complete with access door, squirrel-cage induction motor, V-belt drive, belt guard and vibration isolators, direction of discharge / rotation, and motor position shall be as per the Approved-for- Construction shop drawings.

* + 1. Housing shall be constructed of 2 gage sheet steel welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene / asbestos packing should be provided throughout split joints to make it air-tight.

18 gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout door with handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

* + 1. Fan Wheel shall be backward-curved non-over loading type. Fan wheel and housing shall be statically and dynamically balanced. For fans upto 450 mm dia, fan outlet velocity shall not exceed 550 meter/minute and maximum fan speed shall not exceed 250 rpm. For fans above 450 mm dia, the outlet velocity shall be within 700 meter/minute and maximum fan speed shall not exceed 1000 RPM. High static pressure fan speed shall be as per manufacturer.
    2. Shaft shall be constructed of steel, turned, ground and polished.
    3. Bearings : shall be of the sleeve / ball-bearing type mounted directly on the fan housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil / grease pack pillow block type.
    4. Motor : Fan motor shall be energy efficient and suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, squirrel-cage, totally enclosed, fan-cooled motor, provided with class F insulation, and of approved make. Motor name plate horsepower shall exceed brake horsepower by a minimum of 10%.

Motor shall be designed especially for quiet operation and motor speed shall not exceed 240 rpm. The fan and motor combination selected for the particular required performance shall be of the most efficient (smallest horse power), so that sound level is lowest.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **HP** | **POWER FACTOR** | | | **EFFICIENCY** | | |
| **FL** | **3/4L** | **1/2L** | **FL** | **3/4L** | **1/2L** |
| 0.50 | 0.71 | 0.62 | 0.50 | 73.00 | 73.00 | 68.00 |
| 0.75 | 0.74 | 0.64 | 0.50 | 78.00 | 78.00 | 70.00 |
| 1.00 | 0.76 | 0.67 | 0.55 | 82.50 | 82.50 | 77.00 |
| 1.50 | 0.77 | 0.70 | 0.57 | 83.80 | 83.80 | 80.00 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 2.00 | 0.77 | 0.70 | 0.57 | 85.00 | 85.00 | 81.00 |
| 3.00 | 0.82 | 0.74 | 0.60 | 86.40 | 86.40 | 84.00 |
| 5.00 | 0.82 | 0.78 | 0.63 | 88.30 | 88.30 | 86.00 |
| 7.50 | 0.85 | 0.80 | 0.71 | 89.50 | 88.50 | 88.00 |
| 10.00 | 0.86 | 0.83 | 0.76 | 90.30 | 90.30 | 89.00 |
| 12.50 | 0.84 | 0.82 | 0.73 | 90.50 | 90.50 | 88.00 |
| 15.00 | 0.85 | 0.83 | 0.76 | 91.50 | 91.50 | 89.50 |
| 20.00 | 0.85 | 0.83 | 0.76 | 92.20 | 92.20 | 91.00 |
| 25.00 | 0.85 | 0.82 | 0.76 | 92.40 | 92.40 | 91.00 |
| 30.00 | 0.85 | 0.80 | 0.72 | 92.80 | 92.80 | 92.00 |
| 40.00 | 0.86 | 0.85 | 0.80 | 93.20 | 93.20 | 91.00 |
| 50.00 | 0.87 | 0.85 | 0.77 | 93.60 | 93.60 | 91.60 |
| 60.00 | 0.88 | 0.86 | 0.78 | 93.90 | 93.90 | 91.90 |
| 75.00 | 0.87 | 0.85 | 0.78 | 94.20 | 94.20 | 92.80 |

* + 1. Drive to fan shall be provided through belt with adjustable motor sheave and a standard belt guard. Belts shall be of the oil-resistant type.
    2. Vibration Isolation : MS base shall be provided for both fan and motor, built as an integral part, and shall be mounted on a concrete foundation through resistoflex vibration isolators. The concrete foundation shall be atleast 15 cm above the finished floor level, or as shown in approved-for- construction shop drawings.

#### AIR DISTRIBUTION

(FOR DUCTS FABRICATED IN FACTORY**AS PER “SMACNA” STANDARDS)**

* 1. SCOPE

The scope of this section comprises supply fabrication, installation and testing of all sheet metal / aluminum ducts, supply, installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

* 1. DUCT MATERIALS

4.2.1 RAW MATERIALS

Galvanizing shall be Class VII – light coating of zinc, nominal 180gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner’s site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

* + 1. GAUGES, BRACING BY SIZE OF DUCTS

All ducts shall be factory fabricated from galvanized steel / aluminum of the following thickness, as indicated as below :

* + - 1. For Ducts with external SP upto 250 Pa ( ESPupto 25mmWg)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Rectangular Ducts G. S.** | **Pressure 250 Pa** | | |
| **Duct Section Length 1.2 m (4 ft)** | | |
| **Maximum Duct Size** | **Gauge** | **Joint Type** | **Bracing Spacing** |
| 1–500 mm | 26 | C&S Connector | Nil |
| 501 – 750 mm | 26 | C&S Connector | Nil |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 751 – 900 mm | 26 | TDF Flange | Nil |  |
| 901 – 1200  mm | 24 | TDF Flange | Nil |
| 1201 – 1500 mm | 22 | TDF Flange | Nil |
| 1501 – 1800 mm | 22 | TDF Flange | JTR or ZEE  BAR |
| 1801 – 2100 mm | 20 | TDF Flange | JTR or ZEE  BAR |
| 2101 – above | 18 | TDF Flange | JTR or ZEE  BAR |

\*Distance of reinforcement/bracing from each joint. Bracing material to be same as of material used for joining of duct sections.

* 1. DUCT CONSTRUCTION
     1. All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.
        1. Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section “Insulation” and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities.

The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.

* + - 1. Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.
      2. All ducts up to 75cms width within conditioned spaces shall have C&S connector. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.
      3. Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
      4. Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.
      5. All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.
      6. Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
      7. Self adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.
      8. All fire rated duct, smoke exhaust ducts shall be quoted with flamebar BWII or equivalent to achieve the required fire rating also all the related accessories gaskets shall be suitable for the required fire rating.
  1. SUPPLY AND RETURN AIR REGISTERS

Supply & return air registers shall be of either steel or aluminium sections as specified in schedule of quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodised or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers both horizontal and vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodised in matt black shade.

The registers shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom). The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8 mm in rear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect. The grilles shall be suitable for concealed fixing. Volume control dampers of extruded aluminiumanodised in black color shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be & suitable for clip fixing, permitting its removal without disturbing the flanges.

1. All registers shall be selected in consultation with the Architect. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from Architect for each type of register.
2. All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66 percent of gross face area.
3. Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to +45 degree horizontal arc and upto 30 degree deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.
4. Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.
5. All volume control dampers shall be anodisedaluminium in mat black shade.
   1. SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory coated with rust-resistant primer. Aluminium diffusers shall be powder coated & made from extruded aluminium section as specified in schedule of quantities.

* + 1. Rectangular Diffusers shall be steel / extruded aluminium construction, square & rectangular diffusers with flush fixed pattern for different spaces as per schedule of quantities These shall be selected in consultation with the Architect. These shall be procured only after obtaining written approval from Architect for each type of diffuser.
    2. Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as required in specific applications, and as per requirements of schedule of quantities. All extruded aluminiumdiffusers shall be provided with removable central core and concealed key operation for volume control damper.
    3. Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control/ balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Architect, and provided as per requirements of schedule of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodised in mat black shade.
    4. Slot Diffuser shall be extruded aluminiumconstructionmultislot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control

dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Architect and provided as per requirement of Schedule of Quantities.

* + 1. Data centers shall be provided with floor grilles. Grilles shall be of nominal size of 600mm x 600mm and shall be fitted in floor tile of false floor. Grille shall be with dampers for flow control. Grill shall be heavy duty 16G Aluminium and shall take care of human traffic load. Damper shall be operable in situ without requirement of removal of grille

#### INSULATION

* 1. SCOPE

The scope of this section comprises the supply and application of insulation conforming to these specifications.

Thickness of the insulation shall be as specified for the individual application. **Each lot of insulation material delivered at site shall be accompanied with manufacturer’s test certificate for thermal conductivity values, density, water vapour permeability and fire properties.** Samples of insulation material from each lot delivered at site may be selected by Owner’s site representative and gotten tested for thermal conductivity and density at Contractor’s cost.Adhesive used for sealing the insulation shall be non- flammable, vapour proof adhensive strictly as per manufacturer’s recommendations.

Ducting insulation thickness shall be as per table below.

|  |  |
| --- | --- |
| **Ducting position** | **Thickness** |
| SA duct in RA path | 13mm |
| Ducted return air system | SA duct: 19mm RA duct: 13mm |
| Both SA& RA exposed | Both 25mm |

#### QUALITY ASSURANCE,INSPECTION, TESTING AND COMMISSIONING

* 1. SCOPE

The following quality assurance, inspection, testing and commissioning procedures shall be required to be carried out upon award of work.

1. Provide quality assurance program (QAP), works quality assurance program (WQAP), field quality assurance program (FQAP) and quality plan.
2. Tests at manufacturer’s works.
3. Perform site tests and commissioning.
   1. SUBMITTALS
4. After award of work following information shall be submitted.
   1. Quality Assurance Program (QAP)
   2. Works Quality Assurance programme (WQAP)
   3. Field Quality Assurance Programme (FQAP)
5. For inspection and testing, submit inspection and testing procedures, programme, record sheets applicable at each hold point.
6. After completion of testing, submit test records, packaging, transportation and storage instructions and methods.
7. For site installation and commissioning, submit installation methods or procedures, notification and procedures for precommission and commissioning.
8. After commissioning, submit site test records, as-built drawings, manufacturer’s operation

maintenance manuals and list of recommended spares and tools.

* 1. QUALITY ASSURANCE CONCEPT AND CONTROL

1. Minimum requirements for establishing and implementing a quality assurance programme shall be applied to all aspects of the work necessary for carrying out the contract. Quality assurance shall extend to material parts, components, systems and services as a means of obtaining and sustaining the reliability of critical items, operating performance, maintenance and safety.
2. Acceptance of the Contractor’s quality assurance programme does not relieve the Contractor’s obligation to comply with the requirement of the contract document. If the programme is found to be ineffective, then the Owner’s site representative reserves the right to request for necessary revisions of the programme.
3. The Contractor is required to produce readily identifiable documentary evidence covering the extent

and details of both his own and his sub contractor’s quality assurances system as follows :

* 1. Quality Assurance Program (QAP)
  2. Works Quality Assurance programme (WQAP)
  3. Field Quality Assurance Programme (FQAP)
  4. Quality Plan.

1. These documents shall be prepared separately and submitted to the Owner’s site representative at

the time of starting the work.

1. Quality Plan and Manual shall be prepared by the Contractor for all items and services to be supplied, after the contract has been placed, but before commencement of fabrication, and shall be subject to evaluation and acceptance by the Owner’s site representative before start of work.
   1. QUALITY ASSURANCE MANUAL (QAM)
2. The QAM shall be a general comprehensive document outlining the Contractor’s basic organization,

policies and procedures. The information to be given in the QAM shall include but not limited to :

* 1. Quality Policy.
  2. Quality Assurance Programme
  3. Organisation Structure showing inter relationships.
  4. Functional responsibilities and levels of authority.
  5. Lines of communication.
  6. Customer relations.
  7. Laboratory Facilities.
  8. WORKS QUALITY ASSURANCE PROGRAMME (WQAP)

1. The WQAP shall identify the Contractor’s Quality Assurance Programme at works applicable throughout all phases of Contract performance, including design, procurement, manufacture, inspection and testing. It shall identify each of the programme elements to be designed, developed, executed and maintained by the Contractor for the purpose of ensuring that all supplies and services comply with this specifications.
2. The information to be given under this programme shall include but not limited to :
   1. Organisation and Responsibility.
   2. Contract Review.
   3. Design and Document Control.
   4. Procurement Control.
   5. Production Control.
   6. Control on Sub-contractors.
   7. In-process Quality Control and Traceability.
   8. Inspection and Testing.
3. Control of Non-conformances.
4. Corrective Action.
5. Control of Inspection, Measuring and Test Equipment.
6. Handling, Storage, Packaging and Delivery.
7. Records.
8. Quality Audits.
9. After - Sales Servicing.
   1. FIELD QUALITY ASSURANCE PROGRAMME (FQAP)
10. This programme shall identify the Contractor’s Quality Assurance Programme at site applicable throughout site construction, erection and commissioning. It is the underlying philosophy that the quality built into the product at works shall be maintained throughout the construction and commissioning stages.
11. While, in principle, the FQAP shall include the items discussed in WQAP, it shall, however, be approached differently to take into account site conditions.
12. The FQAP shall include, but not limited to the following information :
    1. Organisation and responsibility.
    2. Control of Drawings and Documentation.
    3. Product Checklist.
    4. Control and Traceability of Purchased materials and services.
    5. Receipt Inspection of materials at site.
    6. Material Storage Control.
    7. Inspection and Examination Procedures.
    8. Control of Painting and Insulation Works.
13. Pre-commissioning.
14. Commissioning.
15. Control of Non-conformances.
16. Corrective Action.
17. Control of Inspection, Measuring and Test Equipment.
18. Records.
19. Completion Documents.
20. List of recommended spares and tools.
21. Personal Training.
22. Servicing during Defects Liability Period.
    1. QUALITY PLAN
23. The contractor shall be required to prepare manufacturing and construction/erection quality plans for all equipment items and services. The quality plan shall also define the involvement of Owner’s site representative in the inspection and test programmes.
24. The Quality Plan shall incorporate as appropriate :
    1. Charts indicating flow of materials, parts and components through manufacturing quality control inspection and test to delivery and erection.
    2. The charts shall indicate the location of hold points for quality control, inspection and test beyond which manufacture shall not continue until the action required by the hold point is met, and the documentation required is generated.
    3. The control documents associated with each hold point, i.e. drawings, material, specification, Works Process Schedule (WPS), Process Quality Records (PQR), quality control methods and procedures and acceptance standards.
    4. SITE QUALITY CONTROL SECTION
25. The Contractor’s Quality Control (Q.C.) section shall be headed by an experienced Quality Control Engineer. He shall be assisted by other supervisors. The section shall be an independent one, reporting to the contractor’s Site Manager only on administrative matters, but otherwise under full control by the Contractor’s Corporate Quality System Management.
26. The Contractor’s Q.C. Section shall liasise closely with the Owner’s site representative in charge of Quality Assurance/Quality Control, and to whom it shall give fullest cooperation. It is the underlying principle of this contract document that while the Contractor’s Q.C. Engineer implements the Contractor’s Quality Programme, the adequacy and effectiveness of that implementation shall be audited by the Owner’s site representative whose recommendations on improving or maintaining quality shall be acted upon promptly by the Contractor’s Q.C. Section.
    1. INSPECTION AND TESTING
27. All equipment and components supplied may be subjected to inspection and tests by the Consultant/ Owner’s site representative during manufacture, erection/installation and after completion. The inspection and tests shall include but not be limited by the requirements of this contract document. Prior to inspection and testing, the equipment shall undergo pre-service cleaning and protection.
28. Tenderers shall state and guarantee the technical particulars listed in the Schedule of Technical Data. These guarantees and particulars shall be binding and shall not be varied without the written permission of the Owner’s site representative.
29. No tolerances shall be allowed other than the tolerances specified or permitted in the relevant approved Standards, unless otherwise stated.
30. If the guaranteed performance of any item of equipment is not met and / or if any item fails to comply with the specification requirement in any respect whatsoever at any stage of manufacture, test or erection, the Owner’s site representative may reject the item, or defective component thereof, whichever he considers necessary; and after adjustment or modification as directed by the Owner’s site representative, the contractor shall submit the item for further inspection and /or test.
31. The approval of the Owner’s site representative of inspection and/or test results shall not prejudice the right of the Owner’s site representative to reject an item of equipment if it does not comply with the contract document when erected, does not or prove completely satisfactory in service.
32. The Contractor shall be responsible for the timely transmission of the relevant and appropriate sections of the contract document to manufacturers and sub-contractors for the proper execution of all tests at their works as per contract specifictions.
    1. TESTS AT MANUFACTURER’S WORKS
33. All tests to be performed during manufacture, fabrication and inspection shall be agreed with the Consultant/ Owner’s site representative prior to commencement of the work. The Contractor shall prepare the details of the schedule and submit these to the Consultant/ Owner’s site representative for approval. It must be ensured that adequate relevant information on the design code/standard employed, the manufacture /fabrication/assembly procedure and the attendant quality control steps proposed are made available to the Consultant/Owner’s site representative who will mark in the appropriate spaces his intention to attend or waive the invited tests, or inspections. Contractor shall arrange inspection and factory witness test for centrifugal, screw chiller and vapour absorption chiller.
34. A minimum of twenty-one days’ notice of the readiness of equipment for test or inspection shall be provided to the Owner’s site representative by the Contractor (whether the tests be held at the Contractor’s of Sub-contractor’s works). The subject items should remain available for Owner’s site representative inspection and test up to a minimum 10 days beyond the agreed date of witnessing the test. Every facility in respect of access, drawings, instruments and manpower shall be provided by the Contractor and sub-contractor to enable the Owner’s site representative to carry out the necessary inspection and testing of the Plant.
35. No plant shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, all tests called for have been successfully carried out in the presence of the Owner’s site representative or approved for shipment, or alternatively inspection has been waived.
36. Functional electrical, mechanical and hydraulic tests shall be carried out on completed assemblies in the works. The extent of these tests and method of recording the results shall be submitted to, and agreed by, the Owner’s site representative in sufficient time to enable the tests to be satisfactorily witnesses, or if necessary for any changes required to the proposed programme of tests to be agreed.
37. The Consultant/Owner’s site representative reserves the right to visit the Manufacturer’s works at any reasonable time during fabrication of equipment and to familiarize himself with the progress made and the quantity of the work to date.
38. Within 30 days of completion of any tests, triplicate sets of all principal test records, test certificates

and correction and performance curves shall be supplied to the Owner’s site representative.

