

INDIAN BANK

**PROPOSED REFUBISHMENT WORKS FOR
INDIAN BANK, HEAD OFFICE, 2ND FLOOR,
#66, RAJAJI SALAI, CHENNAI**

TECHNICAL BID WITH SPECIFICATIONS

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This document has 50 pages.

CIVIL AND INTERIOR WORKS – TECHNICAL SPECIFICATIONS

GENERAL SPECIFICATIONS

To be read in unison with particular specifications and bill of quantities

These specifications are for work to be done, item to be supplied and materials to be used in the works as shown and defined on the drawings and described herein, to the satisfaction of the Employer / Architect.

1. General:

- i. The workmanship is to be the best possible and of a high standard. The Tenderer shall take all steps immediately to make up deficiency if any noticed by the Employer/ Architect.
- ii. The materials to be provided by the Tenderer shall be in accordance with the samples already got approved from the Employer/ Architect by the Tenderer and in conformity with specification and approved list of manufactures and brand. The Tenderer shall produce all invoices, vouchers or receipts for any materials if called upon to do so by the Employer/ Architect.
- iii. Samples of materials are to be submitted to the Employer/ Architects for their approval before the Tenderer orders or deliver the materials to the site. Samples together with their packing are to be provided free of charge by the Tenderer and should any materials be rejected they will be removed from the site at the Tenderers expense. All samples will be retained by the Employer/ Architects for comparison with materials which will be delivered at site. Also the Tenderer will be required to submit specimen finishes of colors, fabrics, etc. for the approval of the Employer/ Architects before proceeding with the works.
- iv. The Tenderer shall be responsible for providing and maintaining temporary coverage required for the protection of finished work. He is also to clean out all wood shavings, cuts ends and other waste from all parts of the works before covering or in fillings is constructed.
- v. The Tenderer shall maintain uniform quality and consistency in workmanship throughout the execution of the work.

2. Joinery in wood work

- i. The contact surfaces between internal frame and skinning shall be glued with approved adhesive in addition to fixing with necessary screws etc.
- ii. After preparing proper surface of skinning by sand papering etc., the laminates or veneers shall be fixed on it with the help of approved adhesive.

- iii. Framework for full height partition shall be rigidly fixed to the floor, walls and ceiling soffit. The partition height shall be measured upto bottom of false ceiling and framing members / ply going above shall not be measured.
- iv. Any portion that are warped or found with other defects are to be replaced. The whole of the work is to be framed and finished in a workman-like manner in accordance with the detailed drawings and the direction of PM / Architect and whenever required, fitted with all necessary metal ties, straps, screws, adhesive, etc. joinery work generally to be finished with fine sand / glass paper.
- v. All joints shall be standard mortise and tendon, dowel, or cross halved screws, nails, etc. will be of standard iron or wire. Tendons should fit the mortise exactly.
- vi. Nailed or glued butt joints will not be permitted.
- vii. Wherever screw heads are on finished surface those will be sunk and the hole plugged with a wood plug of the same wood and grain to match the colour .

3. Timber

- i. All the wood be used shall be properly seasoned ,of natural growth and shall be free from worm holes ,loose or dead knots or other defects, sawn square and shall not suffer warping ,splitting or other defects. White cedar, Malaysian sal both of 1st quality.
- ii. All internal frameworks shall be treated with approved wood preservative.
- iii. All wood brought to the site be clean it shall not have any preservative or other coating/ covering.
- iv. All rejected, decayed, bad quality wood shall be immediately removed from site.
- v. All the dimensions mentioned for any Wood members are finished sizes.
- vi. All exposed T. W to receive polish and should be of 1 st quality Indian T.W.

4. Plywood

- i Marine plywood shall generally conform to IS 71 0-1980, bonded with phenol formaldehyde, B. W .P / BWR grade.
- ii Commercial plywood shall generally conform to IS: 303 bonded with phenol formaldehyde, MR grade.

5. Hardware and Metals

- i. All the screws /bolts with nuts to be used shall have oxidised finish (unless required otherwise) of approved shape, size and quality.
- ii. Fittings shall be only SS, or Brass and suitable for heavy duty unless specified otherwise.
- iv. Samples of all hardware are required to be got approved in advance.
- v. The agencies should cover-up and protect the brass surface against oxidation by suitable material as necessary and subsequently clean it away at the same time of handing over.
- vi. All hardware shall be fitted with good workmanship without the surrounding edges being damaged.

6. Laminate

- i. All laminate shall be 1 mm thick of approved make or as directed.

- ii. The Tenderers shall get the sample showing the surface texture, pattern and color approved, by Employers / Architect.

7. Fabrication in metal

All brazing and welds are to be executed in a clean and smooth manner, rubbed down and finished in flat and tidiest way, particularly where exposed.

8. Glass

- i. All glass to be approved manufacture, complying with I.S 3548 – 1960, or as per approved quality and sample, to be of the qualities specified and free from bubbles, air holes, waviness and other defects.
- ii. In cutting glass, proper allowance shall be made for expansion.
- iii. Glass for mirror shall be silvering quality (S.Q) Conforming to I.S 3458 – 1958 or as approved sample and quality.
- iv. On completion, all glass surfaces shall be cleaned inside and out, all cracked, scratched glass / mirror shall be replaced.

9. Paint and Polishes

- i. All material required for the works shall be specified and approved manufacture, delivered to the site in the manufacturers containers with the seals,etc., unbroken and after use empty containers shall be stored till finally cleared by the employers.
- ii. All iron or steel / metal surfaces shall be thoroughly scrapped and rubbed down with the brushes and shall be entirely free from rust, mill scale, etc. before applying the primary coat.
- iii. Metallic polish finishes shall be properly finished, without any flow marks, spots, roughness etc.
- iv. Painting work shall be of high standard, without any brush marks on the finished surfaces and no spots on adjacent furniture, glass, etc.

FLOOR TILES

Verified tiles, ceramic tiles, chequered tiles, terrazzo tiles shall conform to IS : 1237. For neutral shade tiles grey cement shall be used. Tiles shall be hydraulically pressed. It shall be of choice shade and shall have desired pattern of chip distribution. The size and thickness of tiles shall be as approved by the Architect / Indian bank

GLAZED TILES

White or colored glazed tiles shall comply with IS: 777. It shall be from an approved manufacturer and shall be flat and true to shape. They shall be free from cracks, crazing, spots, chipped edges and corners. The glazing and color shall be of uniform shade and unless otherwise specified the tile shall be min mm thick.

PAINTS

Dry distemper, oil bound distemper, cement primer, oil paint, enamel paint, flat oil paint, plastic emulsion paint, anti-corrosive primer, red lead, water proof cement paint shall be from an approved manufacturer and shall confirm to the latest Indian Standards for various paints,

Ready mixed paints as received from the manufacturer without any admixture shall be used, except for addition of thinner, if recommended by the manufacturer.

PANELED SHUTTERS

Panel shall be of pattern and size as shown on the drawings or as directed by the Employer/Architects. Panels shall be in one piece wherever possible. Panels shall be frames into grooves made in styles and rails to the full depth of groove and faces shall be closely fitted to sides of grooves.

FIRE RETARDANT FLUSH DOOR

All Fire Retardant flush doors shall be solid core unless otherwise specified. It shall conform to the relevant specifications of I.S 2202 and shall be obtained from approved manufacturers. The finished thickness of the shutter shall be as mentioned in the item. Face veneers shall be of the pattern and color approved by the Employer / Architects and an approved sample shall be deposited with the Employer/Architects for reference.