1. These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Owner’s site representative or not. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the Contract reference title.
2. When all equipment has been tested, the test certificates from all works and site tests shall be compiled by the Contractor into volumes and bound in an approved from complete with index and four copies of each volume shall be supplied to Consultant/ Owner’s site representative.
3. Stage wise inspection of equipment in factory in waived.
   1. PERFORMANCE TESTS AT MANUFACTURER’S WOKS
4. All equipment may be subjected to routine performance tests at the Manufacturer’s Works in accordance with the relevant ANSI, ASME, ASTM, BIS standard including operating tests of complete assemblies to ensure correct operation of apparatus and components.
5. Pumps, fans, compressor, and other rotating equipment shall be given full load tests, and run to 15% overspeed for 5 minutes to check vibration. Main and auxiliary gear boxes shall be subjected to shock load tests and a six-hour endurance run at rated speed and maximum torque.
6. The Contractor shall submit single line diagrams including the layout of the Plant together with the location of test instrumentation and the principal dimensions of the layout. All calculations to derive performance data shall be made strictly in accordance with format given in the approved standards. Any alterations or deviations from the approved standard test layout or formulae shall be subjected to the prior approval of the Owner’s Site Representative.
7. The performance test shall be conducted over the full operating range of the pump to a closed valve condition and a minimum of five measurement points covering the full range shall be taken. Curves indicating Quality vs. Head, Quantity vs. Power absorbed, and Quantity vs. Pump efficiency shall be provided. In addition a curve of the NPSH required vs. Quantity shall be provided except when the suction conditions do not require this test. Any proposal for the omission of this test shall be to the approval of the Consultant/ Owner’s site representative.
8. On completion of the tests the Contractor shall submit a report showing the test results obtained together with the curves corrected to the site operating conditions.

### TESTING, ADJUSTING AND BALANCING

* 1. SCOPE
     1. Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.
     2. Testing, adjusting and balancing of HVAC Hydronic system at site.
     3. Testing, adjusting and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and associations including :

ASHRAE : 2007 HVAC Application.

SMACNA : Manual for the Balancing and Adjustment of air distribution system.

* 1. PERFORMANCE
     1. Verify design conformity.
     2. Establish fluid flow rates, volumes and operating pressures.
     3. Take electrical power readings for each motor.
     4. Establish operating sound and vibration levels.
     5. Adjust and balance to design parameters.
     6. Record and report results as per the formats specified.
  2. DEFINITIONS
     1. Test : To determine quantitative performance of equipment.
     2. Adjust : To regulate for specified fluid flow rates and air patterns at terminal equipment (e.g. reduce fan speed, throttling etc.)
     3. Balance : To proportion within distribution system (submains, branches and terminals) in accordance with design quantities.
  3. TESTING, ADJUSTING AND BALANCING (TAB) PROCEDURES

The following procedures shall be directly followed in TAB of the total system.

Before commencement of each one of the TAB procedure explained hereunder, the contractor shall intimate the PMC about his readiness to conduct the TAB procedures in the format given in these specifications.

* 1. DESCRIPTION OF SYSTEM AND REQUIREMENTS

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

* + 1. All supply, return and outside air systems.
    2. All exhaust air systems.
    3. All chilled water systems.
    4. All cooling tower (condenser) water systems.
    5. Emergency purge systems.
  1. AIR SYSTEMS

##### Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results :

* 1. Air-IN DB and WB temperature.
  2. Air-OUT DB and WB temperature.
  3. Dew point air leaving.
  4. Sensible heat flow.
  5. Latent heat flow.
  6. Sensible heat factor.
  7. Fan air volume.
  8. Fan air outlet velocity.
  9. Fan static pressure.
  10. Fan power consumption.
  11. Fan speed.

##### Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts utilising telescoping probes of Electronic Rotating Vane Anemometers and Accubalance for grilles and diffusers.

##### The Preparatory Work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals :

* 1. All outside air intake, return air and exhaust air dampers are in proper position.
  2. All system volume dampers and fire dampers are in full open position.
  3. All access doors are installed & are air tight.
  4. Grilles are installed & dampers are fully open.
  5. Provision and accessibility of usage of TAB instruments for traverse measurements are available.
  6. All windows, doors are in position.
  7. Duct system are of proper construction and are equipped with turning vanes and joints are sealed.
  8. Test holes and plugs for ducting.
  9. READINESS FOR COMMENCEMENT OF TAB

Before starting of any of the tests, the readiness to do so should be recorded as per the prescribed check list.

* 1. TAB INSTRUMENTS
     1. Air Measuring Instruments
        1. For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA make VelociCalcPlus Meter, Model 8386, or equivalent shall be used. This instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.
        2. For measuring Air velocity, DB temperature and Air volume, TSI USA make VelociCalc meter model 8386/ 8345 or equivalent shall be used. It shall be able to provide instant print out of recorded Air volume readings.
        3. Pitot tube.
        4. Electronic Rotary Vane Anemometer TSI make or equivalent.
        5. Accubalance Flow Measuring Hood TSI make or equivalent.

[All above instruments shall have a valid certification from a reputed testing institution.

* + 1. Hydronic Measuring Instruments
       1. For measurement of water flow across balancing valves, instruments as provided by the manufacturer of the valves specific to the type of valves shall be need. This shall include but not be limited to differential pressure manometers. Temperature shall be measured using electric thermometers from thermowells provided at strategic location by the HVAC contractor.

The water balancing shall be carried out being computer simulation program provided / certified by the balancing valve manufacturer.

* + 1. Rotation Measuring Instrument
       1. Electronic Digital Tachometer.
    2. Temperature & RH Measuring Instrument
       1. TSI VelociCalc model 8386 / VelociCalc model 8345 or equivalent.
    3. Electrical Measuring Devices
       1. Clamp on Volt ammeter.
       2. Continuity Meter.
    4. Vibration and Noise Levels

Vibration and alignment field measurements shall be taken for each circulating water pump, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, and other test as directed by the PMC.

Sound level readings shall be taken at ten (10) locations in the building as selected by the PMC. The readings shall be taken on an Octave Band nalyzer in a manner acceptable to him. The contractor shall submit test equipment data and reporting forms for review. In order to reduce the ambient noise level the readings shall be taken at night. All test shall be performed in the presence of PMC/Consultant.

# SYSTEM READY TO BALANCE CHECK LIST

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Ready | | Date |  |  | Ready | | Date |
| **1. HVAC Units (AHU)** | Yes | No. | Corrected |  |  | Yes | No. | Corrected |
|  |  |  |  |  |  |  |  |  |
| **a) General** |  |  |  |  | **e) Vibriation isolation** |  |  |  |
| Louvers installed |  |  |  |  | Springs and compression |  |  |  |
| Manual dampers open & locked |  |  |  |  | Base level and free |  |  |  |
| Automatic dampers set properly |  |  |  |  |  |  |  |  |
| Housing Construction-leakage |  |  |  |  | **2. Duct systems** |  |  |  |
| Access doors-leakage |  |  |  |  | **a) General** |  |  |  |
| Condensate drain piping and pan |  |  |  |  | Manual dampers open & locked |  |  |  |
| Free from dirt and debris |  |  |  |  | Access doors closed and tight |  |  |  |
| Nameplate data |  |  |  |  | Fire dampers open and accessible |  |  |  |
| **b) Filters** |  |  |  |  | Terminal units open and set |  |  |  |
| Type and size |  |  |  |  | Registers and diffusers open and set |  |  |  |
| Number |  |  |  |  | Turning vanes in square elbows |  |  |  |
| Clean |  |  |  |  | Provisions made for TAB measurements. |  |  |  |
| Frame-Leakage |  |  |  |  | Systems installed as per plans. |  |  |  |
| Provisions made for TAB measurements |  |  |  |  | **a) Motors.** |  |  |  |
| **d) Fans.** |  |  |  |  | Rotation |  |  |  |
| Rotation. |  |  |  |  | Lubrication |  |  |  |
| Wheel clearance and balance |  |  |  |  | Alignment |  |  |  |
| Bearing and motor lubrication |  |  |  |  | Set screws tight |  |  |  |
| Drive alignment |  |  |  |  | Guards in place |  |  |  |
| Belt t tension. |  |  |  |  | Tank level and controls. |  |  |  |
| Drive set screws tight |  |  |  |  | Starters and disconnect switches |  |  |  |
| Belt guard in place |  |  |  |  | Electrical service & connections. |  |  |  |
| Flexible duct connector alignment |  |  |  |  | Nameplate data. |  |  |  |
| Starters and disconnect switches |  |  |  |  |  |  |  |  |
| Electrical service & connections. |  |  |  |  |  |  |  |  |
| Nameplate data |  |  |  |  |  |  |  |  |
| b) Piping |  |  |  |  | 5. Refrigeration Equipment |  |  |  |
| Correct flow |  |  |  |  | Crankcase heaters energized |  |  |  |
| Correct connections |  |  |  |  | Operating controls and devices. |  |  |  |
| Leakage |  |  |  |  | Safety controls and devices. |  |  |  |
| Valves open or set |  |  |  |  | Valves open |  |  |  |
| Strainer clean |  |  |  |  | Piping connections and flow |  |  |  |
| Air vented |  |  |  |  | Flexible connectors |  |  |  |
| Flexible connectors |  |  |  |  | Oil level and lubrication |  |  |  |
| Provisions made for TAB measurements |  |  |  |  | Alignment and drives. |  |  |  |
| c) Bases |  |  |  |  | Guards in place. |  |  |  |
| Vibration isolation. |  |  |  |  | Vibration isolation. |  |  |  |
| Grouting |  |  |  |  | Starters, contactors and disconnect switches. |  |  |  |
| Leveling. |  |  |  |  | Electrical connectors. |  |  |  |
|  |  |  |  |  | Nameplate data. |  |  |  |

**INSTRUMENT CALIBRATION REPORT**

PROJECT

|  |  |  |  |
| --- | --- | --- | --- |
| INSTRUMENT / SERIAL NO. | APPLICATION | DATES OF USE | CALIBRATION TEST DATE. |
|  |  |  |  |
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REMARKS.

TEST DATE READINGS BY

# PACKAGE UNIT TEST REPORT (TO BE FURNISHED BY INSTALLER)

**PROJET UNIT**

**LOCATION**

**MANUF.**

**MODEL**

**SERIAL NO.**

**CAPACITY**

**REFRIG**

**STARTER**

**HEATER SIZE**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **COMPRESSOR** | **DESIGN** | **ACTUAL** |  | **MOTOR STARTER** | **DESIGN** | **ACTUAL** |
| Make / Model |  |  |  | Make / Model |  |  |
| Serial No. |  |  |  | Type |  |  |
| Type (Reciprocating, Centrifugal Sealedd, Semi Sealed, Screw Rotart) |  |  |  | Voltas |  |  |
| Piping Material |  |  |  | Amps |  |  |
| Suction Pr / Tem. |  |  |  | O/L Release Range |  |  |
| Discharge Pr/Temp |  |  |  |  |  |  |
| Refrigerant |  |  |  | **EVAPORATOR** | **DESIGN** | **ACTUAL** |
| Oil Pump Type |  |  |  | Make / Model |  |  |
| Oil Pressure |  |  |  | No. of Passes |  |  |
| Oil Failure Switch Pressure |  |  |  | Ref : Level |  |  |
| Unload Arrangement |  |  |  | Ref : Pressure / Temperature |  |  |
| Unload Set Points |  |  |  | Ent. Water Temp/Pressure |  |  |
| Drive |  |  |  | Leaving Water Temp/Pressure |  |  |
| Compressor Speed |  |  |  | Temperature Difference |  |  |
| Oil Level |  |  |  | Pressure Difference |  |  |
| Oil Temperature |  |  |  | Water Quantity CPM |  |  |
| L P Setting |  |  |  | Relief Valve Setting |  |  |
| H P Setting |  |  |  | IKW / Ton |  |  |
| Anti Freeze Setting |  |  |  |  |  |  |
| Purge Unit Type |  |  |  |  |  |  |
| Purge Operation Checked |  |  |  | **CONDENSER** | **DESIGN** | **ACTUAL** |
|  |  |  |  | Make/Model |  |  |
|  |  |  |  | No. of Passes |  |  |
|  |  |  |  | Ref : Pressure / Temp |  |  |
| **COMPRESSOR MOTOR** | **DESIGN** | **ACTUAL** |  | Ent. Water Temp / Pressure |  |  |
| Make / Model |  |  |  | Leaving Water Temp/Pressure |  |  |
| Type |  |  |  | Temperature Difference |  |  |
| Voltage I1 Ie I2 I3 I3 I1 |  |  |  | Pressure Difference |  |  |
| Motor Rated Current |  |  |  | Water Quantity CPM |  |  |
| Motor F L Current |  |  |  | Relief Valve Setting |  |  |

##### REMARKS

**TEST DATE READINGS BY**

**INDOOR UNIT TEST REPORT**

**PROJECT DATE**

**LOCATION**

**MANUFACTURER**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **AREA SERVED** | **FCU MAKE** | **CAPACITY TR** | **TEMPERATURE DEG. F** | |
|  |  |  | **GRILLE** | **ROOM** |
|  |  |  |  |  |

##### REMARKS.

TEST DATE READINGS BY

## FAN TEST REPORT

PROJECT

|  |  |  |  |
| --- | --- | --- | --- |
| **FAN DATA** | **FAN NO.** | **FAN NO.** | **FAN NO.** |
| Location |  |  |  |
| Service |  |  |  |
| Manufacturer |  |  |  |
| Model No. |  |  |  |
| Serial No. |  |  |  |
| Type / Class |  |  |  |
| Motor Make / Style |  |  |  |
| Motor H.P/RPM/ Frame |  |  |  |
| Volts/Phase/Cycles |  |  |  |
| F.L Amps. |  |  |  |
| Motor pully Diam./Bore |  |  |  |
| Fan pully Diam./Bore |  |  |  |
| No. Belts/ Make/Size |  |  |  |
| Pully Distance. |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **TEST DATA** | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** | **DESIGN** | **ACTUAL** |
| CFM |  |  |  |  |  |  |
| FAN RPM |  |  |  |  |  |  |
| S.P IN/OUT |  |  |  |  |  |  |
| TOTAL S.P |  |  |  |  |  |  |
| Voltage T1 T2 T2T3  T3 T1 |  |  |  |  |  |  |
| Amperage T1 T2 T3 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

##### REMARKS:

TEST DATE: READINGS BY

# RECTANGULAR DUCT TRAVERSE REPORT

PROJECT SYSTEM

**LOCATION / ZONE ACTUAL AIR TEMP. DUCT S.P**

|  |  |  |
| --- | --- | --- |
| DUCT  SIZE SQ.FT. | REQUIRED  FPM CFM | ACTUAL  FPM CFM |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| POSITION | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 2 | 15 |
| 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 7 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 11 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| VEL1OCITY SUBTOTALS |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

##### REMARKS.

**TEST DATE READINGS BY**

**GRILLES AND DIFFUSERS TEST REPORT**.

**PROJECT SYSTEM**

**OUTLET MANUFACTURER TEST APPARATUS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| AREA | OUT LET | | | DESIGN | | PRLIMINARY | |  | | FINAL | |  |
| SERVED | NO. | TYPE | SIZE | CFM | VEL | VEL OR  CFM | VEL. OR  CFM |  |  | VEL | CFM |  |
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##### REMARKS.

**TEST DATE READINGS BY**

The scope of this section comprises of colour scheme required for each piece of equipment

8.2 COLOUR SCHEME.

Description **Standard Colour& Reference**

**Lettering Colouring**

Exposed Duct Work (other than plant room) instruction

To Architect’s

Air Conditioning

Duct Work (Plant Rooms)

BSS 111 Pale Blue Black

Ventilation Duct

Duct Work (Plant Rooms)

BSS 111 Pale Blue Black

Conditioner Casings, Air Handling Units, Filter Plenums

BSS 111 Pale Blue Black

Electrical (Conduit Ducts and Motors )

BSS 557 Light Orange Black

Chilled Water Pipe Jade Green Black

Drains Black White

Vents White Black

Fans BSS 111 Pale Blue Black

Valves and Pipe Line Fittings

White with black handles Black

Beltquards Black and yellow diagonal stripes (45 25 mm wide)

Switchboards - exterior

- interior

BS 366 Light Beige White

Machine Bases, Inertia

Bases and Plinths Charcoal Grey

The scope of this section comprises of identification of services for each piece of equipment

* 1. VALVE LABELS AND CHARTS

Each valve shall be provided with a label indicating the service being controlled, together with a reference number corresponding with that shown on the Valve Charts and “ as fitted” drawings. The labels shall be made from 3 ply ( black / white/ black) Traffolyte material showing white letters and figures on a black background. Labels to be tied to each valve with chromium plated linked chain.

A wall mounted, glass covered plan to the approval of the Architect / Engineer shall be provided and desplayed in each plant room showing the plant layout with pipe work, valve diagram and valve schedule indicating size, service, duty, etc.

* 1. IDENTIFICATION OF SERVICES.

Pipe work and duct work shall be identified by colour bands 150 mm. wide or colour triangles of at least 150 mm. / side. The bands of triangles shall be applied at termination points, junctions, entries and exits of plant rooms, walls and ducts, and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

29.3.1. **Pipe work Services :-**

For pipe work services and its insulation the colours of the bands shall comply with BS. 1710: 1971. Basic colours for pipe line identification :

**Pipe Line Contents**

**BS. 4800 Colour Reference Colour.**

Water 12 D 45 Green

Steam 10 A 03 Grey

Oils 06 C 39 Brown

Gas 08 C 35 Yellow / Brown

Air 20 E 51 Blue

Drainage 00 E 53 Black

Electrical 06 E 51 Orange

Colour code indicator bands shall be applied as colour bands over the basic identification colour in the various combinations as listed below :-

Pipe Line Contents Colour Bands to BS. 4800 Water Services :

Cooling 00 E 55

Fresh / drinking 18 E 53

Boiler feed 04 D 45/00 E 55 / 04 D 45

Condensate 04 D 45/2 E 53 / 04 D 45

Chilled 00 D 55/2 E 53 / 00 D 45

Central Heating Services :

Below 100o C 18 E 55/04 D 45/18 E 53

Above 100o C 04 D 45/18 E 53 /04 D 45

Cold Water Storage

Tanks : 00 E 55/18 E 53/00 E 55

Hot Water Supply 00 E 55/04 D 45/00 E 55

Hydraulic Power 04 C 33

Sea / River Untreated Basic Colour only

Fire Extinguishing 04 E 53

Steam Services : Basic Colour only

Air : Compressed Vacuum

Basic Colour only White.

Town Gas : Manufactured

Natural

2 E 53

10 E 53

Oils :

Diesel 00 E 55

Lubricating 2 E 53

Hydraulic Power 04 C 53

Transformer 04 D 45

Drainage and other fluids : Basic Colour only

Electrical Services : Basic Colour only

In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow, identified as follows :-

High Temperature Hot Water HTHW Medium Temperature Hot Water MTHW Low Temperature Hot Water LTHW

Chilled Water CHW

Condenser Water CONDW

Steam ST

Condensate CN

Pipe shall have the letters F and R added to indicate flow and return respectively as well as directional arrows.

9.3.2 **Duct Work Services :**

For Duct work services and its insulation the colours of the triangles shall comply with BS.1710 : 1971. The size of the symbol will depend on the size of the duct and the viewing distance but the minimum size should not be less than 150 mm. length per side. One apex of the triangle shall point in the direction of airflow.

|  |  |  |
| --- | --- | --- |
| Services | **Colour** | **BS.4800 Colour Reference** |
| Conditioned Air | Red and Blue | 04 E 53 / 18 E 53 |
| Ward Air | Yellow | 10 E 53 |
| Fresh Air | Green | 2 E 53 |
| Exhaust / Extract / Recirculated Air | Grey | AA 0 09 |
| Foul Air | Brown | 06 C 39 |
| Dual Duct System Hot Supply Air | Red | 04 E 53 |
| Cold Supply Air | Blue | 18 E 53 |

In addition to the colour triangles specified above all duct work shall be legibly marked with black or white letters to indicate the type of service, identified as follows :-

Supply Air S

Return Air R

Fresh Air F

Exhaust Air E

The colour banding and triangles shall be manufactured from self adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape.

1. **NOISE CONTROL**
   1. SCOPE

The scope of this section comprises of the supply, installation, testing and commissioning of noise and vibration control equipment and accessories.

* 1. STANDARDS

The testing of all noise control equipment and the methods used in measuring the noise rating of air conditioning plant and equipment shall be in accordance with the relevant sections of the following British Standards, unless otherwise stated :

BS 4718 : 1971 Methods of Test of Silencers for Air Distribution Systems. BS 2750 :

Parts 1-9:1980 Laboratory and Field Measurement of Airborne Sound

Insulation of Various Building Elements.

Recommendations for Field Laboratory Measurement of Airborne and Impact Sound Transmission in Buildings.

BS 3638 : 1987 Methods of Measurement of Sound Adsorption in a Reverberation Room.

BS 4773 :

Part 2: 1976 Acoustic Testing.

BS 4856 :

Part 2: 1976 Acoustic performance without additional ducting of forced fan convection equipment.

Part 5: 1976 Acoustic performance with additional ducting of forced fan convection equipment.

BS 4857 :

Par 2:1978 (1983) Acoustic Testing and Rating of High Pressure Terminal Reheat Units.

BS 4954 :

Par 2:1978 (1987) Acoustic Testing and Rating of Induction Units.

BS 5643 : 1984 Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms.

* 1. **GENERAL**

Mechanical services shall generally be designed and installed with provisions to contain noise and the transmission of vibration, generated by moving plant and equipment at source where illustrated on the tender drawings and plant and equipment schedules to achieve acceptable noise rating specified for occupied areas.

In addition to the provisions specified in the Specification, particular attention must be given to the following details at time of ordering plant and equipment and their installation :-

* + 1. All moving plant , machinery and apparatus shall be statically and dynamically balanced at manufacturers works and certificates issued.
    2. The isolation of moving plant, machinery and apparatus including lines equipment from the building structure.
    3. Where duct work and pipe work services pass through walls, floors and ceilings, or where supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimise the outbreak of noise from plant rooms.
    4. The reduction of noise breakout from plant rooms and the selection of externally mounted equipment and plant to meet ambient noise level requirements of the Specifications.
    5. Electrical conduits and connections to all moving plant and equipment shall be carried out in flexible conduit and cables to prevent the transmission of vibration to the structure and nullify the provisions of anti-vibration mountings.
    6. All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units.

Duct work connections to the fan inlets / outlets shall be concentricity aligned so that the flexible connections are not subjected to any strain and not used as a means of correcting bas misalignment.

* + 1. All resilient acoustic absorbing materials shall be non flammable, vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.
    2. Where practicable, silencers shall be built into walls and floors to prevent the flanking of noise the duct work systems and their penetrations sealed in the manner previously described.

Where this is not feasible, the exposed surface of the duct work between the silencer and the wall subjected to noise infiltration shall be acoustically clad as specified.

* + 1. Contractor to demonstrate design NC levels in the areas with FFT (Fast Fourier Transform) analyzer.
  1. SILENCERS

At tender stage all silencers as scheduled in the specification or on tender drawings will be selected based on preliminary sound power levels obtained from fan/air handling unit manufacturers or fan duties to achieve a noise rating in the occupied space as specified in “ Basis of Design”

All plant attenuators shall be selected to maintain noise criteria given in this Specification.

Attenuators shall be constructed from high quality pre-galvanised steel sheet casings with lock formed joints along the casing length. Angle iron cross jointing flanges shall be fitted to silencer casings, drilled as required and finished with zinc cromet primer paint.

Acoustic splitters shall be formed by chancel section pre-galvanised sheet steel framework retaining acoustic fill of a density to attain the required performance. Splitters shall have round nose ends to give smooth entry and exit conditions to minimise air pressure drops.

The acoustic fill shall be protected from the air flow by 22 swg minimum perforated galvanised sheet steel. All silencers shall be selected against a maximum allowable air pressure drop of 75 a.

It will be the responsibility of the Contractor at the time of placing orders for fan equipment to obtain from the manufacturers, certified sound power levels to enable the selected duct silencers to be checked against the original design information, prior to orders being placed.

* 1. ANTI-VIBRATION MOUNTINGS.

All items of rotating and reciprocating plant and equipment shall be isolated from the structure by the use of anti-vibration materials, mountings or spring loaded supports fixed to either concrete bases, inertia blocks or support steels as indicated.

Centrifugal fans and motors within air handling units shall be isolated from the frame of the air handling unit by suitable anti-vibration mountings. Fan discharge air connections shall be fitted with approved flexible connections internally isolating the fan scroll from the air handling unit casing.

Axial flow fans shall be mounted on steel legs as diaphragm plates supported on neoprene in shear anti- vibration mountings, or suspended using spring loaded hangers to suite the application.

Centrifugal pumps shall be mounted on inertia bases consisting of reinforced concrete sub-base, anti- vibration mountings and concrete filled steel upper plinth. The Contractor shall be responsible for issuing the steel upper plinth and mountings to the Contractor for building-in.

Pipe work connections to circulating pumps, chillers, cooler coils and other equipment shall be made with flexible connections as per Specifications.

The construction of the anti-vibration mountings shall generally comply with the following : - Enclosed Spring Mounting( Caged or Restrained Springs)

Each mounting shall consist of cast or fabricated telescopic top and bottom housing enclosing one or more helical steel springs as the principle isolation elements, and shall incorporate a built- in levelling device.

The springs shall have an outside diameter of not less than 75% of the operating height, and be selected to have at least 50% overload capacity before becoming coil bound.

The bottom plate of each mounting shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

Mountings incorporating snubbers of restraining devices shall be designed so that the snubbing damping or restraining mechanism, is capable f being adjusted to have no significant effect during the normal running of the isolated machine.

Restrained isolator shall be provided on chillers subject to approval by the manufacturers.

* 1. OPEN SPRING MOUNTINGS.

Each mounting shall consist of one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in leveling device. The spring shall be fixed or otherwise securely located to cast or fabricated top and bottom plates, and shall have an outside diameter of not less than 75% of the operating height, and shall be selected to have at least 50% overload capacity before becoming coil-bound.

The bottom plate shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

* 1. NEOPRENE-IN-SHEAR MOUNTINGS.

Each mounting shall consist of a steel top plate and base plate completely embedded in oil resistant neoprene. Each mounting shall be capable of being fitted with a levelling device, and bolt holes in the base plate and tapped holes in the top plate so that they may be bolted to the floor and equipment where required.

* 1. INERTIA BASES FOR PUMPS.

The inertia base shall be an all welded mild steel channel frame the minimum depth of which shall be 1/12 of the longest span between isolator but not less than 150 mm. filled with concrete the density of which shall be 2300 kg/m3.

The inertia base shall be sufficiently large to provide support for all parts of the equipment, including any component which overhang the equipment base, such as suction and discharge elbows on centrifugal pumps.

The frame shall include pre-located equipment anchor bolts fixed into position and housed in a steel sleeve allowing minor bolt location adjustment.

Isolator support brackets shall be welded into the corners of the base and suitably re-enforced for the load of the equipment and base.

Additional reinforcing roads shall be provided at 200 mm. centres to ensure the concrete and frame is adequately stiffened against distortion.

* 1. FLEXIBLE CONNECTIONS

Flexible connections shall be provided on all duct work connections to fans, rotating plant and equipment isolated from structure and anti-vibration materials or mountings. Pipe work and duct work crossing building movement or construction joints shall be installed with flexible connections.

Flexible connections on duct work to fans etc., shall be a minimum / maximum free length of 100 mm. / 200 mm. respectively to minimise noise transmission and noise breakout. They shall be completely free from stress and shall not be required to accept any weight.

Thickness and strength of flexible connection materials shall be suitable to withstand the positive and negative fan pressures to which they will be subjected to and shall not allow perceptible leakage. The materials shall be durable, non flammable having food acoustical quality.

Flexible connections shall be fitted to all pump suction and discharge connections, chillers and other vibrating equipment and where anti-vibration mounts and inertia basis are fitted.

Flexible connections shall be fitted to all cooler coil chilled water pipe work connections. Flexible connections shall allow freedom of movement of plant in all plans.

Making flanges to pipe work flexible connections shall be of the smooth faced weld-nick type.

Rubber Bellows shall be fitted as close to the source of vibration at practicable. The pipe at the other end of the bellows shall be a fixed point.

Rubber bellows shall be single convolution of multiply reinforced EPDM rubber with wire reinforced cuffs. Flanges shall be able to swivel and be removable. The date of manufacture shall be moulded on the bellows. For traceability membranes shall have an indelible identification showing manufacturer, country of origin, the type and a batch number.

Tie bars with rubber top hat washers shall be used on bellows.

For working temperatures up to 70o C the rubber bellows shall be high tensile synthetic fibre reinforced.

For working temperature between 70oC and 100oC the bellows carcase shall be steel wire mesh reinforced throughout. Steel reinforced bellows shall be manufactured and approved to the Standards.

For temperatures above 100oC bellow shall be multiply stainless steel with Van Stone ends swivel flanges. The overall length shall not exceed 130 mm.

Flexible connections with screwed connections shall be reinforced EPDM rubber hoses and shall have at least one full union to avoid torturing on installation.

Flexible pipe connections on chilled water systems shall be suitable for a working pressure of 10 bar and test pressure of 17 bar.

**LIST OF APPROVED MAKES**

|  |  |  |
| --- | --- | --- |
| **S.No** | **Materials / Equipment to be installed** | **Manufacturer’s / Vendor’s Name** |
| 1 | Variable Refrigerant Flow Units | Daikin Mitsubushi, Toshiba |
| 2 | U-PVC Pipe for AHU / FCU drainage | Astral Ashirvad Supreme |
| 3 | GI sheet | Jindal Aarati TATA |
| 4 | Flexible connection sandwitched with 25mm fiberglass insulation | Aeroduct Atco Seven star |
| 5 | Fire rated duct work ( For Kitchen Exhaust, Firezone crossing and smoke extraction) | Flamebar ( UK) |
| 6 | Grille/Diffuser | Mapro Precise Titus |
| 7 | Smoke/Fire Damper ( UL listed) | Airmaster Caryaire Ruskin |
| 8 | Nitrile Rubber Insulation | A-Flex and K- Flex |
| 9 | Vibration Isolator | Easyflex Resistoflex |
| 10 | Flexible pipe connection | Easyflex Resistoflex |
| 11 | Flexible duct connector | Easyflex Resistoflex |
| 12 | Heavyduty,pipe,duct and electrical support | Gripple . Diamond pipe support, Hi- Tech |

**SPECIAL CONDITIONS**

1. **GENERAL**

These special conditions are intended to amplify the General Conditions of Contract, and shall be read in conjunction with the same. For any discrepancies between the General Conditions and these Special Conditions, the more stringent shall apply.

##### SCOPE OF WORK

The general character and the scope of work to be carried out under this contract is illustrated in Drawings, Specifications and Schedule of Quantities. The Tenderer shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the OWNER’s site representative. The tenderer shall furnish all labour, materials and equipment (except those to be supplied by the OWNER) as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete Plumbing / Sanitary system as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The Plumbing / Sanitary System shall comprise of following:

* 1. Sanitary Fixtures and Fittings.
  2. Internal Water Supply.
  3. Internal Drainage
  4. Water Treatment
  5. RO System
  6. Pumps
  7. Cutting holes, chases & like through all types of walls /floors and finishing for all services crossings, including sealing, frame woriks, fire proofing, providing sleeve, cover plates, making good structure and finishes to an approved standard.
  8. Balancing, testing & commissioning of the entire plumbing system.
  9. Test reports, list of recommended spares, as-installed drawings, operation & maintenance manual for the entire plumbing system.
  10. Training of Owner’s staff.

##### ASSOCIATED CIVIL WORKS

Following civil works associated with Plumbing / Sanitary installation are excluded from the scope of this contract. These shall be executed by other agencies in accordance with approved shop drawings and under direct supervision of the Plumbing / Sanitary tenderer.

* 1. Water proofing of floors.
  2. Urinals division plates

##### ASSOCIATED SERVICES WORKS

* 1. All **ELECTRICAL WORKS** are excluded from the scope of this contract. However, the plumbing contractor for connections to be provided for motors.
     1. The plumbing contractor within 10 days of issue of LOI shall furnish an electrical load diagram showing the position of the loads.

##### BUILDING AUTOMATION SYSTEM

(No additional cost shall be paid for providing the interfacing).

The scope of Plumbing / Sanitary Tenderer shall include the following for the interface to Building Automation System.

* 1. Sockets /Nipples including shut-off valve for mounting sensors/transmitters on pipe lines.
  2. It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the contract requirements, of the Plumbing / Sanitary system, lies solely with the tenderer.

##### PROJECT EXECUTION AND MANAGEMENT

The Tenderer shall ensure that senior planning and erection personnel from his organisation are assigned exclusively for this project. They shall have minimum 10 years experience in this type of installation. The Tenderer shall appoint one Project Director holding senior management position in the organisation. He shall be assisted on full time basis by a minimum of two erection engineers & two senior supervisors. The entire staff shall be posted at site on full time basis.

The project management shall be through modern technique. Erection engineer and supervisors shall be provided with mobile communication system so that they can always be reached.

For quality control & monitoring of workmanship, tenderer shall assign at least one full-time engineer who would be exclusively responsible for ensuring strict quality control, adherance to specifications and ensuring top class workmanship for the installation.

The Tenderer shall arrange to have mechanised & modern facilities of transporting material to place of installation for speedy execution of work.

##### INSPECTION AND TESTING

That the equipment installed complies with specification in all respects and is of the correct rating for the duty and site conditions.

That all items operate efficiently and quietly to meet the specified requirements

The contractor shall provide all necessary instruments and labour for testing, shall make adequate records of test procedures and readings, shall repeat any tests requested by the Project Manager and shall provide test certificate signed by a properly authorized person Such test shall be conducted on all materials and equipments and tests on completed work as called for by the Project Manager at contractor’s expenses unless otherwise called for.

If it is proved that the installation or part thereof is not satisfactorily carried out, then the contractor shall be liable for the rectification and retesting of the same as called for by the Project Manager whose decision as to what constitutes a satisfactory test shall be final.

The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere. All tests shall be carried out by a test house approved by the Project Manager.

##### BYE-LAWS AND REGULATIONS

The installation shall be in conformity with the Bye-laws, Regulations and Standards of the local authorities concerned, in so far as these become applicable to the installation. But if these Specifications and Drawings call for a higher standard of materials and / or workmanship than those required by any of the above regulations and standards, then these Specifications and Drawings shall take precedence over the said regulations and standards. However, if the Drawings and specifications require something which violates the Bye-laws and Regulations, then the Bye-laws and Regulations shall govern the requirement of this installation.

##### FEES AND PERMITS

The tenderer shall obtain all permits/ licenses and pay for any and all fees required for the inspection, approval and commissioning of their installation. However, all receipted amount shall be reimbursed on production of proof of payment.

##### DRAWINGS

The Plumbing / Sanitary Drawings listed under Appendix-I, issued with tenders are diagrammatic only and indicate arrangement of various systems and the extent of work covered in the contract. These Drawings indicate the points of supply and of termination of services and broadly suggest the routes to be followed. Under no circumstances shall dimensions be scaled from these Drawings. The architectural/interiors drawings and details shall be examined for exact location of sprinklers, hydrants, equipments and water supply / drainage piping etc.

The tenderer shall follow the tender drawings in preparation of his shop drawings, and for subsequent installation work. He shall check the drawings of other trades to verify spaces in which his work will be installed.

Maximum headroom and space shall be maintained at all points. Where headroom appears inadequate, the tenderer shall notify the Architect/Consultant/OWNER’s site representative before proceeding with the installation. In case installation is carried out without notifying, the work shall be rejected and tenderer shall rectify the same at his own cost.

The tenderer shall examine all architectural, structural, plumbing, electrical and other services drawings and check the as-built works before starting the work, report to the OWNER’s site representative any discrepancies and obtain clarification. Any changes found essential to coordinate installation of his work with other services and trades, shall be made with prior approval of the Architect/Consultant/ OWNER’s site representative without additional cost to the OWNER. The data given in the Drawings and Specifications is as exact as could be procured, but its accuracy is not guaranteed.

##### TECHNICAL DATA

Each tenderer shall submit alongwith his tender, the technical data for all items listed in Appendix-IV in the indicated format. Failure to furnish complete technical data with tenders may result in summary rejection of the tender.

##### SHOP DRAWINGS

All the shop drawings shall be prepared on computer through Autocad System based on Architectural Drawings, site measurements and Interior Designer’s Drawings. Within two weeks of the award of the contract, tenderer shall furnish, for the approval of the Architect/Consultant, two sets of detailed shop drawings of all equipment and materials including layouts for Typical toilets drawings showing exact location of supports, flanges, bends, tee connections, reducers, detailed piping drawings showing exact location and type of supports, valves, fittings etc; external insulation details for pipe insulation etc; electrical panels inside/outside views, power and control wiring schematics, cable trays, supports and terminations.

These shop drawings shall contain all information required to complete the Project as per specifications and as required by the Architect/Consultant/OWNER’s site representative. These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work by other tenderers. Each shop drawing shall contain tabulation of all measurable items of equipment/materials/works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all shop drawings. Minimum 12 sets of drawings shall be submitted after final approval along with CD.

Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in Appendix-III and quoted by the tenderer in technical data part of Appendix - IV.

When the Architect/Consultant makes any amendments in the above drawings, the tenderer shall supply two fresh sets of drawings with the amendments duly incorporated alongwith check prints, for approval. The tenderer shall submit further twelve sets of shop drawings to the OWNER’s site representative for the exclusive use by the OWNER’s site representative and all other agencies. No material or equipment may be

delivered or installed at the job site until the tenderer has in his possession, the approved shop drawing for the particular material/equipment/installation.