The solid core shall be of wood laminate prepared from battens of well seasoned and treated good quality wood having straight grains. The battens shall be of uniform size of about 2.5 cm width. These shall be properly glued and machine pressed together with the grains of each piece reversed from that of adjoining one. The longitudinal joints of the battens shall be staggered and no piece shall be less than 50 cm in length. Alternatively, the core shall be of solid teak particle board. Edges of the core shall be lipped with first class teakwood patterns of 4 cm.(1 1/2") Min depth, glued and machine pressed along the core.

PAINTING OIL / ENAMEL / PLASTIC EMULSION ETC.

Ready mixed oil paint, plastic emulsion paint, ready mixed synthetic enamel paint, Aluminum paint, etc., shall be brought in original containers and in sealed tins. If for any reason thinner is necessary the brand and quantity of thinner recommended by the manufacturer or as instructed by the Employer / Architects shall be used.

The surface shall be prepared as specified above and cost of approved primer shall be applied. After 24 hours, drying approved of specified quality paint shall be applied evenly and smoothly. If required a filler putty coating may be given to give smooth finish. Each coat shall be allowed to dry out thoroughly and then lightly rubbed down with sand paper and cleaned of dust before, the next coat is applied. Number of coats shall be as specified in the item and if however, the finish of the surface is not uniform additional coats as required shall be applied to get good and uniform finish at no extra cost. After completion no hair marks from the brush or clogging of paint puddles in the corners of panel angles of moldings shall be left on the work. The glass panes floor etc., shall be cleaned of stains.

When the final coat is applied, if directed, the surface shall be rolled with a roller or if directed it shall be stippled with a stippling brush.

MODE OF MEASUREMENTS

1. Doors, Windows and Grills

Clear area over one face inclusive of frame shall be measured. Holdfasts and portions embedded in masonry or flooring shall not be measured.

2. Partitions in Woodwork

The partition height shall be measured up to bottom of false ceiling and framing members / ply going above shall not be measured.

3. Decorative Paneling over wall or over partitions

The area of cladding shall be measured in square meter, or square feet. The gross area cladded will be measured. No deductions will be made for gaps up to one centimeter between the panels.

4. Paving and tile work

The work mentioned in this section shall be measured in Sq. ft/ Sqm and shall be priced per unit of Sq.ft/ Sqm. In all paving work, the slabs shall be touching the walls and go well under the plaster, but the measurements shall be the clear measurements of the rooms or areas when finished. No allowance shall be made for portions going under the plaster.

5. False ceiling

For false ceiling work, the measurement shall be for the actual area covered. No deductions shall be made for the cutouts, for light fittings, speakers, column upto 5.00 Sq.ft / 0.50 Sqm.

6. Wood work

For conversion of inches to feet/cm to meter, the resultant figure shall be taken up to two digits after decimal point. Third digit shall not be taken into account.

General Scope of Work

The requirement for the Indian Bank shall consist of the following,

- i. Civil
- ii. Interior
- iii. Modular Furniture
- iv. Air Conditioning
- v. Electrical Work.
- vi. EPABX
- vii. PAS
- viii. CCTV
- ix. ACS

Sets of Working Drawing shall be submitted on award of Contract within seven days for the proposed systems.

Guarantee and Warranty

Guarantee and Warranty for the supplies with respect to design, quality of materials used, workmanship and performance shall be covered for a period of 12 months from the date of handing over of the commissioned systems.

The Bidder shall also submit a bar Chart one for the supply of materials and the other for the execution of the work within seven days of the award of Contract.

The Bidder shall use the best engineering practice in the execution of this project and any such provisions to be made shall be brought to the notice of the Clients well in advance of the work being executed.

For water proofing work, the contractor has to submit the Guarantee for 10 years.

ELECTRICAL WORKS – TECHNICAL SPECIFICATIONS

1.0 SCOPE:

- 1.1 This specification covers the requirements of design, fabrication, testing, packing and supply and erection of Medium Voltage Switchgear (MV Switchgear) consisting of Main LT Panel, Sub Switch Boards, control panels, circuit breaker panels, circuit breaker compartment and instrument transformers, measuring transformers, control switches.

2.0 CODES AND STANDARDS :

- 2.1 The Switchgear assembly shall conform to following Indian Standards

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|-------|-----------------|--|
| 2.1.1 | IS : 375 - 1963 | Switchgear bus-bars, main connections and auxiliary wiring, marking and arrangement for (revised). |
| 2.1.2 | IS : 2147 | Degrees of protection provided by enclosures for low-voltage switch gear and control gear. |
| 2.1.3 | IS : 3914 | Selection of AC Induction Motor Starters (voltage not exceeding 1000 volts). |
| 2.1.4 | IS : 4237 | General requirements for switch gear and control gear for voltages not exceeding 1000 V. |
| 2.1.5 | IS : 8623 | Factory-built assemblies of switch gear and control gear for voltages upto and including 1000V AC and 1200 V DC. |

Part II particular requirements for busbar, trunking system (bus ways).

- 2.2 The individual equipment mounted in the switch gear shall conform to following Indian Standards.

- | | | |
|-------|-------------------|---|
| 2.2.1 | IS : 772 Part - 1 | AC Electricity Meters: Part I General requirements and tests (Second Revision). |
|-------|-------------------|---|

- | | | |
|--------|-----------|--|
| 2.2.2 | IS : 1248 | Direct acting electrical indication instruments (First Revision). |
| 2.2.3 | IS : 1822 | Motor Starters, AC, of voltage not exceeding 1000 Volts (First Revision). |
| 2.2.4 | IS : 2208 | HRC Cartridge fuse links upto 650 V. |
| 2.2.6 | IS : 2607 | Air breaks isolators for voltages not exceeding 1000 Volts (First Revision). |
| 2.2.7 | IS : 2705 | Current Transformer :

Part I General requirements.

Part II Measuring Current Transformers.

Part III Protective Current Transformers. |
| 2.2.8 | IS : 2959 | Contactors for Voltage not exceeding 1000 V AC or 1200 V DC (First Revision). |
| 2.2.9 | IS : 3156 | Voltage Transformers :

Part I General requirements (First Revision). |
| 2.2.10 | IS : 3231 | Electrical relays for power system protection. |
| 2.2.11 | IS : 4047 | Heavy duty air-break switches and composite units of air-break switches and fuses for voltage not exceeding 1000 Volts. |
| 2.2.12 | IS : 4064 | Air-break switches, air-break disconnectors, air-break switch disconnectors and fuse combination units for voltages not exceeding 1000 V AC or 1200 V DC.

Part I General requirements (First Revision). |
| 2.2.13 | IS : 6875 | Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages up to and including 1000 V AC and 1200 V DC |

3.0 **GENERAL REQUIREMENTS :**

- 3.1 Medium Voltage Switch Gear shall be metal enclosed, Compartmentalized, Modular type suitable for Indoor installation. The MV Switch gear shall be dust and vermin proof and the enclosure shall provide a degree of protection of not less than IP: 51 as per IS: 2147.

- 3.2 The Switch Gear shall be assembled out of vertical sections of uniform height not exceeding 2000 mm and operating handle of fuse switch unit shall not be more than 1800 mm not less than 300 mm.
- 3.3 The Switch Gear shall be easily extensible on either side by the addition of vertical sections. It shall be possible to extend the switch gear, irrespective of the type of end panel and the design shall be such as to permit addition of extension panels of a type other than the type of end panel.
- 3.4 The switch gear shall be designed to ensure maximum safety during operation, inspection, connection of cables, relocation of outgoing circuits and maintenance, with the bus bar system energized and without taking any special precautions. Means shall be provided to prevent shorting of power and / or control terminal due to accidental dropping of maintenance tools etc., inside the switch board. Checking and removal of components shall be possible without disturbing adjacent equipment. All auxiliary equipment should be easily accessible.
- 3.5 All identical equipment and corresponding parts shall be fully interchangeable without any need for resorting to structural modifications.