Shop drawings shall be submitted for approval four weeks in advance of planned delivery and installation of any material to allow Architect/Consultant ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved programme.

Manufacturers’ drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labelled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

Samples of all materials like valves, pipes etc. shall be submitted to the OWNER’s site representative prior to procurement. These will be submitted in two sets for approval and retention by OWNER’s site representative and shall be kept in their site office for reference and verification till the completion of the Project. Wherever directed a mockup or sample installation shall be carried out for approval before proceeding for further installation.

Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supercede the contract requirements, nor does it in any way relieve the tenderer of the responsibility or requirement to furnish material and perform work as required by the contract.

Where the tenderer proposes to use an item of equipment, other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundation, piping, wiring or any other part of the mechanical, electrical or architectural layouts; all such re-design, and all new drawings and detailing required therefore, shall be prepared by the tenderer at his own expense and gotten approved by the Architect/Consultant/ OWNER’s site representative. Any delay on such account shall be at the cost of and consequence of the Tenderer.

Plumbing / Sanitary Tenderer shall prepare coordinated services shop drawings based on the drawings prepared by Electrical, HVAC & Low Voltage Tenderers to ensure adequate clearances are available for installation of services for each trade.

Where the work of the tenderer has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the OWNER’s site representative, the tenderer shall prepare composite working drawings and sections at a suitable scale, not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Tenderer installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the OWNER.

Within one week of approval of all the relevant shop drawings, the tenderer shall submit four copies of a comprehensive variation in quantity statement, and itemized price list of recommended (by manufacturers’) imported and local spare parts and tools, covering all equipment and materials in this contract. The Project Manager shall make recommendation to OWNER for acceptance of anticipated variation in contract amounts and also advise OWNER to initiate action for procurement of spare parts and tools at the completion of project.

##### QUIET OPERATION AND VIBRATION ISOLATION

All equipment shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the OWNER’s site representative. In case of rotating machinery sound or vibration noticeable outside the room in which it is installed, or annoyingly noticeable inside its own room, shall be considered objectionable. Such conditions shall be corrected by the Tenderer at his own expense. The tenderer shall guarantee that the equipment installed shall maintain the desired NC levels.

##### ACCESSIBILITY

The Tenderer shall verify the sufficiency of the size of the shaft openings, clearances in cavity walls and suspended ceilings for proper installation of his piping and other ancillaries. His failure to communicate

insufficiency of any of the above, shall constitute his acceptance of sufficiency of the same**.** The Tenderer shall locate all equipment which must be serviced, operated or maintained in fully accessible positions. The exact location and size of all access panels, required for each concealed valve or other devices requiring attendance, shall be finalized and communicated in sufficient time, to be provided in the normal course of work. Failing this, the Tenderer shall make all the necessary repairs and changes at his own expense. Access panel shall be standardised for each piece of equipment / device / accessory and shall be clearly nomenclatured / marked.

##### MATERIALS AND EQUIPMENT

All materials and equipment shall conform to the relevant Indian Standards and shall be of the approved make and design. Makes shall be strictly in conformity with list of approved manufacturers as per Appendix - III.

##### MANUFACTURERS INSTRUCTIONS

Where manufacturer has furnished specific instructions, relating to the material and equipment used in this project, covering points not specifically mentioned in these documents, such instructions shall be followed in all cases.

##### ELECTRICAL INSTALLATION

The electrical work related to Plumbing / Sanitary services is excluded from the scope of the tenderer. The termination of the cable to the various motors shall be carried out by the contractor.

##### BALANCING, TESTING AND COMMISSIONING

Balancing of all water systems and all tests as called for the Specifications shall be carried out by the tenderer through a specialist group, in accordance with the Specifications and ASPE / ASHRAE Guide lines and Standards. Performance test shall consist of three days of 10 hour each operation of system for each season.

The installation shall be tested again after removal of defects and shall be commissioned only after approval by the OWNER’s site representative. All tests shall be carried out in the presence of the representatives of the Architect/Consultant and OWNER’s site representative.

##### COMPLETION DRAWINGS

Tenderer shall periodically submitt completion drawings as and when work in all respects is completed in a particular area. These drawings shall be submitted in the form of two sets of floppies / CD’s and four portfolios (300 x 450 mm) each containing complete set of drawings on approved scale indicating the work as - installed. These drawings shall clearly indicate complete plant room layouts, piping layouts, location of wiring and sequencing of automatic controls, location of all concealed piping, valves, controls, wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The tenderer shall frame under glass, in the plant room, one set of these consolidated control diagrams.

##### OPERATING INSTRUCTION & MAINTENANCE MANUAL

Upon completion and commissioning of part Plumbing / Sanitary system **t**he tenderer shall submit a draft copy of comprehensive operating instructions, maintenance schedule and log sheets for all systems and equipment included in this contract. This shall be supplementary to manufacturer’s operating and maintenance manuals. Upon approval of the draft, the tenderer shall submit four (4) complete bound sets of typewritten operating instructions and maintenance manuals; one each for retention by Consultant and OWNER’s site representative and two for OWNERs Operating Personnel. These manuals shall also include basis of design, detailed technical data for each piece of equipment as installed, spare parts manual and recommended spares for 4 year period of maintenance of each equipment.

###### “*Preventive Maintenance Schedule for each equipment / panel shall be submitted along with*

***Operation and Maintenance Manual”.***

1. **ON SITE TRAINING**

Upon completion of all work and all tests, the Tenderer shall provide necessary operators, labour and helpers for operating the entire installation for a period of fifteen (15) working days of ten (10) hours each, to enable the OWNER’s staff to get aquainted with the operation of the system. During this period, the tenderer shall train the OWNER’s personnel in the operation, adjustment and maintenance of all equipment installed**.**

##### MAINTENANCE DURING DEFECTS LIABILITY PERIOD

* 1. Complaints

The Tenderer shall receive calls for any and all problems experienced in the operation of the system under this contract, attend to these within 10 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

* 1. Repairs

All equipment that require repairing shall be immediately serviced and repaired. Since the period of Mechanical Maintenance runs for one year concurrently with the defects liability period, all replacement parts and labour shall be supplied promptly free-of-charge to the OWNER.

##### UPTIME GUARANTEE

The tenderer shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the Defects Liability period shall be extended by a month for every month having shortfall. In case of shortfall beyond the defects liability period, the contract for Operation and Maintenance shall get extended by a month for every month having the shortfall and no reimbursement shall be made for the extended period.

The Tenderer shall provide log in the form of diskettes and bound printed comprehensive log book containing tables for daily record of all pressures, power consumption. Starting and stopping times forvarious equipment, daily services rendered for the system alarms, maintenance and record of unusual observations etc. Tenderer shall also submit preventive maintenance schedule.

Each tenderer shall submit along with the tender, a detailed operation assistance proposal for the OWNER’s site representatives/Consultant’s review. This shall include the type of service planned to be offered during Defects Liability Period and beyond. The operation assistance proposal shall give the details of the proposed monthly reports to the Management.

The tenderer shall include a list of other projects where such an Operation Assistance has been provided.

##### OPERATION AND MAINTENANCE

Tenderer may be required to carry out the operation of the PLUMBING / SANITARY installation for a period of one year from the date of commissioning and handing over of the entire system. Further, he may also be required to carry out operation and all inclusive maintenance of the entire system for a period of four years beyond the defects liability period**.**

* 1. Operation contract (Plumbing / Sanitary)
     1. 16 hours a day, year round.
     2. All stand-by equipment to be operated as per mutually agreed programme.

ii. Proper entry and unkeep of relevant log books.

1. Maintain complaints register. Submit weekly report.
2. Proper housekeeping of all areas under the contract.
3. Prepare daily consumption report and summary of operation.
   1. Terms of payment
      1. Monthly at the end of each month on pro-rata basis.
   2. All Inclusive Maintenance Contract
4. Routine Preventive Maintenance Schedule to be submitted
   1. Schedule to cover manufacturer’s recommendation and/or common engineering practice

(for all plant and machinery under contract).

* 1. Plant and machinery history card giving full details of equipment and frequency of checks and overhaul.
  2. Monthly status report.
  3. Entire Plumbing / Sanitary installation to be painted in fourth year (from end of defects and liability period) before the expiry of operation and maintenance contract.

1. Uptime during maintenance contract
   1. 98% uptime of all systems under contract.
   2. Up time shall be assessed every month and in case of shortfall during any month the contract shall be extended by a month.
   3. There shall be no reimbursement for the extended period.
   4. Break-downs shall be attended to within ten hours of reporting.
   5. Spare compressor/motor assembly to be made available within seven calendar days in case of total breakdown/burnout.
2. Manpower
   1. Adequate number of persons to the satisfaction of the OWNER’s site representative shall be

provided including relievers.

* 1. Statutory requirements of EPF, ESIC and other applicable labour legislations to be complied with; and monthly certification to that effect to be submitted.
  2. Duty allocation and Roaster control shall be tenderer’s responsibility.

1. Shut Downs
   1. Routine shut downs shall be permitted only during winter season.
   2. Tenderer shall be at liberty to carry out routine maintenance as and when required but with prior permission of the OWNER.
2. Payment Terms
   1. Monthly payment at the end of each month on pro-rata basis**.**

##### PARTIAL ORDERING

OWNER through the Architect/Consultant/ OWNER’s site representative reserves the right to order equipment and material from any and all alternates, and /or to order high side and /or low side equipment and materials or parts thereof from one or more tenderers**.**

LIST OF DRAWINGS

|  |  |  |
| --- | --- | --- |
| ***S.***  ***NO.*** | ***DRAWING No.*** | ***DRAWING TITLE*** |

##### A. PLUMBING SYSTEM LAYOUT

1 PL-FLOM-01 FORYER LEVEL PLUMBING LAYOUT

***GUARANTEE PROFORMA***

GUARANTEE FOR PLUMBING, SANITARY SYSTEM INSTALLATION

We hereby guarantee the year round Plumbing, Sanitary & Drainage Which We Have Installed In The Complex Described Below :

Building :

Location :

For a period of one year from the date of acceptance of the total installation, WE AGREE TO repair or replace to the satisfaction of the Owner, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or neglect excluded, together with any other work, which may be damaged or displaced in so doing. In the event of our failure to comply with the above mentioned conditions within a reasonable time, after being notified in writing, we collectively and separately, do hereby authorise the Owner to proceed to have the defects repaired and made good at our expense, and we shall pay the cost and charges thereof, immediately upon demand.

WE ALSO HEREBY UNDERTAKE to test the entire installation in first SUMMER, WINTER AND MONSOON on following the completion of the installation, to check and do everything necessary to ensure that the specified design conditions and functional requirement are met, that all water, sewage, air pollution control systems are properly balanced, that all controls are calibrated accurately, and that all units are functioning satisfactorily.

***SIGNATURE OF TENDERER for* PLUMBING, SANITARY SYSTEM**

##### DATE : SEAL

**LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS**

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Details of Materials / Equipment** | **Manufacturer’s Name** |

1. **PLUMBING SYSTEM**
   1. a. Vitreous China Sanitaryware Duravit

American standards European standards

1. WC Connectors Multikwik (UK)
2. Concealed Cistern Duravit

American standards Gebrit

Commander

* 1. Seat Cover (Heavy Duty) Duarvit, Commander
  2. Stainless Steel Sink Jayna Neelkanth Kingston
  3. Auto Urinal Flush System (Battery operated)

AOS Auto Robo Flushing System Toshi

UTEC System Euronics

* 1. Hand Drier Blue Circle

Kopal

UTEC System Euronics

* 1. CP Brass Fittings Duravit, American standard Jaquar Ess-Ess

Gem Aquaplus

* + 1. Angle valve with filter Arco
  1. Floor Drain Fixture & Channel Gratings Neer -GMGR
  2. C.P. Grating for Floor Trap Chilly Cockroach Trap
  3. Cast Iron Pipes & Fittings Manhole covers and frames
     1. As per IS:3989 (Pipes & Fittings)
     2. As per IS:1729 (Manhole covers

and frames)

NECO

NECO

Raj iron Foundry Agra BIC Calcutta

Kajeco

* + 1. As per IS:1536 (CILA pipe) Kesoram Calcutta

Electro Steel Calcutta IISCO

* 1. GI Pipes (IS : 1239 and IS : 3589) TATA Jindal

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Details of Materials / Equipment** | **Manufacturer’s Name** |

* 1. GI pipes fittings Unik

Zoloto M R Brand

* 1. PVC Pipe Supreme

Astral Ashirvad Prince Finolex

* 1. Drip Seal Vinod Cement Co. Chandigarh (PJS-43)
  2. GI pipe sealent Henkel - LOCTITE 55
  3. Pipe clamp & supports Chilly Euroclamp
  4. CPVC Pipe Astral

Aashirvad Ajay

* 1. GM / Forged Brass Ball Valves Zoloto RB CIM Leader
  2. Butterfly Valve Audco

Jayahiwa Intervalve

* 1. Wafer Type Check Valve Advance Kirloskar Audco Intervalve
  2. Solenoid Valve Avcon

Danfoss

* 1. Isolation Ball / Gate / Globe Valve Zoloto R.B. CIM
  2. Air Release Valve Zoloto OR Arco Sukham
  3. Pressure Gauge H Guru Fiebig
  4. Water Meter (Mechanical Type) Actaris Capstan Kaycee Kranti
  5. Electronic Flow Meter Rockwin
  6. Paints Asian Paints

Shalimar Rajdoot

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Details of Materials / Equipment** | **Manufacturer’s Name** |

* 1. Insulation for Hot Water Pipes Armacell – Armaflex (UK / German)

Trocellen Thermaflex

* 1. Electric Water Heater Venus Bajaj Spherehot Racold
  2. Welding Rods Advani

ESAB

* 1. Fastner Hilti

Fisher

**A P P E N D I X – IV**

**LIST OF BUREAU OF INDIAN STANDARDS CODES**

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended upto 30th April, 2003. All equipment and material being supplied by the tenderer shall meet the requirements of IS. Tarrif advisory committee’s regulation (fire insurance), electrical inspectorate and Indian Electricity rules and other Codes / Publications as given below:

1. **General**

SP : 6 (1) Structural Steel Sections

IS : 27 Pig Lead

IS : 325 Three Phase Induction Motors

IS : 554 Dimensions for pipe threads where pressure tight joints are required on the threads.

IS : 694 PVC insulated cables for working voltages upto & including 1100 V. IS : 779 Specification for water meters (domestic type).

IS : 782 Specification for caulking load.

IS : 800 Code of practice for general construction in steel

IS : 1068 Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.

IS : 1172 Code of Basic requirements for water supply drainage and sanitation.

IS : 1367 (Part 1) Technical supply conditions for threaded steel fasteners: Part 1 introduction and general information.

IS : 1367 (Part 2) Technical supply conditions for threaded steel fasteners: Part 2 product grades and tolerances.

IS : 1554 (Part 1) PVC insulated (heavy duty) electric cables: Part 1 for working voltages upto and including 1100 V.

IS : 1554 (Part 2) PVC insulated (heavy duty) electric cables: Part 2 for working voltages from 3.3 KV upto and including 11 KV.

IS : 1726 Specification for cast iron manhole covers and frames. IS : 1742 Code of practice for building drainage.

IS : 2064 Selection, installation and maintenance of sanitary appliance code of practice.

IS : 2065 Code of practice for water supply in buildings.

IS : 2104 Specification for water meter for boxes (domestic type) IS : 2373 Specification for eater meter (bulk type)

IS : 2379 Colour code for identification of pipe lines.

IS : 2629 Recommended practice for hot dip galvanizing on iron and Steel.

IS : 5329 Code of practice for sanitary pipe work above ground for buildings.

IS : 6159 Recommended practice for design and fabrication of material, prior to galvanizing.

IS : 7558 Code of practice for domestic hot water installations. IS : 8321 Glossary of terms applicable to plumbing work.

IS : 9668 Code of practice for provision and maintenance of water supplies. IS : 9842 Preformed fibrous pipe insulation.

IS : 10446 Glossary of terms relating to water supply and sanitation. IS : 11149 Rubber Gaskets

IS : 11790 Code of practice for preparation of butt-welding ends for pipes, valves, flanges and fittings.

IS : 12183 (Part 1)

Code of practice for plumbing in multistoried buildings : Part 1 water supply.

IS : 12251 Code of practice for drainage of building basements. IS : 5572 Code of practice for sanitary pipe work.

BS : 6700 Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages.

BS : 8301 Code of practice for building drainage.

BSEN : 274 Sanitary tap were, waste fittings for basins, bidets and baths. General technical specifications.

1. **Pipes and Fittings**

IS : 458 Specification for precast concrete pipes (with and without reinforcement)

IS : 651 Salat glazed stone ware pipes and fittins.

IS : 1239 (Part 1) Mild steel, tubes, tubulars and other wrought steel fittings : Part 1 Mild Steel tubes.

IS : 1239 (Part 2) Mild Steel tubes, tubulars and other wrought steel fittings : Part 2 Mild Steel tubulars and other wrought steel pipe fittings.

IS : 1536 Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.

IS : 1537 Vertically cast iron pressure pipes for water, gas and sewage. IS : 1538 Cast Iron fittings for pressure pipes for water, gas and sewage.

IS : 1729 Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

IS : 1879 Malleable cast iron pipe fittings.

IS : 1978 Line pipe

IS : 1979 High test line pipe.

IS : 2501 Copper tubes for general engineering purposes

IS : 2643 (Part 1) Dimensions for pipe threads for fasterning purposes : Part 1 Basic profile and dimensions.

IS : 2643 (Part 2) Dimensions for pipe threads for fastening purposes : Part 2 Tolerances.

IS : 2643 (Part 3) Dimensions for pipe threads for fastening purposes : Part 3 Limits of sizes.

IS : 3468 Pipe nuts.

IS : 3589 Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).

IS : 3989 Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

IS : 4346 Specifications for washers for use with fittings for water services. IS : 4711 Methods for sampling steel pipes, tubes and fittings.

IS : 6392 Steel pipe flanges

IS : 6418 Cast iron and malleable cast iron flanges for general engineering purposes.

IS : 7181 Specification for horizontally cast iron double flanged pipe for water, gas and sewage.

1. **Valves**

IS : 778 Specification for copper alloy gage, globe and check valves for water works purposes.

IS : 780 Specification for sluice valves for water works purposes (50 mm to 300 mm size).

IS : 1703 Specification copper alloy float valves (horizontal plunger type) for water supply fittings.

IS : 2906 Specification for sluice valves for water works purposes (350 mm to 1200 mm size)

IS : 3950 Specification for surface boxes for sluice valves.

IS : 5312 (Part 1) Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.

IS : 5312 (Part 2) Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.

IS : 12992 (Part 1)

Safety relief valves, spring loaded : Design

IS : 13095 Butterfly valves for general purposes.

1. **Sanitary Fittings**

IS : 771(Part 1 to 3)

Specification for glazed fire clay sanitary appliances.

IS : 774 Specification for flushing cistern for water closets and urinals (other than plastic cistern)

IS : 775 Specification for cast iron brackets and supports for wash basins and sinks

IS : 781 Specification for cast copper alloy screw down bib taps and stop valves for water services.

IS : 1700 Specification for drinking fountains.

IS : 2548 (Part 2) Specification for plastic seats and covers for water closets: Part 1 Thermoset seats and covers.

IS : 2556 (Part 1) Specification for vitreous sanitary appliances (Vitreous china) : Part 1 General requirement.

IS : 2556 (Part 2) Specification for vitreous sanitary appliances (vitreous china): Part 2 Specific requirements of wash-down water closets.

IS : 2556 (Part 3) Specification for vitreous sanitary appliances (vitreous china): Part 3 Specific requirements of squatting pans.

IS : 2556 (Part 4) Specification for vitreous sanitary appliances (vitreous china): part 4 specific requirements of wash basins.

IS : 2556 (Part 6

Sec 2)

Specification for vitreous sanitary appliances (vitreous china): part 6 Specific requirements of urinals, section 2 half stall urinals.

IS : 2556 (Part 6

Sec 4)

Specification for vitreous sanitary appliances (vitreous china): Part 6 specific requirements of urinals, section 4 partition slabs.

IS : 2556 (Part 6

Sec 5)

Specification for vitreous sanitary appliances (vitreous china): Part 6 Specific requirements of urinals, section 5 waste fittings.

IS : 2556 (Part 6

Sec 6)

Specification for vitreous sanitary appliances (vitreous china) : Part 6 Specific requirements of urinals, section 6 water spreaders for half stall urinals.

IS : 2556 (Part 7) Specification for vitreous sanitary appliances (vitreous china) : Part 7 Specific requirements of half round channels.

IS : 2556 (Part 8) Specification for vitreous sanitary appliances (vitreous china): Part 8 Specific requirements of siphoning wash down water closets.

IS : 2556 (Part 11)

Specification for vitreous sanitary appliances (vitreous china): Part 11 Specific requirements for shower rose.

IS : 2556 (Part 12)

Specification for vitreous sanitary appliances (vitreous china): Part 12 Specific requirements of floor traps.

IS : 2556 (Part 15)

Specification for vitreous sanitary appliances (vitreous china): Part 15 Specific requirements of universal water closets.

IS : 2692 Specification for ferrule for water services

IS : 2717 Glossary of terms relating to vitreous enamelware and ceramic metal systems

IS : 2963 Specifications for waste plug and its accessories for sinks and wash basins. IS : 3311 Specification for waste plug and its accessories for sinks and wash basins. IS : 5961 Specification for cast iron gratings for drainage purposes.

IS : 6249 Specification for gel-coated glass fibre reinforced polyester resin bath tubs. IS : 6411 Specification for gel-coated glass fibre reinforced polyester resin bath tubes.

IS : 8931 Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services.

IS : 9758 Specification for flush valves and fitting for water closets and urinals.

**TECHNICAL SPECIFICATIONS**

**SECTION-01:: BASIS OF DESIGN**

1. **BASIS OF DESIGN**

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

* 1. Requirement of adequate and equal pressure availability of hot and cold water lines in Toilets and Pantries.

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

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

##### CONCEPT OF THE SYSTEM

**The following services are envisaged for the complex:**

* 1. Domestic water supply through gravity feed System for making water available at the residual pressure 1.5 to 2.0 kg / sq.cm.

##### WATER STORAGE & DISTRIBUTION SYSTEM

* 1. **Water Requirement**

The water requirement for the project is proposed to be based on the provisions of IS:1172 and prevalent practice. The estimated requirement of water per day for the Complex based on the number of users and other services.

* 1. **Source of Water**

It is expected that part of the daily domestic water requirement for the Building shall be through municipal mains supply. Since it is unlikely that municipality would be able to meet the entire daily requirement, supply will have to be supplemented by having provision of existing of tubwell. Provision of tanker water fill feasibility shall also be made.

* 1. **Water Quality**

**Domestic Water Requirement**: The total domestic water shall be passed through basic water treatment plant and further specialized treatment shall be done based on the water analysis report and requirement. The basic water treatment plant shall comprise of MG filter, iron removal filter, degassifier, iron removal filter, organic scavanger and Hypo dosing.

* 1. **Water Distribution**

The water distribution cold water supply for the Building shall be designed to ensure availability of adequate residual head at user outlet. Provision of pressure reducing station and non-return valve shall be made for effective and efficient water distribution in the Building. Design is such that the cold water pressure and flow shall be fairly equal to avoid reversal of flow from one service to another.

* 1. **Appurtenant**

Following components shall be included in the water supply system for efficient functioning:

* + 1. Automatic air vent at each of the high point (Air Valve)
    2. Drain valve at each of the low point (Scour Valve)
    3. Pressure Release valve where abnormally high pressure is to be reduced.
    4. Flow meter.
    5. Pressure Gauge.

vi Anchor block / thrust block.

##### SEWAGE, SULLAGE AND STORM WATER

The soil and waste shall be carried down in separate independently vented pipes. Two pipe drainage systems shall be adopted as per NBC (Part-IX). Provision of ASP vertical vent shall also be made for hygiene, safety consideration and to avoid foul smell entering through trapped gully in WC.

* 1. **Design Limitations**

The system is designed considering the following:

1. High thrust developed at soil & water pipe connections.
2. Termination of vent cowl at terrace level.
3. Provision of adequate slope for horizontal header pipes for achieving self-cleaning velocity in the pipes.
4. Provision of cleanout plug.

##### WORKMANSHIP

The workmanship shall be best of its kind and shall conform to the specifications, as below or Indian Standard Specifications in every respect or latest trade practices and shall be subject to approval of the Owner’s Site Representative. All materials and/or Workmanship which in the opinion of the Owner’s Site Representative / Architect / Consultant is defective or unsuitable shall be removed immediately from the site and shall be substituted with proper materials and/or workmanship forthwith.

##### MATERIALS

All materials shall be best of their kind and shall conform to the latest Indian Standards.

All materials shall be of approved quality as per samples and approved by the Owner’s Site Representative /

Architect / Consultants.

As and when required by the Owner’s Site Representative / Consultant, the contractor shall arrange to test the materials and/or portions of works at his own cost to prove their soundness and efficiency. If after tests any materials, work or portions or work are found defective or unsound by the Owner’s Site Representative / Consultant, the contractor shall remove the defective material from the site, pull down and re-execute the works at his own cost to the satisfaction of the Owner’s Site Representative / Consultant. To prove that the materials used are as specified the contractor shall furnish the Owner’s Site Representative with original vouchers on demand.

SECTION-02: SANITARY FIXTURES & FITTINGS

###### *SCOPE*

The scope of this section consists of but is not necessarily limited to supply, installation, testing and commissioning of following items:

* 1. Sanitary appliances and fixtures for toilets.
  2. Chromium plated brass fittings
  3. Stainless steel sinks
  4. Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.
  5. Hand driers, drinking water fountains etc.

Whether specifically mentioned or not the Contractor shall provide for all appliances and fixtures all fixing devices, nuts, bolts, screws, hangers as required.

All exposed pipes within toilets and near appliances/fixtures shall be of chromium plated brass or copper unless otherwise specified.

###### *2 GENERAL REQUIREMENT*

Sanitary appliances and fixtures for toilets, chromium plated brass fittings, stainless steel sinks, bathroom accessories like towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails coat hooks etc and mirrors, hand driers, drinking water fountains etc as listed in the relevant items in the Schedule of Quantities shall be supplied free of cost by the Owner’s Site Representative. The rates shall be inclusive of accessories (in such case) required for installation. All sanitary fixtures and fittings shall received from the Owner’s Site Representative and thereafter be stored under covered roof and handled carefully to prevent any damage by the Contractor.

All appliances, fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, drawings. Accessories shall include proper fixing arrangements, brackets, nuts, bolts, washers, screws and required connection pieces.

The sanitary fixtures and fittings shall be installed at the correct assigned position as shown on the drawings and as directed by the Architect / Owner’s Site Representative and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Architect / Interior Designer

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architect requirements. Wherever necessary, the fittings shall be centered to dimensions and pattern as called for.

Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice.

All appliances , fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown on the drawings and in accordance with the manufacturers recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the Contractor at his own cost. Fixtures shall be mounted rigid, plumb and true to alignment.

All materials shall be rust proofed ; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

Wall flanges shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pierce through them. These wall caps shall be or chromium plated brass fittings and the receiving pipes and shall be large enough to cover the punctures properly.

Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following :

1. Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection so as to absolutely prevent any damage to the appliances until handing over (The original protective wrapping shall be left in position for as long as possible)
2. The appliances shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.
3. The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.
4. The appliance shall be securely fixed. Manufacturer's brackets and fixing methods shall be used wherever possible. Compatible rust-proofed fixings shall be used. Fixing shall be done in a manner that minimize noise transmission.
5. Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. ceramic unit)
6. Pipe connections shall be made with demountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports and appliance.
7. Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

Sizes of sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogues of make considered. Dimensions of similar models of other makes may very within + 10% and the same shall be provided and no claim for extra payment shall be entertained NOR shall any payment be deducted on this account.

The contractor shall fix all plumbing fittings such as water faucets, shower fittings, mixing valves etc. in accordance with manufacturer’s instructions and connect to piping system. The contractor shall supply all fixing materials such as screws, rawl plugs, unions, collars, compression fittings etc., as required.

Joints / gaps between all sanitary appliances / fixtures and the floor / walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of colour and shade to match that of the appliances / fixture and the floor / wall to the extent possible.

##### Water Closet

Water Closet shall be wash down or symphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 5-7 litres of water, flushed by means of a porcelain flushing cistern or an exposed or concealed type (as detailed in the drawings or as directed by the Owner’s Site Representative) 32 mm size CP brass flush valve with regulator valve. Flush pipe / bend shall be connected to the WC by means of a suitable rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair which shall be fixed in a manner as approved by the Owners Site Representative.

Each WC set shall be provided with approved quality of seat, rubber buffers and chromium plated hinges. Seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.

Each WC shall be provided with 110 mm dia (OD) PVC Pan connector connecting the ceramic outlet of WC to CI pipe.

##### Urinals

Urinals shall be lipped type half stall with glazed vitreous China of size as called for in the Bill of Quantities.

Half stall urinals shall be provided with 15mm dia CP spreader, 32mm dia CP domical waste and CP cast brass bottle trap with pipe and wall flange and shall be fixed to wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the Owner’s Site Representative.

Flushing for urinals shall be by means of no hand operation, infrared electric flush valve with complete kit of plumbing, electrical and electronic items, infrared photo cells, solenoid valve transformer and electrical connection. The automatic flush sensor plate shall be flush and press fitted and be of high quality mirror polish finish. Each urinal shall be provided with one flush valve unit.

Flush pipes shall be GI pipes concealed in wall chase but with chromium plated bends at inlet and outlet. Urinal Partitions

Urinal partitions shall be white glazed vitreous china of size specified in the Schedule of Quantities.

Porcelain partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as

recommended by the manufacturer and directed by the Owner’s Site Representative.

##### Cisterns / Flush Valve

Low level flushing cistern (exposed or concealed) shall be provided for WC in specified toilets. Contractor shall install cistern in accordance to the manufacturer’s specification to the satisfaction of the Owner Site Representative. Provision of flush valve shall be made for Public / Staff toilets.

##### Bidets

Every pedestal bidet shall be secured to the floor using stainless steel or non-ferrous fixing screws. Provision shall be made in the floor to receive the fixing screws.

Wall hung bidet pan shall be fixed with stainless steel bolts and nuts or other approved means to an underground support frame such that no strain is transmitted to the bidet pan connection or any other part of the plumbing system. The support frame, depending on the design, shall be either fully or partially fixed within the structure of the building.

Every bidet shall be provided with a spray nozzle fixed above the spill over level of the bidet pan.

Every bidet shall be provided with a fitting trap of at least 40 mm in diameter. The connection by means of a bidet trap of at least 75 mm in diameter shall be made directly to an individual branch drain line or to a discharge pipe on the upper story level.

##### Bath Tub

Bath tub shall be white enameled cast iron, pressed steel, acrylic, built-up marble (polymarble) or of any other material as specified in the Schedule of Quantities.

Each bath tub shall be provided with 40 mm dia (lever operated pop-up brass waste if required) waste with 32 mm CP overflow assembly with brass P tap with cleaning eye.

Bath tubs shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer. Edges touching the walls shall be thoroughly sealed. The fixing shall be perfectly done with hold fasts or bathtubs with PCC and plaster done so that the wall behind does not tend to get damp or patchy.

Contractor shall during the entire period of installation and afterwards protect the bath tub by providing suitable cover over the entire bath tub by providing suitable sheet protection to prevent any damage to the bath tub until completion of the works

##### Wash Basin

Wash basins shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.

Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall/counter slab. Placing of basins over the brackets without secure fixing shall not be accepted. The MS

angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make , brand and colour as approved by the Owner’s Site Representative. The cost of fixing the basin shall be inclusive of supply and installation of brackets as described above.

Each basin shall be provided with 32mm dia CP waste with overflow, pop-up waste or rubber plug and CP brass chain as specified in the Schedule of Quantities.

Each basin shall be provided with hot and cold water mixing fitting or as specified in the Schedule of Quantities.

##### Sinks

Sinks shall be stainless steel or any other material as specified in the Schedule of Quantities.

Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable painted angle iron brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40mm dia CP waste and rubber plug with CP brass chain as given in the Schedule of Quantities. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Owner’s site representative.

Sanitary fittings for sinks shall be deck mounted or wall mounted CP swivel faucets with or without hot and cold water mixing fittings as specified in the Schedule of Quantities. Installation of fittings shall be measured and paid for separately.

2.8. **Shower Set**

Shower set shall comprise of two CP brass concealed stop cocks, four/five way auto-diverter, adjustable type over-head shower with CP shower arm , all with CP wall flanges of approved quality all as specified in the Schedule of Quantities. Bath spout, hand showers and pop up wastes shall also be provided wherever, specified. Wall flanges shall be kept clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

##### Flow Control Device

Approved / rated flow control fitment in brass body, chrome outer cover, rated for flow / discharge of the fixture.

##### Toilet Paper Holder

Toilet paper holder shall be white glazed vitreous china or chrome plated of size, shape and type specified in the Schedule of Quantities.

Porcelain toilet paper holder shall be fixed in walls and set in cement mortar 1:2 (1 cement : 2 coarse sand) and fixed in relation to the tiling work.

The latter (chrome) shall be fixed by means of screws/capping having finish similar to the toilet paper holder in wall/temper partitions with raw l plugs or nylon sleeves. When fixed on timber partition, it shall be fixed on a solid wooden base member provided by the Owner’s Site Representative.

##### Towel Rail

Towel rail shall be chromium plated brass or of stainless steel or powder coated brass of size, shape and type specified in the Schedule of Quantities.

Towel rail shall be fixed with screws/capping having finish similar to the towel rail in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by the Owner’s Site Representative.

##### Janitor's Sink

Janitor's sink shall be stainless steel, single bowl type of size as called for in the Schedule of Quantities, provided with painted R.S. or CI brackets and clips and securely fixed. Each sink shall be provided with 40mm dia CP waste. Fixing shall be as directed by the Owner’s Site Representative.

The supply fittings for Janitor's sink shall be wall mounted type of size as mentioned in Schedule of Quantities.

##### Drinking Water Fountain

Drinking water fountain shall be well mounting type made of vitreous china, stainless steel or any other material as given in the Schedule of Quantities.

The drinking water fountain shall be with anti-squirt bubble less, self closing valve type with automatic volume regulator.

The drinking water fountain shall be provided with an anti-splash back and integral strainer with 32mm or 40mm cast brass trap.

##### Liquid Soap Dispenser

Liquid Soap Dispenser shall be wall/counter mounted suitable for dispensing liquid soaps, lotions, detergents. The cover shall lock to body with concealed locking arrangement, opened only be key provided.

Liquid soap dispenser body and shank shall be of high impact resistance material. The piston and spout shall be stainless steel with 1 litre capacity polyethylene container.

The valve shall operate with less than 2.27 Kg (5 lbs) of force.

##### Hand Drier

The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.

The hand drier shall be fully hygienic, rated for continuous repeat use (CRU).

The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds.

The hand drier shall be of wall mounting type suitable for 230 V, single phase, 50 Hz, AC power supply.

###### *TOILETS FOR THE DISABLED*

Where specified, in washroom facilities designed to accommodate physically disabled, accessories shall be

provided as directed by the Owner’s Site Representative.

Stainless steel garb brass of required size suitable for concealed or exposed mounting and opened non-slip gripping surface shall be provided in all washroom. The flushing cistern/valve shall be provided with chromium plated long handles.

###### *MOCKUP AND TRIAL ASSEMBLY*

The installation of the Sanitary fixtures and fittings shall be as per the shop drawings approved by the Architect/Consultant.

The contractor shall have to assemble at least one set of each type of sanitary fixtures and fittings in order to determine precisely the required supply and disposal connections. Relevant instructions from manufacturers shall be followed as applicable. This trial assembly shall be developed to determine the location of puncture

holes, holding devices etc. which will be required for final installation of all sanitary fixtures and fittings. The above assembly shall be subject to final approval by the Architect / Interior Designer.

The fixtures in the trial assembly can be re-used for final installation without any additional payments for fixing or dismantling of the fixtures.

###### *SUPPORTING AND FIXING DEVICES*

The contractor shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly appearance in the final assembly. Where the location demands, the Architect may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply the fixing devices and shall be installed complete with appropriate vibration isolating pads, washers and gaskets.

###### *FINAL INSTALLATION*

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

###### *PROTECTION AGAINST DAMAGE*

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handing over, the contractor shall clean, disinfect and polish all the fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

###### *MEASUREMENT*

* 1. Rate for fixing only of sanitary fixtures accessories, CP fittings shall etc. include all items, and operations stated in the respective specifications and bill of quantities and nothing extra is payable.
  2. Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, CP screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning and making good to the satisfaction of the Owner’s Site Representative.

##### TESTING

All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The contractor shall block the ends of waste and ventilation pipes and shall conduct an air test.

**SECTION-03:: WATER SUPPLY (COLD & HOT)**

1. **SCOPE**

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply for internal & external services as follows:

* 1. Drinking Water Supply.
  2. Flushing Water Supply

The Contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities.