4.0 **FABRICATION REQUIREMENTS:**

- 4.1 The frame of vertical individual vertical panels shall be fabricated using pressed and shaped cold rolled sheet steel of adequate thickness or by using suitable mild steel structural sections. **The frames and doors of all floor mounted panels shall be fabricated by using minimum 14 SWG cold rolled sheet and 16 SWG sheet steel for wall mounted Sub Switch Boards.** Wherever required, stiffeners for large size doors and covers shall be provided.
- 4.2 The switch gear shall be provided with integral base frame for each vertical panel. The switch gear integral base frame shall be suitable for directly bolting with the help of foundation bolts and shall also be suitable for tack welding at two diagonally opposite points to the embedded base frame.
- 4.3 All openings, covers and doors shall be provided with neoprene gaskets around the perimeters to make the switch gear dust and vermin proof.
- 4.4 All hard ware shall be corrosion resistant. All joints and connections of the panel members shall be made by galvanized, zinc passivity or cadmium plated high quality steel bolts, nuts and washers, secured against loosening.
- 4.5 Suitable lifting hooks and / or jacks shall be provided on each panel or shipping section for ease of lifting of switch board.
- 4.6 Each switch board section shall have removable gland plates with adequate number of holes drilled for fixing glands suitable for the incoming and outgoing cables as specified in box (Cost of glands and lugs are not to be included).

- 4.7 The opening for fixing ammeters, voltmeters, push button indicating lamps, etc., shall be machine punched.

5.0 **PANEL DESIGN REQUIREMENTS :**

- 5.1 The Switch Gear shall be formed using distinct vertical sections each comprising following compartments.
- 5.1.1 A Completely metal enclosed horizontal busbar compartment running horizontally at top unless specified at bottom. In case of double busbar arrangement the busbars shall be at top and bottom.
- 5.1.2 Individual feeder modules organized in multitier mode.
- 5.1.3 Completely enclosed vertical bus bars serving all feeder modules in the vertical panel.
- 5.1.4 Cable termination compartment.
- 5.1.5 Perforated sheet steel / insulating material enclosed horizontal auxiliary bus way for control, interlock, indication and metering wiring running horizontally.
- 5.2 Metal sheets shall be provided between two adjacent vertical panels running to the full width of the wider panel and up to full useful height of the switch gear.
- 5.3 Panels shall be in single front execution.
- 5.4 The Switch Gear shall be of compartmentalized, modular construction. All equipment associated with a particular circuit shall be housed in a separate and independent compartment earmarked for that particular circuit in the fixed portion of the vertical panel.
- 5.5 All auxiliary devices for control, indication, measurement and protection such as push buttons, control and selector switches, indicating lamps, Ammeters, Voltmeters, KWH Meters, Protective Relays except motor thermal overload relay and single phasing preventer relay, shall be mounted on the front side of the respective compartment only.

5.6 **BUSBAR SIZING, CONNECTION AND SUPPORTS :**

- 5.6.1 Bus bars shall be of high conductivity copper as specified and supported on insulators made of SMC/DNC. The current density of bus bar shall not exceed 1.2 A /sqmm in respect of copper bus bar. The main bus bar shall have uniform current rating throughout their length as indicated in the BOQ. The current rating of the neutral shall be half that of the phase bus bars throughout the length of the switch board for bus bar rating above 100 A. For bus bar rating of 200 A & below the neutral bus bar shall be rated for phase current. Removable neutral links shall be provided on feeders to permit isolation of the neutral bus bar.

- 5.6.2 The bus bar and supports shall be capable of withstanding the short circuit currents stated in the BOQ. Only zinc passivity or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar joints and supports.
- 5.6.3 The thermal design of the bus bars shall be based on installation of the switch gear in poorly ventilated condition. The cooling air volume shall take into account only the bus bar enclosure and not the air volume of the vertical panels. The maximum operating temperature of bus bars at maximum design temperature shall not exceed 85 Deg. C. for normal operating condition and 200 Deg. C for short circuit condition.
- 5.6.4 All bus bars shall be colour coded by means of identifying colour rings at every power tap off point. Red, Yellow and Blue colour shall be used for phase bus bars and Black Colour shall be used for neutral bus bars. They shall be provided with heat shrinkable PVC Insulation of appropriate colour.
- 5.6.5 Minimum clearance between live parts, between live parts / neutral to ground shall be as per CEIG regulations..

5.7 **AUXILIARY WIRING AND TERMINALS :**

- 5.7.1 Inside the switch boards the wiring for power, control, signaling, protection and instrument circuits shall be done with PVC Insulated copper conductors. The insulation grade for these wires shall be 660 / 1100 Volts. All control wiring shall preferably be enclosed in plastic channels or neatly bunched together.
- 5.7.2 1.5 sqmm size wires shall normally be used provided if the control fuse rating is 10 Amps or less. For 16 Amps control fuse circuit 2.5 sq.mm size wires shall be used. Each wire shall be terminated at a separate terminal. Termination of two outgoing wires on a single terminal will not be acceptable. Wires shall not be joined or tied between terminal parts. Shorting links shall be provided for all C.T terminals.
- 5.7.3 Each wire shall be identified at both ends by self sticking wire marker tapes or PVC Ferrules. Ferruling of wire shall be as per relevant IS.
- 5.7.4 Control Cables shall enter the switch gear from top or bottom. Supporting facilities shall be provided for clamping the control cables in the cabling compartment.

Inter panel wiring within each shipping section shall be Tenderers responsibility. For wiring between shipping sections, Tenderer shall provide terminal blocks on adjoining shipping sections and supply suitable jumper wires, inter panel wiring shall be taken through PVC Sleeves or rubber grommets.

- 5.7.5 A minimum of 10% spare terminals shall be provided on each terminal block if requirements of terminals are not specified in the BOQ for starter / control modules. Conductors shall be terminated with adequately sized compression type lugs. "Elmex" (direct conductor termination) type terminals will be acceptable for wires upto 10 sq.mm size and bolted type terminals with crimping type copper lugs shall be provided for all outgoing cable connections larger than 10 sqmm.

5.8 **EARTHING CONNECTIONS :**

All vertical panels shall be connected to a copper earth busbar running throughout the length of the switch board. The size of earth bus shall be equal to the neutral busbar size. All doors and movable parts shall be connected to the earth-bus with flexible copper connections. Provision shall be made to connect the earthing busbar to the plant earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Earthing bolts shall be provided to ground cable armours. Minimum 4 Nos. 3/8" dia bolts with nuts shall be provided on the earth bus for termination of fourth core of cable per each front of MCC Panels.

5.9 **NAME PLATE :**

A name plate with the switch gear designation shall be fixed at the top of the control panel. A separate name plate giving feeder details shall be provided for each compartment. A separate name plate giving details of bus section shall also be provided for switch gears having more than one bus sections.

Engraved name plate shall be provided for each equipment (lamps, push buttons, switches, relays, auxiliary contactors etc.,) mounted on the switch board. Special warning plates one each on each front of a shipping section shall be provided on removable covers or doors giving access to cable terminals and busbars. Special warning labels shall be provided inside the switch board also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

Engraved name plates shall preferably be of 3-ply (Black-White Black) lamicoid sheets or anodised aluminium. However back engraved perspex sheet name square / vee groove cutters. Hard paper name plates will not be acceptable. Name plates shall be fastened by screws and not by adhesives.

The Name Plates for feeder compartments shall be in two parts. One part shall have necessary details pertaining to the switch board. The other part shall be removable and shall contain all details regarding the drives / equipment controlled by the particular module.

5.10 **PAINTING :**

- 5.10.1 All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then finished to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint

and coat of yellow zinc chromate primer. The under surface shall be made free from all imperfections before undertaking the finishing coat.

5.10.2 After preparation of the under surface, the switch board shall be **powder coated** with two coats of final paint. Colour shade of final paint shall be as per manufacturer standard. The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, runoff paint etc.

5.10.3 The inside surface of all switch boards shall be given a coat of fire retardant paint.

5.10.4 All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased.

6.0 **SPECIFIC REQUIREMENTS OF CIRCUIT BREAKER PANELS :**

6.1 The Circuit Breaker compartment enclosure shall be IP:31 as per IS:2147 with the circuit breaker in position or withdrawn from the compartment. Spring actuated and gravity operated safety shutters shall be provided for isolating the bus bars and other live parts when the breaker is completely withdrawn. The design of the compartment shall be such as to prevent movement of vermin from a particular circuit breaker compartment of any other portion of the panel when the breaker is withdrawn and the compartment door is closed. Suitable isolating barriers shall be provided between circuit breaker and all auxiliary devices for control, indication, metering and protection.

6.2 Separate compartment totally enclosed from all sides shall be provided for cable termination, preferably on the rear side of circuit breakers. Access to cables shall be from the rear side after opening the cabling compartment door. The incoming / outgoing cable termination shall be staggered for each circuit and barriers of sheet steel or insulating material shall be provided between terminations of two circuits such that maintenance on one circuit could be carried out while the other circuit is live. Suitable clamping arrangements shall be provided for cables and cable termination / terminal blocks shall not be used for supporting the cables.

The incoming supply for PCC Panels shall be through top entry bus ducts or through bottom entry single core or multi core Aluminum conductor cables. Similarly the outgoing cabling shall have bottom or top entry as per site requirement. The cable terminations shall be suitably sized for receiving specified number of cables per termination and provision shall be made for terminating each outgoing cable with a separate bolted connection. In case the total number of cables entering a particular panel cannot be accommodated in the cabling compartment of PCC Panels an add on type of panel shall be added to the cabling compartment for accommodating extra cables. The enclosure design of cabling compartment shall be such as to prevent the movement of vermin from this compartment to any other part of the switchgear and shall be minimum IP-31 as per IS-2147 with the door closed. In case of bus duct entry, the bus duct shall be terminated on the TOP of the panel only and the rear portion of panel shall not be used for this purpose.

6.3 **CIRCUIT BREAKER COMPARTMENT :**

- 6.3.1 The Circuit breaker compartment shall be fully draw out , that is, bus side & outgoing power and control connections shall be through draw out contacts (It shall be possible to draw out the withdraw able trolley without having to unbolt or unscrew any power and control connections). Suitable guides shall be provided to facilitate easy withdrawal of the trolley. All identical feeder compartments shall be interchangeable.
- 6.3.2 The Current Transformers for the Ammeter / Protection Circuits shall be mounted on the fixed portion of the compartment. However, current transformers associated with built-in releases may be mounted on the breaker trolley. All terminals except wiping / sliding type control terminals shall be shrouded with plastic covers to prevent accidental contact. For direct termination - clip on shrouded type (ELMEX Type) terminals shall be provided.

There shall be three positions for the draw out trolley viz :

- “Full in” or “service” position in this position both power and control circuits shall be connected. This shall be then normal operating position of the circuit breaker.
- “Test” position - The power contacts shall be disconnected in this position but the control connections shall not be disturbed, it shall be possible to close and trip the breakers in this positions.
- “Full out” position - Both power and control circuits shall be disconnected in this position. It shall be possible to close the cubicle door in this position.

The circuit breaker shall be lockable in “service”, “test” and “Full out” positions.

The earth connections must remain connected in “test” position, earthing of the unit shall be done with a “pin” or with scrapping earth connections. The earth connection shall make before the main power / control make and break after the power / control contacts are disconnected. Earthing connection through a plug and socket connection shall not be acceptable.

6.4 **INTERLOCKS :**

Following interlocks shall be provided.

- 6.4.1 Compartment doors shall be interlocked against opening when breaker is in closed or ON condition. However, it shall be possible to bypass this interlock for inspection purposes.
- 6.4.2 It shall not be possible to push “in” a drawn out circuit breaker in closed condition or withdraw a circuit breaker in closed condition.
- 6.4.3 It shall be possible to operate a circuit breaker only in the defined “Full in” or “Service” and “test” position inside the panel. It shall not be possible to operate the breaker in

intermediate positions while inserting or withdrawing a circuit breaker or while in “Full out”, position inside the panel.

- 6.4.4 Mechanical “Castell” interlocks shall be provided for ACB as shown in the BOQ 'Schematic.
- 6.4.5 In case of multiple ACBs of different rating in a panel, a common cutout shall be provided for the entire range of ACBs. These ACBs shall have rating error prevention device to avoid accidental interchange of ACBs.

7.0 **SWITCH GEAR COMPONENTS :**

7.1 **Circuit Breakers :**

- 7.1.1 Circuit Breakers shall be air break, draw out type. The ratings shall be as indicated on switch board data sheets and rated for 1000 V insulation.
- 7.1.2 The circuit breaker shall be provided with thermal magnetic releases or static relay for overload, short circuit and earth fault protection.
- 7.1.3 The circuit breakers shall be provided with mechanically operated emergency tripping device. This device shall be available on the front of the panel. If available as a manufacturer's standard design, mechanically operated 'closing' device shall be provided for all breakers except circuit breakers controlling motor feeders
- 7.1.4 The Circuit Breakers shall be provided with minimum 6 Nos. normally open and 6 Nos. normally close spare auxiliary contacts, wires and available for Purchaser's use, if spare auxiliary contacts are not available, an auxiliary relay of approved make shall be used to multiply the available spare auxiliary contact.
- 7.1.5 Circuit breaker positions shall be indicated electrically. The following indicating colours shall be used.

<i>BREAKER 'CLOSE '</i>	-	<i>RED</i>
<i>BREAKER 'OPEN '</i>	-	<i>GREEN</i>
<i>BREAKER 'AUTO TRIP '</i>	-	<i>AMBER</i>

In addition, if available as a manufacturer standard design, the following positions / conditions shall also be indicated electrically. The colour to be used shall be as indicated below:

<i>BREAKER DRAWOUT IN "TEST POSITION"</i>	-	<i>BLUE</i>
<i>BREAKER SPRING 'CHARGED'</i>	-	<i>WHITE</i>

- 7.1.6 Circuit Breaker positions (OPEN AND CLOSE), location (SERVICE AND TEST) and spring charged condition shall also be indicated mechanically.

7.1.7 Operating Mechanism:

- a. Electrical Power operating mechanism shall be motor would spring charged energy type. However, manual operating mechanism may be of the spring charging stored energy type or the spring assisted type. For circuit breakers with electrical power operating mechanism, provision shall be made for manual spring charging. Closing time of circuit breakers with manual operating mechanism shall be independent of the speed of the operating handle.
- b. All stored energy operating mechanism shall be equipped with following features.
 - (i) Failure of springs, vibrations or shocks shall not cause unintended operating of breaker or prevent intended tripping operation.
 - (ii). Closing of circuit breaker shall be prevented unless the spring is fully charged.
- c. All Electrical power operating mechanism shall be suitable for remote operation and shall be equipped with following features.
 - (i) Provided with universal motor operating on 230 V A.C designed to operate satisfactorily from 85% to 110% of rated voltage.
 - (ii) Provided with emergency manual charging facility. The motor shall be automatically, (mechanically) delinked once the manual charging handle is inserted.
 - (iii) Closing operation of circuit breaker shall automatically initiate charging of the spring for the next closing operation.
 - (iv) One complete closing operation shall be completed once the closing impulse is given and the first device in the control scheme has responded even though the control switch / P.B. is released provided no counter trip impulse is present.