The Contractor shall be solely responsible for obtaining the Authorities approval of his works prior to the handing over of the complete water supply / distribution installation to the Owner.

##### PIPING MATERIALS

The piping system shall consist of heavy class galvanized iron pipes and fittings conforming to IS:1239. The sizes and makes is specified in the Schedule of Quantities.

The piping system shall also consist of CPVC pipes as per CT’s SDR11 for domestic plumbing.

For any internal works, the galvanized iron pipes and fittings shall be embedded in the wall chase or run on the floor/ceiling unless otherwise specified. No unsightly exposed runs shall be permitted. Outside the building the piping shall be installed at least 1.0 m below the finished grade level.

**2.1** Galvanised Iron Pipes & Fittings

The pipes shall be galvanised mild steel welded (ERW) or (HFW) screwed and socketed conforming to the requirements of IS:1239. The Galvanising shall conform to IS:4736, the zinc coating shall be uniform, adherent reasonably smooth and free from such imperfections as flux, ash and drop inclusions, bare patches, black spots, pimples, lumpiness, runs, rust strains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the pipe.

The fittings shall be malleable iron and comply with all the requirements of the pipes. The sizes of pipes and fitting are specified in the schedule of quantities.

* + 1. **Laying And Jointing Of GI Pipes**

The galvanised pipes and fittings shall run in wall chase or ceiling or as specified. The fixing shall be done by means of standard pattern holder bat clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on surface. Where it is specified to conceal the pipes, chasing may be adopted for pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes with the usual tools. As far as possible, pipes may be buried for short distances provided adequate protection is given against damage and where so required special care to be taken at joints. Where directed by the Owner’s Site Representative, pipe sleeves shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. In case of pipe is embedded in walls or floors it shall be painted with anticorrosive bitumastic paints of approved quality. Under the floors the pipes shall be laid in layer of sand filling.

Galvanised iron pipes shall be jointed with threaded and socket joints, using threaded fittings. Care shall be taken to remove any burr from the end of the pipes after threading.Teflon tape, White lead or an equivalent jointing compound of proprietary make shall be used, according to the manufacturer’s instructions, with a grommet of a few strands of fine yarn while tightening. Compounds containing red lead shall not be used because of the danger of contamination of water. Any threads exposed after jointing shall be painted with bituminous paint to prevent corrosion.

**CPVC Pipes & Fittings**

The pipes shall be CPVC (Chlorinated Poly Vinyl Chloride) material for hot & cold water supply piping system wth pipes as per CTs SDR -11at a working pressure of 320 PSI at 23 deg C and 80 PSI at 82 deg.C, using solvent welded CPVC fittings i.e. Tees, Elbows, Couplees, Unions, Reducers, Brushing etc. including transition fittings (connection between CPVC & Metal pipes / GI) i.e. Brass adapters (both Male & Female threaded and all conforming to ASTM D-2846 with only CPVC solvent cement conforming to ASTM F-493, with clamps / structural metal supports as required /directed at site including cutting chases & fitting the same with cement concrete / cement mortar as required, including painting of the exposed pipes with one coat of desired shade of enamel paint. All termination points for installation of faucets shall have brass termination fittings. Installation shall be to the satisfaction of manufacturer & Project Manager. The material shall have to be gotten approved from Chief Fire Officer.

##### Joining Pipes & Fittings

* + - * 1. **Cutting:**

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

##### Deburring / Beveling:

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

##### Fitting preparation:

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

##### Solvent Cement Application:

Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket, otherwise too much of cement solvent can cause clogged water ways.

##### Assembly

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

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

Set & Cure times:

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

Minimum Core prior to pressure testing at 150 PSI

**Ambient Temperature during**

**Pipe Size**

|  |  |  |
| --- | --- | --- |
| **Core period** | **½ " - 1"** | **1.¼" - 2"** |
| Above 15 deg. C | 1 Hr | 2 Hrs |
| 4-15 deg.C | 2 Hrs | 4 Hrs |
| Below 4 deg C | 4 Hrs | 8 Hrs |

Special care shall be exercised when assembling flow guard systems in extremely low temperature ( below 4°C) or extremely high temperature (above 45°C) In extremely hot temperatures, make sure that both surfaces to be joined are till wet with cement solvent when putting them together.

##### Testing

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

##### Transition of Flowguard CPVC to Metals

When making a transition connection to metal threads, special Brass / plastic transition fitting (Male and female adapters) should be used. Plastic threaded connections should not be over torqued Hard tight pluts one half turn should be adequate.

##### Threaded Sealents

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

##### Solvent Cement

Only CPVC solvent cement conforming to ASTMF 493 should be used for joining pipe with fittings and valves. Flowguard CPVC cement solventhave a minimum shelf life of 1 year. Aged cement solvent will often change colour or being to thicken and become gelatinous or jelly like and when this happens, the cement should not be used. The cement solvent should be used within 30 days after opening the company’s seal and tightly close the seal after using inorder to avoid its freezing. The freezed cement solvent should be discarded immediately and fresh one should be used. The CPVC solvent cement usage should be adhered to as given in table below

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Diameter of pipe in inch ( flowguard)** | **½”** | **¾”** | **1”** | **¼”** | **1½”** | **2”** |
| Approx. nos. of joints which can be mode per litre of  solvent cement. | 200  Nos | 180  Nos | 150  Nos | 130  Nos | 100  Nos | 70  Nos |

##### Hangers and supports

For Horizontal runs, support should be given at 3 foot ( 90 cm) intervals for diameters of one inch and belwo and at 4 foot (1.2m) intervals for larger sizes.

Hangers should not have rough or sharp edges which come in contact with the tubing.

Supports should be as per the below mentioned table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Size of Pipe** | **21°C** | **49°C** | **71°C** | **82°C** |
| **Inch** | **Ft.** | **Ft.** | **Ft.** | **Ft.** |
| ½” | 5.5 | 4.5 | 3.0 | 2.5 |
| ¾” | 5.5 | 5.0 | 3.0 | 2.5 |
| 1” | 6.0 | 5.5 | 3.5 | 3.0 |
| 1¼” | 6.5 | 6.0 | 3.5 | 3.5 |
| 1½” | 7.0 | 6.0 | 3.5 | 3.5 |
| 2” | 7.0 | 6.5 | 4.0 | 3.5 |

##### PIPING INSTALLATION SUPPORT

Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. All accessories and ancillaries of support system such as brackets, saddles, clamps, hangers etc. shall be hot dip galvanized after fabrication. Further to permit free movement of common piping, support shall be from a common hanger bar, fabricated from galvanised steel sections.

Pipe hangers shall be provided at the following maximum spacings:

|  |  |  |
| --- | --- | --- |
| **Pipe Dia (mm)** | **Hanger Rod Dia (mm)** | **Spacing between Supports (m)** |
| Up to 25 | 6 | 2 |
| 32 to 50 | 10 | 2.7 |
| 80 to 100 | 12 | 2.7 |
| 125 to 150 | 16 | 3.6 |
| 200 to 300 | 19 | 5.3 |

Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 14 gauge metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending atleast 15 cm. on both sides of the clamps, saddles or roller.

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation with other agencies work, so that area can be carried out in one stretch.

Cut-outs in the floor slab for installing the various pipes area are indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out wherever the cut-outs shown in the drawings, do not meet with the requirements.

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fibreglass and finished with retainer rings.

The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely. In other locations, concentric reduces may be used.

All buried pipes for CWS shall be cleaned and coated with two coats of bitumen and then wrapped with two layers of 400 microne polythene sheet coating.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size isolation ball valve. Automatic air valves shall also be provided on hot water risers.

Discharge from the air valves shall be piped through a galvanized steel pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided as shown on the approved drawings and include in Bill of Quantities. Care shall be taken to protect pressure gauges during pressure testing.

Temperature gauge as specified shall be provided at the hot water supply and return and as shown on drawings and included in Bill of Quantities.

###### *FERRULES*

The ferrules for connection with main shall generally conform to IS:2692. It shall be of non-ferrous materials with a bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting of the water supply to the communication pipe, as and when required.

4.1 **Fixing Ferrules**

For fixing ferrule in cast iron mains, the empty main shall be drilled and tapped at 45 deg to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.

##### WATER METERS

Water meters of approved make and design shall be supplied for installation at locations as shown. The water meters shall meet with the approval of local supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also the be provided along with the meters.

The meters shall conform to Indian Standard IS:779 and IS:2373.

Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

##### 5.1 Installation of Water Meter and Stop Cock

The G.I. lines shall be cut to the required lengths at the position where the meter and stop cock are required to be fixed. Suitable fittings shall be attached to the pipes. The meter and stop cock shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter.

1. TESTING

The Contractor shall notify the Architect three days in advance of any test so that the Architect can witness the tests if he so wishes.

All water supply system shall be tested to hydrostatic pressure test of atleast one and a half (1.5) times the maximum pressure but not less than 10Kg/Sq.cm for a period of not less than 8 hours. All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner.

System may be tested in sections and such sections shall be entirely retested on completion.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through the entire piping network of the system concerned. In case of improper circulation, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required.

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

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

A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Owner’s site

representative.

##### DISINFECTION OF PIPING SYSTEM AND STORAGE TANKS

Before commissioning the water supply system, the contractor shall arrange to disinfect the entire system as described in the succeeding paragraph.

The water storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water.

If ordinary bleaching powder is used, the proportions will be 150 gm of power to 1000 liters of water. The power shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the manufacturer. When the storage tanks is full, the supply shall be stopped and all the taps on the distributing pipes are opened successively working progressively away from the storage tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

The pipework shall be throughly flushed before supply is restored.

##### STERILIZATION OF MAIN

After the pipework has been tested and approved, but before it is coupled, it shall be sterilized with a solution of chloride of lime.

##### CUTTING CHASES IN MASONARY WALLS

Cold water distribution pipes to fixtures and equipment exposed to view in the bathrooms, kitchens, and sanitary compartments shall be chased into walls or floors or placed in wall cavities. The Contractor shall be responsible for cutting all notches, chases, and recesses in walls and floors and only a diamond cutter shall be used. The maximum size of conduit or pipe permitted to be concealed in floor slabs shall be 32 mm diameter unless otherwise approved by the Architect.

The chases upto 7.5 x 7.5 cm shall be made in the walls for housing GI pipes etc. These shall be provided in correct positions as shown in the drawings or directed by the Architects. Chases shall be made by chiseling out the masonry to proper line and depth. After the pipes etc are fixed in chases, the chases

shall be filled with cement mortar 1:2:4 or as may be specified, and made flush with the masonry surface. The concrete surface shall be roughened with wire brush to provide a key for plastering.

Where pipes pass through beams or structural walls, subject to the approval of the Structural Consulting Engineer, the Contractor shall ensure that sizes and locations of openings required are formed in when the relevant beams or walls are cast.

##### VALVES

All valves (gate, globe, check, safety) shall be of gun metal suitable for the particular service as specified. All valves shall be of the particular duty and design as specified. Valves shall either be of screwed type or flanged type, as specified, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS:776 and non-return valves and swing check type reflux to IS:5312.

Sluice valves, where specified shall be flanged sluice valves of cast iron body. The spindle, valve seat and wedge nuts shall be gunmetal. They shall generally have non-rising spindle and shall be of the particular duty and design as specified. The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian standard IS:780 and IS:2906.

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

Globe valves on Hot-water line shall be union bonnet with stem/disc and body seat ring of SS. Suitable for temperature upto 80° C.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.No** | **Type of Valve** | **Size** | **Constructio**  **n** | **Ends** |
| a. | Isolating Valve | 15 mm to 50 mm 65 mm and above | Gun Metal Gun Metal | Screwed Flanged |
| b. | Sluice Valve & Butterfly Valve | 65 mm and above | Cast Iron | Flanged |
| c. | G.M. non return valve | 15 mm to 50 mm  65 mm above | Gun Metal Gun Metal | Screwed Flanged |
| d. | Flap Type – Non return valve | 65 mm and above | Cast Iron | Flanged |

All valves shall be suitable for the working pressure involved.

##### Pressure Relief Valves

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure reducing valve.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

##### Pressure Gauge

The pressure gauge shall be constructed of die cast aluminium and stove enamelled. It shall be weather proof with an IP 55 enclosure. It shall be a stainles steel Bourden tube type pressure gauge with a scale range from 0 to 16 Kg / cm square and shall be constructed as per IS:3524. Each pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by Ball Valve.

##### WATER FITTINGS

Unless otherwise specified all Gunmetal fittings such as gate, globe, check & safety valves shall be fitted in pipe line in workman like manner. Necessary unions shall be provided on both ends of the valves for easy replacement. The joints between fittings and pipes shall be leak-proof when tested to desired pressure rating. The defective fittings and joints shall be replaced or redone.

##### CONNECTIONS TO VARIOUS MECHANICAL EQUIPMENT SUPPLIED BY OTHER AGENCIES

All inlets, outlets, valves, piping and other incidental work connected with installation of mechanical equipment supplied by other agencies all be carried out by the contractor in accordance with the drawings, requirements for proper performance of equipment, manufacturers instructions and the directions of the Owner’s site representative / Architect. The equipments to be supplied by the other agencies consist mainly for Kitchen, Back-of-the-House area and other similar areas. The work of connections to the various equipments shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirement of equipment suppliers, under the directions of the Owner’s site representative / Architect. The various aspects of connection work shall be executed in a similar way to the work of respective trade mentioned elsewhere in these specifications.

##### CONNECTIONS TO RCC WATER TANKS

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflows control valves and all such other piping connections including level indicator to water storage tanks as called for. All pipes crossing through RCC work shall have puddle flanges fabricated from MS/GI pipes of required size and length and welded to 6/8 mm thick MS plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.

Full way gate valves of a approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. Overflow and vent pipes shall terminate with mosquito proof grating.

The overflow pipe shall be so placed to allow the discharge of water being readily seen. The overflow pipe shall be of size as indicated. A stop valve shall also be provided in the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning.

##### MEASUREMENTS

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include pipe and fittings such as coupling, bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, unions. Deductions for length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chased and making good the same and all items mentioned in the specifications and Bill of Quantities.

All pipes below ground shall be measured per linear meters (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, deduction for valves shall be made rate quoted shall be inclusive of all fittings, excavation, back filling and disposal of surplus earth, cutting holes and chase and making good all item mentioned in Bill of Quantities.

##### 15 HOT WATER PIPING INSULATION Material

Insulation material for Pipe insulation shall be Closed Cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/moK or 0.0313 Kcal / Mhr oC or 0.212 BTU / (Hr-ft2-oF/inch) at an average temperature of 30oC. The product shall have temperature range of –40 oC to 105oC. Density of material shall not be less than 0.06 gm/cm3. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of flame. Water vapour permeability shall not exceed 0.024 perm inch (3 x 10-14 Kgs / m.sec.Pa). The material shall have approval from the Chief Fire Officer.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer test certificate for thermal conductivity values. Samples of insulation material from each lot delivered at site may be selected by AHI’s site representative and gotten tested for thermal conductivity and density at Tenderer’s cost All joints shall be sealed properly with adhesive, which shall provide similar vapour barrier as the original insulating material.

All hot water piping shall be insulated in the manner specified herein. Before applying insulation, all pipe shall be brushed and cleaned. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

##### --------------------------------------------------------------------------------------------------------------------

**Pipe size (mm) Thickness of Nitrile rubber insulation**

**--------------------------------------------------------------------------------------------------------------------**

15 mm to 25 mm 9 mm

32 mm to 50 mm 13 mm

65 mm and above 19 mm

##### --------------------------------------------------------------------------------------------------------------------

Insulation for pipes in wall chase and for pipes in shaft / plant room.

Insulating material in tube form shall be sleeved on the pipes. On existing piping, slit opened tube from insulating material shall be placed over the pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre.

Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The insulation shall be continuous over the entire run of piping, fittings and valves. All valves, fittings, joints, strainers etc. in hot water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labeled (HWS / HWR / HWRR) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. All painting shall be as per relevant BIS codes.

**Protective Coating Over Insulation**

To provide mechanical strength and protection from damage & UV rays all exposed pipe insulated with nitrile rubber as indicated in BOQ shall be covered with fibreglass fabric. The fibreglass fabric shall be applied with one coat of fire proof epoxy or acrylic compound. The coat shall be allowed to cure to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

**Measurement Of Insulation**

Unless otherwise specified measurement for pipe insulation for the project shall be on the basis of centre line measurements described herewith

Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers shall not be separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including valves, orifice plates and strainers etc. shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

**SECTION-04:: INTERNAL DRAINAGE (SOIL, WASTE, VENT & RAIN WATER PIPES)**

###### *SCOPE*

The scope of this section comprises the supply, installation, testing and commissioning of internal drainage services.

Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the schedule of quantities.

###### *BASIC PIPING SYSTEM*

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. false ceilings etc. shall consist of cast iron pipes & fittings as called for. In general wastes and vents smaller than and upto 50mm dia shall be of heavy class GI.

The soil pipes shall be circular with a minimum diameter of 100mm. Pipes shall be fixed by means of stout GI clamps in two sections, bolted together, built into the walls, wedged and neatly jointed as directed and approved by the Owner’s site representative / Architect. All bends, branches, swan neck and other parts shall conform to the requirement and standards as described for the pipes. Pipes shall be rested against the walls on suitable wooden cradles. Local authority regulations applicable to the installations shall be strictly followed.

Where indicated, the soil pipes shall be continued upwards without any diminution in its diameter, without any bend or angle to the height shown in the drawings. Joints throughout shall be made with molten lead as described under jointing of cast iron pipes. Soil pipes shall be painted as provided under `painting'. The soil pipes shall be covered on top with cast iron terminal outlets as directed and approved. All vertical soil pipes shall be firmly fixed to the walls with properly fixed clamps, and shall as far as possible be kept 50mm clear of wall. Waste pipes and fittings shall be of cast iron or galvanised mild steel pipes. Pipes shall be fixed, jointed and painted as described in installation of soil, waste & vent pipes.

Every waste pipe shall discharge above the grating of properly trapped gully. The contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided, it shall be ensured that atleast one wash is connected to such floor traps to avoid drying of water seal in the trap. Ventilating pipes shall be of cast iron or galvanised mild steel pipes, conforming to the requirements laid down earlier. Anti-syphon vent pipes/relief vent pipes where called for on the drawings shall be of cast iron or galvanised mild steel pipes as specified. The pipes shall be of the diameter shown on the drawings.

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

Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawings so that other agencies are instructed to provide the same.

All the fittings used for connections between soil, waste and ventilation pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. The doors shall be provided with 3mm thick rubber insertion packing and when closed and bolted shall be air and water tight.

Where soil, waste and ventilating pipes are accommodated in shafts ducts, adequate access to cleaning eyes shall be provided.