7.1.8 Circuit breaker trip and closing coils in case of electrically operated breakers and trip coil in case of mechanically operated breakers and circuit breaker indications shall be suitable for satisfactory operation on 230 V A.C

7.1.9 Circuit breaker trip and closing coils shall be rated for satisfactory operation under the following conditions of supply voltage variation:

- a). Trip coil : 50% to 110% of rated voltage.
- b). Closing coil : 85% to 110% of rated voltage.

7.1.10 The Circuit Breaker closing time shall be approximately in the range of 100 to 150 Millisecs and the tripping time shall not exceed 100 Millisecs.

- 7.1.11 The under voltage relay shall be suitable for operation on 415 V 50 Hz supply and shall be provided with a fixed time delay of 3 to 1 sec.
- 7.1.12 The breakers shall be trip free. If available as a manufacturer's standard feature, the breakers shall be provided with a release to trip the breakers instantaneously if closed on to a fault.

7.1.13. **Releases:**

If provided, the releases shall have the following features:

- ◆ The overload release shall be provided with a setting of 50% to 100% of the breaker rated current.
- ◆ The short circuit release shall be provided with settings corresponding to 200% to 1000% of the rated current and shall be provided with adjustable time delay range of 100 MS to 350 MS.

7.13.1.1 In case of static / micro processor based relays separate indication shall be provided for individual fault. They shall be self powered with true RMS sensing.

7.13.1.2 In case of breakers controlling motor feeders the setting values shall correspond to the motor capacity.

7.2 **MCCB:**

7.2.1 Circuit Breakers shall be air break and shall be of current limiting type with positive isolation. They shall be fixed type unless specified otherwise. The ratings shall be as indicated on switch board BOQ.

7.2.2 They shall be rated for not less than 650 V insulation voltages. The Service breaking capacity shall not be less than the value specified in the switch board BOQ.

7.2.3 In case of motorized MCCB, the motor voltage will be 230 V.

7.2.4 Where accessories such as shunt release, UV Release etc are specified they shall be of drop in type and shall be common for all ranges.

7.2.5 The MCCBs of all ranges shall have CPRI certification or any recognized foreign body.

7.3 **SWITCH DISCONNECT FUSE UNITS :**

7.3.1 All switches shall be load break, heavy duty air break type provided with quite make / break manual operating mechanism suitable for AC23 A duty. The operating handle shall be mounted in the door of the compartment having the switch.

7.3.2 Switches shall be designed to carry the rated current continuously without overheating. The neutral rating shall be same as phase rating. The switches shall have current breaking feature at four points / phase and have self contact cleaning facility.

- 7.3.3 Barriers shall be provided to prevent inter phase arcing and live terminals shall be shrouded to avoid accidental contact.
- 7.3.4 Rating of heavy duty switches for a particular starter module shall be as indicated in the BOQ. Motor duty switches of smaller ratings meeting the requirements of AC 23 duty as per IS:4064, may be accepted in place of specified heavy duty switch rating for particular starter module only if, motor duty switches have been tested and certified for use with the larger size of fuse link specified in the BOQ for the same Starter module.

7.4 **FUSES :**

- 7.4.1 Fuses shall be non deteriorating HRC Cartridge link type. Diazed fuses are not acceptable.
- 7.4.2 The fuses shall be provided with operation indicator which shall be visible without removal of fuses from service.
- 7.4.3 Fuses shall be pressure fitted type and shall preferably have ribs on the contact blades to ensure good line contact.
- 7.4.4 It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be provided. The fuse bases shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problems.

7.5 **CONTACTORS :**

- 7.5.1 The contactors shall be air break type, equipped with three main contacts and minimum 2 No + 2 NC auxiliary contacts. The main contacts of a particular contactor shall have AC 3 ratings as shown in the relevant switch board data sheet for that contactor.
- 7.5.2 The auxiliary contacts shall be rated for minimum 5 Amps at 240 V AC and 1.3 Amps at 110 V DC (Inductive Load).
- 7.5.3 Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240 V, 1 Ph. AC supply and shall work satisfactorily between +10 and -15% of the rated voltage.
- 7.5.4 The contactor drop off voltage shall be between 15% to 65% of the rated coil voltage.

7.6 **THERMAL OVERLOAD RELAY :**

- 7.6.1 Thermal overload relays shall be three element, positive acting, ambient temperature **compensated** type with adjustable setting range.
- 7.6.2 Thermal overload relays shall be manually reset type with the reset push button brought out on the front of the panel. The reset push button shall be capable of being operated without opening the compartment door.

- 7.6.3 Thermal overload relays shall be provided with minimum 1 NO + 1 NC contacts with a rating of 5 Amps at 240 V, 1 Ph, 50 Hz AC and 1.3 Amps at 110 V DC (Inductive Load).

7.7 **Single Phasing Preventor (SPP) :**

- 7.7.1 Unless specified otherwise, SPPs shall be provided in all motor starter modules. The SPP shall be of the current operated type and shall operate on the principle of sensing negative sequence component of current.
- 7.7.2 In case of single phasing, the SPP shall operate after a time delay of 2 to 3 secs. The relay shall be of the hand reset type and visual indication of the relay operation shall be available.
- 7.7.3 The SPP shall be suitable for protection of the non-reversible and reversible motors. The relay operation shall be independent of the loading and RPM of the motor prior to the occurrence of single phasing.
- 7.7.4 The SPP shall be fail safe type and shall operate without any external power supply. In case of failure of internal wiring the relay shall trip the motor.

7.8 **INSTRUMENT TRANSFORMERS :**

- 7.8.1 Current Transformers shall be tape wound or wire wound type as specified in data sheets. The CT Ratio and VA burden shall be as indicated in the BOQ.
- 7.8.2 Current Transformers shall generally conform to IS: 2075. The C.T ratio and ratings shall be as indicated in the BOQ. For general guidance the vendor shall note that the protective current transformers shall have an accuracy class "5P" and an accuracy limit factor greater than "10". Low reactance C.Ts shall be used for protection.
- 7.8.3 Current Transformers for instruments shall have an accuracy class 1.0 and accuracy limit factor less than 5.0. However, accuracy class of 3.0 is acceptable for Ammeters only. If a metering load is fed from a protection C.T., suitable 1/1 or 5/5 ratio saturable interposing C.Ts shall be used. The current transformers shall be capable of withstanding the peak momentary short circuit and the symmetrical short circuit current for 1.0 second. The neutral side of the current transformers shall normally be earthed through a link.

7.9 **MEASURING INSTRUMENTS :**

- 7.9.1 All measuring instruments shall be of 96 x 96 mm square pattern, flush mounting type.
- 7.9.2 All A.C Ammeter, Voltmeters, KW Meters shall be of moving iron type for A.C and permanent magnet type for D.C. Accuracy class shall be 1.0 for KW / KWH Meters and 1.5 for Ammeters and Voltmeters as per IS: 1248. The range shall be as indicated in the

BOQ. Ammeters for motor feeders shall have a non-linear compressed scale at the end to indicate motor starting current. Voltmeter shall be suitable for direct line connection.

7.10 **CONTROL SWITCHES :**

7.10.1 All control switches shall be rotary, back connected type, having a cam operated contact mechanism. Preferably phosphor bronze contacts shall be used on the control switches. They shall have pistol grip handles for circuit breaker control and knob type handle for other applications. Ammeter, Selector Switches shall have make before break feature on its contacts. The selector switch shall generally have 4 positions for reading 3 phase currents and fourth position for OFF. The voltmeter selector switch shall also have 4 positions. These shall be used to measure phase to phase voltage and fourth shall be OFF Position.

7.11 **PUSH BUTTONS :**

7.11.2 Push Buttons Colours shall be as follows:

Stop / open / emergency	-	Red
Start / Close	-	Green
Reset / Test	-	Yellow/Black/White

7.12 **INDICATING LAMPS :**

7.12.1 Indicating Lamps shall be LED type or filament type as specified. In case of filament type the lamp shall be suitable for 6.0 volts A.C complete with built in 240 / 6 V Transformer. Lamps shall be provided with translucent covers to diffuse light.

8.0 **ERECTION :**

8.1 It will be the responsibility of Tenderer to unload the panel from lorry, store in temporary stores and final shifting for installation.

8.2 Before grouting of panels, assembling, paneling and alignment of panels has to be completed. The panel level shall be checked with spirit levels.

8.3 The panels and all components shall be cleaned and checked for tightness of all components. All contacts shall be cleaned with CTC. All relays shall be noted by secondary injection.

8.4 Provision of MS channels or angle iron for mounting the panels wherever required across the trench etc shall be included in the cost of erection and nothing extra shall be paid against the same.

9.0 **MODE OF MEASUREMENTS :**

9.1 Panels shall be considered as one unit for purpose of measurement as per BOQ.

EPABX WORKS - TECHNICAL SPECIFICATIONS

1.0 Technical specifications:

1. The exchange should be based on true IP communication server architecture. Legacy PCM / TDM, SPC based systems are not acceptable.
2. The server should be 19" rack mountable latest industry standard server processor based architecture. It should be a true IP based communication server supporting IP, Digital, Analog Extensions and TDM/SIP Trunks.
3. The operating system of the server should be stable and should not be affected by viruses.
4. The server should support peer-to-peer connection to the IP network.
5. The following call scenarios should not use any IP bandwidth on the LAN network deployed.
 - a. Calls between Legacy Terminals, Analog, Digital Extensions
 - b. Calls between Legacy Trunks, Analog, PRIs
 - c. Calls between Legacy Terminals and Legacy Trunks.
6. Modularity of the each Legacy extension and trunk cards should be 8 / 16 port maximum per card with universal slot architecture.
7. Maintenance and configuration of the server should be possible from digital / IP extension, PC based software on LAN and Web-based.
8. The server should have built-in SIP server.
9. The server should have in-skin auto attendant feature (100 recordable messages) to provide welcome message to 16 callers simultaneously.
10. Server configuration on PC should be GUI based and not tedious command based.
11. SMDR output shall be available in serial port and LAN.
12. The server should support PRI, BRI (S bus & T bus), and SIP trunk (Public carrier and private network) and also to support SIP terminals proprietary and third party.
13. Should support a built in paging and MOH interface.

2.0 General features of Server system:

1. The EPABX system should be suitable for flexible numbering scheme.

2. Caller ID information for both internal and external calls should be available to all analog, digital, IP and SIP phone users through Analog Trunks, PRI and SIP trunks.
3. System should have abbreviated dialing (2000 entries) feature configurable for department based and individual user basis.
4. System should have boss – secretary calling feature.
5. Call back features.
6. Call forwarding internal and external.
7. Caller id based call routing.
8. Should have built in 2 groups of 32 party conference circuit used for meet me conference, configurable for 4 X 8 parties / 2 X 16 parties / 1 X 32 parties.
9. System should have dial by name features for digital phones.
10. System should have 4 levels of Do not disturb feature.
11. System should generate howler tone for off hook state phones.
12. System should have facility of sending return messages to operator & to digital phone users.
13. System should have set relocation feature to swap two extensions by access codes.
14. System should have the facility for the users to set timed reminder.
15. Should have voice guidance facility.
16. Should support interface of third party SIP phones.
17. Should support Unified messaging in-skin and not external. It must have a minimum of 125 hrs recording.
18. Should have forced trunk disconnect for terminating existing call.
19. Should have long conversation cut-off for incoming and outgoing calls for selective users.

3.0 Trunk interfaces for the system:

The trunk ports can be combinations of ISDN BRI, ISDN, PRI, CO, E&M & IP trunking.

The telephone server shall support following trunk interfaces / protocols:

1. Analog PSTN trunk: The system should have analog PSTN trunk interface to connect normal CO lines for making and receiving calls.
2. ISDN PRI: The system shall be able to provide maximum of 6 ISDN PRI trunks.

3. SIP trunks: The server shall have integrated SIP trunk interface that based on internet protocol (IP) technology to provide a lower cost of usage by transmitting voice and fax over corporate intranet, or private local area network (LAN). Routing certain direct, point to point communication over IP network.

4.0 Digital Phone Specifications:

1. Digital phones should have large display with 24 character X 3 lines.
2. Should have soft keys to access user features.
3. Should have 12 programmable keys with dual color leds.
4. Should have 4 way navigation keys.
5. Should have backlit key pad.
6. Apart from programmable keys it should have dedicated keys for transfer, conference, hold, speaker, and mic, redial. Should not program a key for the said features.
7. Should have full duplex speaker phone for hands free talking.
8. Should store 50 incoming call history.

5.0 Maintenance:

1. Configuration should be possible through any designated digital phones.
2. Configuration should be possible through PC based GUI software application.
3. It should be possible to connect PC through LAN / Serial port / built in Modem.
4. Configuration should also be possible through Web-based URL.
5. PC programming should be password protected.
6. Should be able to schedule system data backup.
7. Should be able to collect system information, fault display and able to reset the system from PC maintenance console if required.
8. Should be able to read system configuration, card information and detailed port status and to be presented in HTML format.

AIR CONDITIONING WORKS - TECHNICAL SPECIFICATIONS

A. Brief Scope of work :

- a) Supply, install, test & commission the systems as shown in the drawings. The cooling capacities and dehumidified air quantities shall be as shown on the equipment schedules / tender drawings.
- b) Supply and Install GSS ductwork for supply air, along with all duct accessories.
- c) Supply and Install thermal insulation to ductwork
- d) Supply and Install air distribution terminals.
- e) Supply and install copper refrigerant piping complete with closed cell foam insulation on the suction lines for the systems.
- f) Supply and Install UPVC condensate drain piping up to the nearest drain point, including insulation wherever required
- g) Supply and Install final electrical connections (within 1M from isolators) to airconditioning units along with control wiring between indoor & outdoor units.

B. Standards & Codes of Practice :

The design for various systems shall be in accordance with the latest editions of following Standards and Codes :

- a) ASHRAE standard 62.1-2007 for ventilation rates in high rise buildings.
- b) BS5588, part 4 & 5 : Fire Precautions in the design of Buildings : Smoke control in protected escape routes using pressurization
- a) National Building Code of India (NBC)
- b) Energy Conservation Building Code 2007 (ECBC)
- c) Bureau of Energy Efficiency (BEE)
- d) SMACNA and DW-142 standards for duct construction.
- e) CIBSE codes for commissioning & testing.
- f) Relevant BIS / BS / ASTM / IS specifications for materials
- g) Various ASHRAE & ARI design standards
- h) LEED / IGBC pre-requisites for New Construction Buildings

C. Basis of Design :

The system design is based on the following climatic conditions :

- a) Ambient design conditions:
Summer: 103 deg F DBT / 82 deg F WBT
- b) Internal design conditions:
All areas covered by A/C : 76 + 2 deg F DBT / RH not exceeding 60%
- c) Areas to be air-conditioned: all areas as per lists attached and as shown in Architectural / HVAC drawings
- d) Fresh air: Nil
- e) Lighting: 1.0 W per sq.ft.
- f) Glass areas: as per elevation & sectional drawings furnished and Covered with venetian blinds on the inside
- g) Occupancy density: as per furniture layouts
- h) Computer load : 1 PC of 150W in each study room
- i) Other equipment heat dissipation: Nil or negligible
- j) Exposed roof: to be insulated underdeck with minimum 25 mm