Head (starting point) of drains and sewage / waste water sumps (as and where applicable) having a length of greater than 4 m upto it connection to the main drain or manhole shall be provided with a 80 / 100 mm vent pipe.

###### *PIPING MATERIALS*

* 1. **Cast Iron Pipes**

Cast iron pipes and fittings shall be of good and tough quality and dark grey on fracture. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and nicely cast, shall be free from cracks, taps, pinholes and other manufacturing defects.

The pipes and fittings shall conform to IS:3989 / IS:1729 as called for. Fittings shall be of required degree with or without access door. All access doors shall be made up with 3mm thick insertion rubber gasket of white lead and tightly bolted to make the fittings air and water tight. The fittings shall be of the same manufacture as the pipes used for soil and waste.

All CI pipes and fittings shall bear the manufacturer's name and ISI specification to which it conforms.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fittings being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar/other suitable base. The coating material shall have good adherence and shall not scale off. The coating shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree C but not so brittle at a temperature of '0' degree C as to chip off when scratched lightly with a pen knife.

All pipes and fittings before installation at site shall be tested hydrostatically to a pressure of 0.45 Kg/sq. cm without showing any sign of leakage, sweating or other defects of any kind. The pressure shall be applied internally and shall be maintained for not less than 15 minutes. All these tests shall be carried out in the presence of the representative of the Project Manager. Alternatively a test certificate from manufacturers be obtained before dispatch of material to site.

Cast Iron Specialities

If required, Cast iron speciality items such as deep seal floor traps, urinal traps, trap integral pieces with integral inlet/outlet connections, manhole cover with frame, chamber cover etc. shall be fabricated to suit individual location requirements. The contractor shall arrange the fabrication of these items from an approved source.

Lead Caulked joints with pig lead:

The approximate depth and weights of pig lead for various diameters of CI pipes and specials shall be as follows:

|  |  |  |
| --- | --- | --- |
| **Nominal size of Pipe** | **Lead per Joint (Kg)** | **Depth of Lead Joint (mm** |
| **(mm)** |  |  |
| 50 | 0.77 | 25 |
| 80 | 0.88 | 25 |
| 100 | 0.99 | 25 |
| 150 | 1.5 | 38 |

**Drip Seal Joints :**

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition. Drip seal PJS - 43 is the proprietary item of M/s. Vinod Cement Co., Chandigarh.

**Application Procedure**:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. **\*** Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (**\*** The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

##### Galvanised Iron Pipes

Waste pipes of 50mm dia and below and where called for shall be galvanised iron pipes screwed and socketed conforming to the requirements of IS:1239 of heavy grade. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws, laminations and other defects. All screw thread shall be clean and well cut. All pipes and fittings shall bear manufacturer's trade mark and conform to the IS as specified.

##### UPVC Pipes and Fittings

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter and shall conform to IS:4985-1981. The pipes shall be of Class-III; 6 Kg/sqm pressure rating.

Fittings

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard. Laying and Jointing

The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and ‘O’ rubber ring for vertical line. The type of joint shall be used as per site conditions / direction of the Owner’s site representative. Where UPVC pipes are to be used for rain water pipes, the pipe shall be finished with GI adopter for insertion in the RCC slab for a water proof joint complete as directed by Owner’s site representative.

Supports

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.

Repairs

While temporary or emergency repairs may be made to the damaged pipes, permanent repairs shall be made by replacement of the damaged section. If any split or chip out occur in the wall of the pipe, a short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut. The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged hard pipe.

##### Cast Iron Class (LA) pipes

All drainage passing under building floor and passing through retaining wall shall be cast iron class (LA) pipes (IS : 1536)

Cast iron class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casing stress; provided that the specified mechanical properties are satisfied.

Material

Cast iron pipe shall be centrifugally spun cast iron pipe and conforming to IS:1536-1976 Fittings

Fittings shall be used for cast iron class (LA pipes shall conform to IS:1538-1976). Whenever possible junction from branch pipe shall be made by wyes.

All cast iron water main pipes and fittings shall be manufactured to IS:1536 of tested quality. The pipes and fittings shall either be spigot and socket type or as called for. The pipes and fittings shall be of uniform material throughout and shall be free from all manufacturing defects.

Joints

Cast iron class (LA) pipe used for soil and waste pipes shall be jointed with **drip seal** / lead joints sufficient skein of jute rope shall be caulked to leave minimum space of 25 mm for the **drip seal**. Lead to be poured in.

Laying

* + 1. Fittings used for CI drainage pipe shall conform to IS:1538-1976. Wherever possible junction from branch pipes shall be made by a Y/tee.

**Drip Seal Joints :**

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition. Drip seal PJS - 43 is the proprietary item of M/s. Vinod Cement Co., Chandigarh.

**Application Procedure**:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. **\*** Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (**\*** The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

* + 1. Lead Caulked joints with pig lead :

The approximate depth and weights of pig lead for various diameters of CI pipes and specials shall be as follows:

|  |  |  |
| --- | --- | --- |
| **Nominal size of Pipe (mm)** | **Lead per Joint (Kg)** | **Depth of Lead Joint (mm** |
| 80 | 1.8 | 45 |
| 100 | 2.2 | 45 |
| 125 | 2.6 | 45 |
| 150 | 3.4 | 50 |
| 200 | 5.0 | 50 |
| 250 | 6.1 | 50 |

* + 1. The spigot of pipe of fittings shall be centered in the adjoining socket by caulking. Sufficient turns of tarred gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten Lead shall then be poured to the remainder of the socket.
    2. For lead wool joints the socket shall be caulked with tarred gasket, as explained above. The lead wool shall be inserted into the sockets and tightly caulked home skin by skin with suitable tools and hammers of not less than 2 Kg weight until joint is filled.

###### *PIPES HANGERS, SUPPORTS, CLAMPS ETC.*

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

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

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

All pipes clamps, supports and hangers shall be galvanized. Factory made prefabricated clamps shall be preferred. Contractor may fabricate the clamps of special nature and galvanize them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanized.

Clamps shall be of approved design and fabricated from MS flats (which shall be galvanized after fabrication) of thickness and sizes as per drawings or contractor’s shop drawings. Clamps shall be fixed in accordance to manufacturer’s details/shop drawings to be submitted by the contractors.

When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanized expansion anchor fasteners (Dash fasteners) of approved design and size according to load.

Structural clamps e.g.. trapeze or cluster hangers shall be fabricated by electro-welding from MS structural members e.g. rods, angles, channels flats as per contractors shop drawings shall be galvanized after fabrication. All nuts, bolts and washers shall be galvanized.

Galvanized slotted angle/channel of approved sizes supports on walls shall be provided wherever shown on shop drawings. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with anchor fasteners mentioned above. The spacing of support bolts on support members fixed horizontally shall not exceed 1 m.

###### *INSTALLATION OF SOIL, WASTE & VENT PIPES*

Soil, waste & vent pipes in shafts under the floors / suspended below slab shall consist of cast iron pipes as described earlier. Waste pipes from bottle trap to floor/urinal traps for wash basin, urinal and sink shall be GI pipes and fittings.

All Horizontal pipes running below the slab and along the ceiling, shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

All cast iron pipes and fittings shall be jointed with drip seal / Best Quality pig lead free from impurities confirming to IS 27.

Before jointing, the interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of threaded spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment. The reminder of the socket is left for the lead caulking. Where the gasket has

been tightly held, a jointing ring shall be placed round the barrel against the face of the socket. Molten Lead shall be poured to the remainder of the socket.

The depth of the lead joints for the cast iron pipes shall be 45mm for the pipes upto 100mm dia and 50mm for the pipes beyond 100mm dia respectively.

The joint shall not be covered till the pipe line has been tested under pressure. Rest of pipe line shall be covered so as to prevent the expansion and contraction due to variation in temperature.

Rainwater Pipes

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

Rainwater down takes are separate and independent of the soil and waste system and will discharge into the underground storm water drainage system of the complex.

Rainwater in open courtyards shall be collected in catch basins and connected to the Storm Water Drains.

Any dry weather flow from waste appliances, e.g. AHU’s pump rooms, waste water sumps shall connected to

sewers after traps and not in the storm water drainage systems. Balcony / Planter drainage

Wherever required, all balconies, terraces, planters and other frontal landscape areas will be drained by vertical down takes or other type of drainage system shown on the drawings and directed by the Project Manager.

###### *TRAPS*

* 1. **Floor Traps**

Floor traps where specified shall be siphon type full before P or S type cast iron having a minimum 50 mm deep seal. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size).

Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30 x 30 cms of the required depth.

##### Floor Trap Inlet /Hopper

Bath room traps and connection shall ensure free and silent flow of discharging water. Where specified, contractor shall provide a special type of floor inlet fitting fabricated from GI pipe, with one, two or three inlet sockets welded on side to connect the waste pipe. All joint between waste hopper and CI inlet socket shall be drip seal/Lead Caulked. Inlet shall be connected to a CI “P” trap. Floor trap inlet and the traps shall be set in cement concrete blocks where burried in floors without extra charge. Floor trap for the shower cubicle shall suit site and as per the approval of Owner’s site representative. All fabricated hopper shall be hot dip galvanized.

##### Floor Trap Grating

Floor and urinal traps shall be provided with 100 – 150 mm square or round stainless steel gratings, with frame and rim of approved design and shape or as specified in the schedule of quantities approved by the Owner’s site representative.

##### Cleanout Plugs

Floor Clean Out Plug

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, “Y” and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor level. They shall be threaded and provided with key holes for opening. Cleanout

plugs shall be cast brass suitable for the pipe dia. With screwed to a GI socket. The socket shall be drip seal joined/ Lead Caulked to the drain pipes.

Cleanout on Drainage Pipes

Cleanout plugs shall be provided on head of each drain and in between at locations indicated on plans or directed by Owner’s site representative. Cleanout plugs shall be of size matching the full bore of the pipe but no exceeding 150 mm dia CO plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.

Floor cleanout plugs shall be cast brass.

Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanized sheets and angles with hinged type doors with fly nuts, gasket etc. as per drawing.

###### *PIPE SLEEVES*

Pipe sleeves, next larger diameter than pipes shall be provided wherever pipes pass through walls & slabs and annular space filled with fiberglass & finished with retainer rings. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance of foreign matter.

###### *PIPE PROTECTION*

Cast iron soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate of 12 mm size) 10 cm bed and around. When pipes are running well above the structural slabs, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals directed by the Project Manager.

###### *CUTTING AND MAKING GOOD*

Pipes shall be fixed and tested as building proceeds. The contractor shall provide all necessary holes, cutouts and chases in structural members as building work proceeds. Wherever holes are cut or left originally they shall be made good with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement : 2 coarse sand). Cured and the surface restored to original condition.

###### *PAINTING*

Soil, waste, vent and rain water pipes in exposed location, in shafts and pipe space shall be painted with two or more coats of ready mix oil paint to give an even shade. Before painting all dust and extraneous matter shall be removed.

Paint shall be of approved quality and shade. Where directed by the Owner’s site representative pipes shall be painted in accordance with approved pipe colour code.

Pipe in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with synthetic enamel paint after removing dust and extraneous matter.

C.I. Soil and waste pipes below ground and covered in cement concrete shall not be painted.

###### *TESTING*

Testing shall be done in accordance with IS:1172 and IS:5329 except as may be modified herein under.

Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work tests,

All materials obtained and used on site must have manufacturer’s hydraulic test certificate for each batch of

materials used on the site.

Before use at site all CI pipes shall be tested by filling up with water for at least 30 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours. Pipes with minor sweating may be accepted at the discretion of the Project Manager.

Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All openings and connections shall be suitably plugged as approved by the Project Manager. The total head in the stack shall be 4.5 m at the highest point of the section under test. The period of test shall be minimum for 30 minutes or as directed by the Project Manager. If any leakage is visible, the defective part of the work shall be cut out and made good.

On completion of the work the entire installation shall be tested by smoke testing machine. The test shall be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging the outlets with bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections.

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

A test register shall be maintained and all entries shall be signed and dated by the Contractor and the Project Manager or his representative.

All pipes in wall chase or meant to be encased or burried shall be hydro tested before the chase in plastered or the pipe encased or burried.

SECTION-05:: COMMISSIONING & GUARANTEE

###### *SCOPE OF WORK*

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rota meters. Contractor shall also supply all required pressure gauge, temperature

gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

###### *PRECOMMISSIONNIG*

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

* 1. Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.
  2. All strainers shall be inspected and cleaned out or replaced.
  3. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:
     + Remove oil, grease and foreign residue from the pipe work and fittings;
     + Pre-condition the metal surfaces to resist reaction with water or air.
     + Establish an initial protective film;
     + After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
     + Details and procedures of the pre-treatment shall be submitted to the Architect for approval.
  4. Check all clamps, supports and hangers provided for the pipes.
  5. Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.
  6. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

###### *STATUTORY AUTHORITIES' TESTS AND INSPECTIONS*

As and when notified in writing or instructed by the Architect, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Architect as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.

The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.

The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Architect may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

The Contractor shall notify the Architect at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Architect without delay.

###### *FINAL ACCEPTANCE TESTS*

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

###### *REJECTION OF INSTALLATION / PLANT*

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Architect/Employer.

###### *WARRANTY AND HANDOVER*

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

###### *HANDING OVER OF DOCUMENTS*

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner’s site representative and all testing and commissioning documents shall be handed over to the Owner’s site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other

documentation as per the terms of the contract to the Owner’s site representative.

Specification: CCTV

IP Based CCTV system

The Closed-Circuit Television (CCTV) System shall provide surveillance of unmanned areas and visitors. The primary objective of implementing CCTV system shall be to ensure effective surveillance of an area and also create a record for post event analysis. Cameras with suitable lenses shall be used to view specific

areas of interest. The system shall be monitored on-line and also shall be recorded. The following components and accessories shall be considered in CCTV System.

Network Video Recorder (NVRVMS BASED) Fixed Dome Cameras (IP Based)

Bullet Cameras (IP Based)

PTZ Dome Cameras (IP Based). CPU, software license for two viewers. Active data points in server rooms.

All Cameras should be high Definition.

System should be capable for Face tracking system.

System can read vehicle number plates and capable to authorize vehicle for entry in coordination with boom- barrier/other security systems.

System should be capable for imaging during night operation.

The CCTV system with 24x7 surveillance shall be provided for all common areas like main Entrance/Exit, corridors, Directorates/open office areas, Toilet entry, Services areas, parking, Ramps, staircase, Equipment’s room, server room, security room, etc. within the building with indoor type fixed dome camera, bullet camera, PTZ camera etc. with 180 deg. viewing angle and at Lifts, Lift Lobby, Basements etc. with 360 deg. viewing angle cameras as per approval from Consultant/Employer/Engineer-in-charge.

For the whole Site surveillance, CCTVs shall be proposed for all main entry/exits, Gate Office, Watch Towers, Service/Utility Building area, Surface Car Parking, DSC Accommodation area, internal roads, Main Building Entry points, etc. with Outdoor type cameras with night vision facility and peripheral walls @ approx. 30-40m distance, with 180 deg/360 deg cameras as per the as per approval from Consultant/Employer/Engineer-in-charge.

All Cameras shall be connected to network Video Recorder (NVR) with the help of POEP (Power over Ethernet Protocol) switches through Cat 6/Cat 6A Optical fiber as required to ensure good connectivity without losing any data and protection of cable. NVR shall be located in server room and monitoring of entire system shall be done at Security room. For clear views of all cameras, video wall shall be provided. Further for close monitoring, 5 monitors of 50” size approx. UHD screens shall be provided as per approval from Consultant/Employer/Engineer-in-charge.

System shall have a storage facility for min. 60 days. Further system shall be capable for backup by all kind media writing facility like blue ray, DVD, CD, portable storage, external hard-disk etc. with the authentication only.

UPS power arrangement for POEP switches shall be provided as per manufacturer standard or as approved by as per approval from Consultant/Employer/Engineer-in-charge. The CCTV shall be installed on separate GI poles at suitable Height as per the manufacture standard and clear visibility requirements. In no case, cameras should be installed on electrical/external lighting poles.

Cables shall be laid underground for external LV works and Cable tray/conduit/raceway for internal LV works with full protection against damage/water etc.

IP CCTV SYSTEM

CCTV stands for Closed circuit television - the signals are for the use by a closed community and are not for public domain as against a normal broadcast TV

All the cameras, Encoders and Video Management software with Built in Video Analytics shall be from a single Original Equipment Manufacturer

The interested system integrators should visit the site to assess the exact Bill of quantity. The System Integrator is responsible for any item to be added to have a complete workable solution without any additional cost from the final offer.

2.0 MP 30X Outdoor PTZ

2.0 MP IR Bullet Camera

2.0 MP Dome Camera

NVR & Management software.

ITEM # 1: 2.0 MEGAPIXEL OUTDOOR DAY & NIGHT IR HIGH SPEED PTZ DOME CAMERAS

The HD megapixel IP PTZ domes shall provide a high-definition, high frame rate and high light compensating real- time images acquisition system. The PTZ domes shall provide the ability to view and control H.265/H.264/H.264+ dual-stream encoded HD video, and also shall support three video streams. The maximum resolutions can be1920×1080 @ 30fps. The user-friendly GUI interface shall be provided for easy PTZ control and convenient camera parameter settings. The camera shall be able to address Night visibility r requirement for a minimum of 200m. Thus, it shall make easier to set the PTZ and perform operations with a mouse than traditional keyboard or software control. In addition, area zoom and image PTZ are also offered. The domes shall also provide functions such as preset, pattern, auto scan and auto pan etc.