Thick closed cell polyolefin foam insulation with
Aluminum foil facing or with an equivalent insulation
Note : over deck insulation is also acceptable
overall U-factor : 0.1 Btu/hr/sq.ft./deg F (0.56
W/sq.M/deg K)

- k) Other construction features : 200 mm thick hollow core blockwork, with 12mm
Thick cement plastering on both sides
overall U-factor : 0.446 Btu/hr/sq.ft./deg F (2.534
W/sq.M/deg K)
- l) Noise Levels : not greater than NC 35
- m) Vibration isolation : All HVAC equipment shall be isolated from
building fabric with suitable anti-vibration
mounts
- n) Ambient temperature to be considered
for outdoor unit selection : 103 deg FDB
- o) Winter heating: Not envisaged

D. Technical Data / Submittals:

The Tenderer shall furnish the required technical data, in the specified formats, along with their tenders, so as to facilitate proper evaluation of the technical parameters of the proposed equipment. Bids may be disqualified for failure to furnish such technical data. In addition, the successful tenderer shall furnish the following documents in the form of formal submittals for the approval of the Consultants, prior to commencement of work / ordering of equipment :

- Manufacturer's data for materials
- Method of Construction
- Installation requirements

E. Shop drawings / As-built drawings:

Tenderer to submit scaled working drawings with detailed arrangement of air distribution systems and equipment. Sections shall be double the scale of plans. Drawings to show all installation requirements and shall be coordinated with both building structure and other building services. Three sets of 'As-built' drawings shall be prepared and submitted, in both hard and soft copy formats, 3 weeks prior to handing over.

F. Warranty / Guarantee:

The Tenderer shall be responsible to remedy at his own expense any fault or defect, which may occur during the maintenance period and do routine maintenance works as per

Manufacturer's written instructions including spares and labour for one year from the date of Testing and commissioning and handing over the plant to the Client.

Hermetic and scroll compressors shall have a minimum warranty of five years from the date of commissioning and handing over.

The Tenderer shall guarantee the performance of the equipment installed by them to maintain the design

indoor temperatures and the RH values within the specified tolerances. The Tenderer shall also guarantee that the capacity of various equipment and system components and the overall plant shall not be less than those specified. The Tenderer shall further ensure, that the system is free of any vibrations and any disturbing noise and that the noise levels are maintained within design levels.

G. Materials / Quality :

All materials used in the project shall be “new” and of high quality. “New” is defined as newly manufactured, state of the art, tested and proven item of equipment. Items that have been held in stock for extended periods of time will not be accepted. Further, all materials shall bear third party quality assurance stamp such as IS, BEE star rating, BS Kitemark, UL, FM, LPC or others.

H. Sheet Metal Duct work:

All galvanized steel sheet ductwork fabrication shall be factory fabricated using specialist sheet metal machinery for each operation such as cutting, shearing, bending, pressing, folding, lock forming etc. Site fabrication of ducting is not permitted.

Ductwork fabrication and installation shall conform to DW-144 standards published by the Heating and Ventilation Tenderers Association, U.K., or to SMACNA standards for 500 Pa WG pressure class or to IS-655 specifications. The maximum velocity in the main duct shall not exceed 7.5 m/s. The maximum noise level inside the conditioned areas shall be in accordance with ASHRAE / CIBSE guidelines.

Unless otherwise specifically mentioned, all duct work to be constructed from hot dipped galvanized sheet steel of Lock Forming Quality (LFQ) to ASTM A527, G90 coating. Self sealing test holes to be provided in the main supply and return air ducts. Foster Duct Sealant 32-17 shall be applied and gaskets shall be provided at all joints so that the permitted air leakage for duct work shall not exceed those specified under DW-144 or SMACNA Leakage Test Manual, as the case may be.

Duct fittings comprising of elbows, tees, offsets, reducers etc. shall be fabricated out of the same base material as that specified for ducts.

Ductwork shall be complete with all fittings and accessories as required viz., volume control dampers, fire dampers, access doors, plenums, duct supports, test plugs, collar connections to terminals, flexible duct connectors, expansion joints, sound attenuators etc.

I. Duct work accessories:

I.1. Volume control dampers:

Volume control dampers shall be multi leaf opposed blade pattern, made from heavy duty Galvanized steel complete with hand looking quadrant. Clear marking of open and closed Position on each damper unit is required. Dampers shall be provided in all branch ducts and wherever required for air balancing.

I.2. Flexible duct:

Flexible ducts shall be of constructed of tough polyester with a double lamination that encapsulates a steel wire helix and rated for 2500 Pa positive pressure as per UL-181. Flexible ducts shall be insulated with 25 mm thick fiberglass blanket, held in place with another re-inforced metalized outer jacket. The use of flexible ducts shall be limited to only final duct connections to air terminals and length of each piece shall not exceed 1.5M. Purpose made duct clamps or 100% nylon straps shall be used for fixing.

I.3. Fire dampers :

Fire dampers shall be constructed of heavy gauge galvanized steel, interlocking blade type or curtain type, as per UL-555 standards, 1-1/2 hour rating, 72 degrees C fusible link, 100 percent free opening with no part of the blade stack or damper frame in contact with the air stream.

I.4. Air terminals : (Grilles and Diffusers)

Grilles and diffusers shall be provided as indicated in the drawings, which shall be selected

to deliver the specified air volume and to achieve the required air flows without draughts or excessive noise levels. Tenderer shall ensure that this tender intent is achieved in the final working layouts. One sample shall be submitted for each type. All samples shall be subject to the final approval of the Architect, including colour finish.

Grilles and diffusers shall be generally of the following types :

- a) Supply Air Grille: shall be rectangular and of double deflection type having individually Adjustable front horizontal and rear vertical aerofoil blades; 20 mm blade spacing; suitable for wall mounting; constructed out of extruded aluminium profiles; powder coated finish to RAL9010 or other as per Architect's choice of colour; c/w rear mounted opposed blade volume control dampers operable from the face and black powder coated; suitable for concealed fixing with spring clips; grille shall be fitted with a foam gasket around the back of the frame to prevent any leakage of air.
- b) Return Air Grille : shall be similar to Supply Air Grille as above, but without damper.
- c) Exhaust Air Grille : shall be of egg crate type with frame made of extruded aluminium profiles; Egg crate core shall be of aluminium and 12.5 mm x 12.5 mm x 12.5 mm grid size, rigidly fixed to the frame; powder coated finish to RAL9010 or other as per Architect's choice of colour; concealed fixing with spring clips; grille shall be fitted with a foam gasket around the back of the frame to prevent any leakage of air.
- d) Supply Air Diffuser : shall be square or rectangular, suitable for ceiling mounting and of louvre type manufactured from extruded aluminium profiles or a single piece die formed and arranged for 4-way air flow pattern; centre core shall be removable; diffuser shall be powder coated to RAL9010 or other finish as per Architect's choice of colour; c/w rear mounted opposed blade volume control dampers operable from the face and black powder coated; suitable for concealed fixing; diffuser shall be fitted with a foam gasket around the back of the frame to prevent any leakage of air; where specified, diffuser shall be suitable for 1 or 2 or 3-way air patterns.
Where specified in drawings, diffusers shall be of circular (round) shape and constructed of aluminium sheets for adjustable air pattern by extending or retracting the centre cones.
- e) Return Air Diffuser / Exhaust Air Diffuser : shall be similar to Supply Air Diffuser as above, but without damper.
- f) Supply Air Linear Slot diffusers: shall be suitable for ceiling mounting and constructed out of extruded aluminum profiles for frames & blades; deflection blades adjustable from diffuser face; 20 mm slot width; no. of slots shall be as shown in drawings; c/w hit & miss volume control dampers cum equalizing grid; provided with alignment strips for adjacent sections and end caps at the ends of a single length of diffuser; fitted with foam gasket sealing around back of frame to prevent any air leakage; powder coated finish to RAL9010 or other colours as per Architect's choice; concealed C-clamp fixing to plenum box.
Diffuser shall be supplied with a suitable plenum box by the manufacturer or locally fabricated; the plenum shall be provided with internal acoustic liner and external thermal insulation with similar specifications to adjacent ducts; plenum shall also be provided with circular collars and butterfly dampers to receive flexible duct connections from main ducts.
Where shown in drawings, special fittings including mitred corner joints or curved type diffusers shall be supplied for aesthetic purposes to match with the Interior Design.
- g) Return Air Linear Slot Diffusers : shall be similar to Supply Air Linear Slot Diffusers, but without hit & miss dampers
- h) Continuous Linear Bar Grille : shall be generally a single continuous length of grille with 50% each for supply air and return air; frame and bars shall be of extruded aluminium profiled construction; horizontal face bars set at 0 deg & 12 mm spacing; c/w alignment strips for unbroken continuous appearance; foam gasket sealing around back of frame; C-clamps for concealed fixing; without rear full length dampers (dampers shall be provided in supply air collars in ducts); powder coated finish to RAL9010 or other colours as per Architect's choice.