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| SPECIFICATIONS | | COMPLIANCE | REMARKS |
| Optical zoom | 30X |  |  |

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| Video Management & Analytics Software | Shall be from the same manufacturer |  |  |
| Presets | 1-255 |  |  |
| Patterns | 4 |  |  |
| Autopans | 4 |  |  |
| Tours | 6 |  |  |
| Privacy Mask | 4 Areas |  |  |
| HLC | Required |  |  |
| Image Mirror | Yes |  |  |
| Video compression | H.265 / H.264 switchable |  |  |
| Image Freeze | Yes |  |  |
| Scanning System | Progressive scanning |  |  |
| Image Sensor | 1/3" CMOS |  |  |
| Video Resolution | 2.0 Mega Pixel, 1920×1080 @ 30fps |  |  |
| Aperture/Focal Length | F1.6 ~ F 4.8 f=4.0-  4.5mm(lower)~120-135mm (upper) |  |  |
| Angle of View | >60°(Wide)/ <2.2°(Tele) |  |  |
| BLC | Required |  |  |
| Sensitivity | Color mode: 0.005 and B/w: 0.0005lux |  |  |
| Home Return | Required |  |  |
| Time Tour | Required |  |  |
| Autopan | Required |  |  |
| S/N Ratio | >50dB |  |  |
| Web Server | Required |  |  |
| Area Zoom | Required |  |  |
| Sync System | Internal |  |  |
| DWDR | Min 100dB |  |  |
| Auto Gain Control | Auto |  |  |
| Preset | Min 256 |  |  |
| Remote Upgrade | Required |  |  |
| Focus | Auto/Manual |  |  |
| White Balance | Auto/Manual |  |  |
| Shutter Speed | Auto: PAL: 1/1~1/30000s |  |  |
| Iris | Auto/Manual |  |  |
| Data Rate | Variable bit rate (vbr); Constant bit rate (cbr):  256Kbps~8Mbps |  |  |
| Audio Compression | G.711 Optional available |  |  |
| Network Delay | <300ms |  |  |
| Network Protocols | TCP/IP, HTTP, HTTPS, 802.1X, ICMP, UDP, SMTP, RTP, RTSP, SNMP,  IGMP |  |  |
| Network Port | 1 RJ45 10M/100M self-  adaptive Ethernet port |  |  |
| Motion detection | 4 areas from software |  |  |
| Sync System | Internal |  |  |
| IR Range | Required a min of 150metres |  |  |
| Alarm | 2 input, 1relay out |  |  |
| Comply with ONVIF S specification | Support Onvif |  |  |
| Motion detection, Video Tampering, Storage card | Required |  |  |

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| Removed, Network Loss Alarmas  and ALerts |  |  |  |
| Manual Pan/Tilt Speed | 0.1°~400°/0.1°~300°per  second |  |  |
| Preset Speed | 360° per second |  |  |
| Pan Travel | 360° continuous |  |  |
| Tilt Travel | -4° ~ 90° |  |  |
| Preset Accuracy | ±0.1° |  |  |
| Motor | Stepping Motor |  |  |
| Input Voltage | 24VDC/24VAC self adaptive or PoE/24VAC self  adaptive |  |  |
| Power Consumption | Should be less than 65W |  |  |
| Operating Temperature | -40°C ~55°C |  |  |
| Operating Humidity | 0~90%RH (non-condensing) |  |  |
| Rating | IP66 |  |  |
| Mounting | Bracket |  |  |
| Certifications | CE/EMC, FCC: Part15  Subpart B, UL, ISO 9001:2008, IP66, IK10 |  |  |
| Makes | Heinrich , MARCH  NETWORKS, Mobotix, |  |  |

ITEM # 2: 2.0 Megapixel IR Bullet Camera

The HD megapixel IR IP Bullet camera shall adopt 1/2.9" or better progressive scan CMOS sensor or better with H.264 /M- JPEG video compression format allows image output resolution up to [1920x1080p@25fps.The](mailto:1920x1080p@25fps.The) camera shall support minimum two simultaneous video streams functioned with ICR day/night switch, motion detection, privacy mask, alarm input/output, the camera shall be bound to enhance security and convenience for your CCTV surveillance system. The built-in motorized zoom lens with the focal length of minimum 3-12mm should adjusts focal length remotely. The high-power LED illuminators shall provide with long lifespan, allowing a minimum of 40m illumination distance. With Smart-IR technology, it shall change power consumption of IR illuminators according to the ambient light.

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| FEATURES | MINIMUM REQUIRED PARAMETERS | CONFORMANCE (YES/NO) | VENDOR REMARKS  (in case of deviation) |
| Image Sensor | 1/2.9’’progressive scan CMOS |  |  |
| Lens | Motorized zoom lens, F1.4, f=3- 12mm |  |  |
| DWDR | Min 80dB |  |  |
| IR Wave Length | 850nm required |  |  |
| IR Illumination Distance | Minimum 40m |  |  |
| Day/Night Functionality | ICR |  |  |
| Sensitivity | Color mode: 0.05 lux; B/W mode: 0.0 lx(IR ON) |  |  |
| Exposure | Scene Mode, Manual mode, Shutter mode |  |  |
| Shutter | Auto/Manual (1/30s~1/10000s) |  |  |
| White Balance | Auto/Manual/Outdoor |  |  |
| Gain Control | Auto/Manual |  |  |

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| Noise Reduction | 3D/2D |  |  |
| Video Compression | H.264 High profile/M-JPEG/H.265 |  |  |
| Maximum Resolution | 1920x1080p |  |  |
| Maximum Frame Rate | 25fps@1920x1080p |  |  |
| Data Rate | Variable bit rate; |  |  |
| Constant bit rate | 256Kbps~10Mbps |  |  |
| Motion Detection | Supported |  |  |
| Privacy Mask | Supported |  |  |
| Remote upgrade | Required |  |  |
| Network Port | One RJ45 10/100M self-adaptive Ethernet port |  |  |
| Applicable Protocols | IPv4, TCP/IP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP, |  |  |
| Alarm | Motion detection software. |  |  |
| Power Supply | PoE IEEE 802.3af Class 3/12VDC |  |  |
| Power Consumption | ＜10W |  |  |
| Operating Temperature | -40°C~+55°C |  |  |
| Storage Temperature | -20°C~+60°C |  |  |
| Operating Humidity | 0%-90% RH (non-condensing) |  |  |
| Housing | Metal body, IP66 |  |  |
| Certifications |  |  |  |
| Construction Form Factor | Bullet for Outdoor and Dome for Indoor |  |  |
| Make | Heinrich/Mobotix /March network |  |  |

ITEM # 2: 2.0 Megapixel IR Dome Camera

The HD megapixel IR IP dome camera shall adopt 1/2.9" or better progressive scan CMOS sensor or better with H.264 /M- JPEG video compression format allows image output resolution up to [1920x1080p@25fps.The](mailto:1920x1080p@25fps.The) camera shall support minimum two simultaneous video streams functioned with ICR day/night switch, motion detection, privacy mask, alarm input/output, the camera shall be bound to enhance security and convenience for your CCTV surveillance system. The built-in motorized zoom lens with the focal length of minimum 3-12mm should adjusts focal length remotely. The high-power LED illuminators shall

provide with long lifespan, allowing a minimum of 30m illumination distance. With Smart-IR technology, it shall change power consumption of IR illuminators according to the ambient light.

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| --- | --- | --- | --- |
| FEATURES | MINIMUM REQUIRED PARAMETERS | CONFORMANCE (YES/NO) | VENDOR REMARKS  (in case of deviation) |
| Image Sensor | 1/2.9’’progressive scan CMOS |  |  |
| Lens | Motorized zoom lens, F1.4, f=3- 12mm |  |  |
| DWDR | Min 80dB |  |  |
| IR Wave Length | 850nm required |  |  |
| IR Illumination Distance | Minimum 30m |  |  |
| Day/Night Functionality | ICR |  |  |
| Sensitivity | Color mode: 0.05 lux; B/W mode: 0.0 lx(IR ON) |  |  |
| Exposure | Scene Mode, Manual mode, Shutter mode |  |  |
| Shutter | Auto/Manual (1/30s~1/10000s) |  |  |
| White Balance | Auto/Manual/Outdoor |  |  |
| Gain Control | Auto/Manual |  |  |
| Noise Reduction | 3D/2D |  |  |
| Video Compression | H.264 High profile/M-JPEG/H.265 |  |  |
| Maximum Resolution | 1920x1080p |  |  |
| Maximum Frame Rate | 25fps@1920x1080p |  |  |
| Data Rate | Variable bit rate; |  |  |
| Constant bit rate | 256Kbps~10Mbps |  |  |
| Motion Detection | Supported |  |  |
| Privacy Mask | Supported |  |  |
| Remote upgrade | Required |  |  |
| Network Port | One RJ45 10/100M self-adaptive Ethernet port |  |  |
| Applicable Protocols | IPv4, TCP/IP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP, |  |  |
| Alarm | Motion detection software. |  |  |
| Power Supply | PoE IEEE 802.3af Class 3/12VDC |  |  |

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| --- | --- | --- | --- |
| Power Consumption | ＜10W |  |  |
| Operating Temperature | -40°C~+55°C |  |  |
| Storage Temperature | -20°C~+60°C |  |  |
| Operating Humidity | 0%-90% RH (non-condensing) |  |  |
| Housing | Metal body, IP65 |  |  |
| Impact Resistance | IK 10 |  |  |
| Certifications |  |  |  |
| Construction Form Factor | Bullet for Outdoor and Dome for Indoor |  |  |
| Make | Heinrich/Mobotix /Axis/March network |  |  |

Item # 3: NVR & Intelligent Network Video Management Software . General

The intelligent video management software & recorder shall enable management and control of live and recorded video, seamlessly integrating analog and digital video components. This shall be designed for small and medium sized deployments and all-in-one architecture shall be based on one standard box serving as the recording server, system and client. The system shall be easy to install, configure, maintain and provides all levels of security personnel with intuitive and reliable control. This shall enable fast detection of potential threats and emergency event management.

32 CH. NVR Standalone NVR with VMS .

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| --- | --- | --- | --- |
| FEATURES | MINIMUM REQUIRED PARAMETERS | CONFORMANCE (YES/NO) | VENDOR REMARKS  (in case of deviation) |
| System | Embedded Linux system |  |  |
| Image Compression support | H.264/H.265 |  |  |
| Network Video Input | 32Ch. Input |  |  |
| Network Bandwidth | 256 Mbps |  |  |
| Network video access protocol | Onvif supported |  |  |
| Network Video Bandwidth | 256 Mbps |  |  |

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| --- | --- | --- | --- |
| Recording Resolution | 4K/5MP/3MP/1080P/1600×1200/720P/  640×480/ D1 |  |  |
| Recording Methods | Manual, motion detection, timing and alarm |  |  |
| Playback | Supports 4 channels 1080P synchronous playback |  |  |
| White Balance | Auto/Manual/Outdoor |  |  |
| HDMI Output | 1 ch, resolution 1920×1080P/60Hz |  |  |
| VGA Output | 1 ch, resolution 1920×1080P/60Hz |  |  |
| Video Compression Split Preview | H.264 High profile/M-JPEG/H.265 |  |  |
| Maximum Resolution | 1/4/8/9/16 |  |  |
| Audio Output | 1 ch, BNC port |  |  |
| Type | 2/4/8 \* SATA ports |  |  |
| Max. Capacity | Each port supports an HDD of 4TB capacity |  |  |
| Voice Intercom Input | Input 1 ch, BNC port |  |  |
| Network Port | 2/1 \* RJ45，10/100/1000M self- adaptive Ethernet port |  |  |
| USB Port | 2 \* USB2.0 |  |  |
| Alarm I/O | 08-ch input, 8-ch output |  |  |

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| Protocol | Supports TCP/IP, UDP, DHCP, DNS, NTP, DDNS, PPPOE, FTP, UPNP etc. |  |  |
| Power | 100~240VAC, 50 ~ 60Hz self-adaptive |  |  |
| Consumption (no HDD included) | <20W |  |  |
| Operating Temperature | 23°F ~ 131°F (-5°C ~ 50°C） |  |  |
| Operating Humidity | 10% ~ 90% (non-condensing) |  |  |
| Weight (no HDD included | ≤18.74lbs (≤4.5Kg) approx. |  |  |
| Dimension (W×D×H ) | 17.32"×17.72"×3.54"(440mm×450mm  ×90mm) |  |  |
| Certifications |  |  |  |
| Make | Heinrich/Mobotix /Axis/March network |  |  |

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| Simultaneous Functioning |  |  |
| Recording |  |  |
| Alarms handling |  |  |
| Live view |  |  |
| Camera control |  |  |
| Map view |  |  |
| Video analytics |  |  |
| Playback |  |  |
| Configuration and reports |  |  |
| Multiple monitor support |  |  |

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| Video Input |  |  |
| Hybrid solution supporting analog video though converter as well  as IP video |  |  |
| Video cameras, video encoders, video servers. |  |  |
| Support for mega pixel cameras. |  |  |
| MJPEG, MPEG4, H264, H265 formats |  |  |
| IR / thermal cameras |  |  |
| Supports dual stream cameras, triple stream cameras |  |  |
| Independent FPS, resolution and bit rate settings for display stream, recording stream and video analytics stream |  |  |
| Fully optimized video capture to minimize the bandwidth usage |  |  |
| Flexible architecture to quickly integrate any new cameras |  |  |
| Auto search for IP video devices |  |  |
| Y-flip video to manage difference in co-ordinate systems |  |  |
| Automatic restore of video connection |  |  |
| Fixed cameras and PTZ cameras. |  |  |
| Security Device |  |  |
| Primary and secondary videos association with devices. |  |  |
| Recording |  |  |
| User configurable video resolution and frame-rate for each channel |  |  |
| Multiple recording modes – continuous, scheduled, on alarm |  |  |
| Pre and post event recording |  |  |
| High FPS recording on alarm |  |  |
| Operator activated recording |  |  |
| Time lapse video recording |  |  |
| Video overlay text |  |  |
| Available disk space and expected recording time indicators |  |  |
| Recording history indicator |  |  |
| Watermarking on recorded video |  |  |
| Automatic hard disk recycling |  |  |
| Network time server synchronization |  |  |
| Multiple drives selection |  |  |
| Redundant recording for external device. |  |  |
| Highly optimized to record 256 channels per servers |  |  |
| Alarms |  |  |
| In-built video motion detection |  |  |

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| Video Analytics alarms |  |  |
| Camera tampering / scene change |  |  |
| Network loss, network recovery |  |  |
| Video loss, video recove |  |  |
| Low disk space, disk space recovery |  |  |
| Camera / video server alerts |  |  |
| Alerts from the integrated security devices |  |  |
| External digital alarm input |  |  |
| Alarms Management |  |  |
| Dedicated recent alarms console screen |  |  |
| Ability to independently configure alarm management for alarms generated from different sources |  |  |
| Wide range of alarm handing options - Indicators on map, Audio indicator, Start multi-channel recording, Multi-channel PTZ, Digital output to devices, Pop up alarm acknowledge window, Pop  up preconfigured live video screen, E-mail, Save alarm image, Execution of user defined macros, Digital output etc. |  |  |
| Alarms stacking / queuing |  |  |
| Alarm categories – Logs, Warnings and Alerts |  |  |
| Manual and auto alarm acknowledgement |  |  |
| Advanced alarm acknowledgement screen displaying active alarms queue; and live and alarm videos associated with each of them |  |  |
| Live Video View |  |  |
| Tree view of cameras and sequences |  |  |
| Drag and drop camera selection |  |  |
| Patrolling mode / video sequences |  |  |
| Multiple layout options combined with patrolling mode |  |  |
| Page navigation within layout |  |  |
| Compact layout button |  |  |
| Digital PTZ |  |  |
| Interactive digital PTZ |  |  |
| Magnifying glass |  |  |
| Video overlay text |  |  |
| Bandwidth usage indicator |  |  |
| Multiple live view screens |  |  |
| Independent layout settings for each screen |  |  |
| 64 video view in single screen |  |  |
| Instant replay |  |  |

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| Virtual linkage of cameras |  |  |
| Quick access toolbar for each video window |  |  |
| Image snapshot from live video |  |  |
| Camera Control |  |  |
| Camera PTZ |  |  |
| Presets and tours |  |  |
| USB joystick support |  |  |
| CCTV keyboard support |  |  |
| Drag and drop camera selection |  |  |
| Map View |  |  |
| Dedicated map view screen |  |  |
| Tree view of cameras and sequences |  |  |
| Drag and drop camera selection |  |  |
| JPEG / BMP map images |  |  |
| Camera / device indicators on map |  |  |
| Alarm indication on map |  |  |
| Live video display of multiple channels and sequences on map |  |  |
| Video view state and camera indicator state for each camera |  |  |
| Device indicators display on the map |  |  |
| Alarm indicator on map |  |  |
| Digital PTZ for map |  |  |
| Interactive digital PTZ |  |  |
| Map location presets |  |  |
| Reports and Logs |  |  |
| Session logs display |  |  |
| Session alarms display |  |  |
| Detailed user logs / activity reports / system logs |  |  |
| Search user logs to generate reports |  |  |
| Report includes details like activity description, source IP address |  |  |
| Alarms search to generate alarm reports |  |  |
| Search alarms based on alarm type, channel and time duration |  |  |
| Alarm video display with video navigation controls |  |  |
| Quick access to multi-channel playback and video export  associated with search results |  |  |
| Print logs |  |  |
| Save logs in TXT, CSV or PDF formats |  |  |

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| Print reports |  |  |
| Save reports in TXT, CSV or PDF formats |  |  |
| Automated daily reports saving |  |  |
| Print images |  |  |
| Playback |  |  |
| Synchronized playback of multiple video channels |  |  |
| Video navigation - play, pause, up to 8X fast forward and up to 8X  rewind |  |  |
| Time-lapse video playback mode |  |  |
| Time based playback |  |  |
| Alarm based playback |  |  |
| Tree view of cameras |  |  |
| Drag and drop camera selection |  |  |
| Multiple layout options |  |  |
| Page navigation within layout |  |  |
| Compact layout button |  |  |
| Digital PTZ |  |  |
| Interactive digital PTZ |  |  |
| Magnifying glass |  |  |
| Video overlay text |  |  |
| Multiple playback screens |  |  |
| Independent layout settings for each screen |  |  |
| Up to 64 video view in single screen |  |  |
| Virtual linkage of cameras |  |  |
| Quick access toolbar for each video window |  |  |
| Image snapshot from recorded video |  |  |
| Recording history indicator |  |  |
| Users and Privileges |  |  |
| Multiple user levels and privileges |  |  |
| Built in standard privileges |  |  |
| Ability to define custom privileges |  |  |
| Built in standard uses |  |  |
| Ability to associate / change privilege for any user |  |  |
| Ability to disable a user. Ability to delete a user |  |  |
| Administrator control to change password for any user |  |  |
| User information like name, contact information etc. |  |  |

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| Video Export |  |  |
| Video export based on time duration or alarm |  |  |
| Option for video overlay text on exported video |  |  |
| Standard format video export, exported video can be played in any standard media player like Windows Media Player |  |  |
| Native format video export with player application |  |  |
| User Interface |  |  |
| Multiple monitors and video walls support. |  |  |
| Virtual matrix |  |  |
| Video thumbnail views |  |  |
| Full screen view of any video channel |  |  |
| Quick set up wizard for easy initial configuration |  |  |
| All windows can be resized to custom sizes |  |  |
| Single click 'Fit to screen size' support for all windows |  |  |
| Recording status summary |  |  |
| Video channel availability summary |  |  |
| Video analytics status summary |  |  |
| Integrated web server |  |  |
| Simultaneous functioning of all features |  |  |
| View video channels as a list or as thumbnails |  |  |
| Make same as NVR |  |  |