Grille lengths up to 5.8M shall be supplied in a single piece.

Where shown in drawings, special fittings including mitred corner joints or curved type grilles shall be supplied for aesthetic purposes to match with the Interior Design.

- i) Door Grille : shall be of double frame construction in extruded aluminium profile; blades shall be of inverted "V" type spaced at 15 mm pitch and non-vision type; suitable for standard door thickness of 44 mm or other thicknesses as per project requirements; powder coated finish to RAL9010 or other colours as per Architect's choice.

Where fire rated doors are specified, grilles shall be supplied of matching fire rating.

- j) Disc Valve : shall be used for supply or exhaust applications for relatively low air volumes; suitable for wall or ceiling mounting; frame and disc shall be constructed out of sheet steel, mounting rings shall be GSS; entire assembly powder coated to RAL9010 or other colours as per Architect's choice; fitted with foam gasket sealing around back of frame to prevent any air leakage.

- k) Fresh Air / Exhaust Air Louvre : shall be in extruded aluminium profiles and powder coated to RAL9010 or other finish as per Architect's choice of colour; blades set at 45 deg to horizontal with 40 mm pitch and inclined downwards to prevent ingress of rain water; c/w aluminium PVC coated bird mesh at rear

Where specified, fresh air louver shall be supplied with a filter and damper.

- l) Sand Trap Louvres : shall be designed to separate sand and dust from the air stream and of extruded aluminium profiled construction for frame and blades; shall comprise of two sets of inverted U-channels mounted vertically on opposite rows; self draining holes of 20 mm diameter shall be provided at the bottom of the louver for emptying filtered dust and sand; a 12 mm x 12 mm aluminium bird screen shall be fitted as standard; suitable for concealed screw fixing; Louver shall have 90% efficiency on particle sizes up to 700 microns, 80% efficiency up to 200 microns and 50% up to 70 microns on bare louver without filter; powder coated finish to RAL9010 or other colours as per Architect's choice. Where specified, a 50 mm thick washable, removable extruded aluminium filter with aluminium mesh media shall be attached to the rear side and supplied

J. Insulation:

J.1. Thermal insulation of ducting above false ceilings:

a) Using flexible foam insulation :

All conditioned air supply, return and exhaust air where return air is surrounding the supply air ducts above false ceiling voids, shall be thermally insulated using fire retardant, physically cross linked, closed cell polyolefin foam insulation, 25 kg / M3 density, thermal conductivity of 0.032 W/mK, 8 mm thickness, faced with reinforced aluminum foil; insulation shall be applied after cleaning of ducts and removing any traces of oil & moisture; fire retardant adhesive shall be applied for 100% coverage; all lateral & longitudinal joints shall be covered airtight with 50 mm wide aluminum tapes; insulation shall be further banded around the circumference with 50 mm wide aluminum tapes at every running meter of duct; the thickness shall be increased to 15 mm wherever return air is separately ducted and run indoors above false ceilings.

b) Using fiberglass insulation:

All conditioned air supply, return and exhaust air where return air is surrounding the supply air ducts above false ceiling voids, shall be thermally insulated using fiberglass faced with glass reinforced aluminium foil, 25 mm thick flexible blankets of 24 kg/m³ density and thermal conductivity 0.037 W / m deg C @ 25 deg C mean temperature; the thickness shall be increased to 50 mm wherever return air is separately ducted and run indoors above false ceilings.

The ductwork shall be cleaned and applied with an adhesive similar to Foster 81-10 for 100% coverage.

All joints (lateral and longitudinal) shall be sealed with 50 mm wide glass reinforced self adhesive aluminium tapes and further covered with a 150 mm band of 8 oz. canvas cloth applied with one tack coat and one final coat of Foster Sealfas 30-36 coating.

J.2. Thermal insulation of ducting in exposed areas:

a) Using flexible foam insulation:

All conditioned air supply, return and exhaust air running on roof exposed directly to outside weather, shall be thermally insulated using thermally insulated using fire retardant, physically cross linked, closed cell polyolefin foam insulation identical, 25 kg / M3 density, thermal conductivity of 0.032 W/mK, specified fiberglass faced with glass reinforced aluminium foil, 25 mm thickness, faced with reinforced aluminium foil; insulation shall be applied after cleaning of ducts and removing any traces of oil & moisture; fire retardant adhesive shall be applied for 100% coverage; all lateral & longitudinal joints shall be covered airtight with 50 mm wide aluminium tapes; insulation shall be further banded around the circumference with 50 mm wide aluminium tapes at every running meter of duct.

All duct insulation on roof and other areas exposed to direct outside weather shall be clad with 0.63 mm (24G) aluminium plain or corrugated sheets.

b) Using fiberglass insulation:

All conditioned air supply, return and exhaust air running on roof exposed directly to outside weather, shall be thermally insulated using fiberglass faced with glass reinforced aluminium foil, 50mm thick rigid boards of 48 kg/m³ density and thermal conductivity 0.037 W / m degC @ 25deg C mean temperature.

The ductwork shall be cleaned and applied with an adhesive similar to Foster 81-10 for 100% coverage before positioning the insulation with GI mechanical fastener pins. The pins shall be at 300 mm centres as per manufacturer's recommendations and fitted with washers. All joints (lateral and longitudinal) shall be sealed with 50 mm wide glass reinforced self adhesive aluminium tapes.

Entire insulation shall be covered with 8 oz. canvas cloth applied with one tack coat and one final coat of Foster Sealfas 30-36 coating. After drying, one additional finish coat of Foster Sealfas 30-36AF shall be applied to prevent any fungus growth.

All duct insulation on roof and other areas exposed to direct outside weather shall be clad with 0.63 mm (24G) aluminium plain or corrugated sheets.

J.3. Acoustic insulation of ducting:

All supply and return ducts shall be acoustically insulated for a length of minimum 5 M from the Air-conditioning unit with 12 mm thick rigid boards faced with black glass tissue (BGT facing) bonded to the fiberglass during manufacture. The lining should be capable of preventing fiber emission at air velocities of up to 12.5 m/s within ducts. Density of the acoustic board shall be 48 kg/m³.

The ductwork shall be cleaned and applied with an adhesive similar to Foster 81-10 for 100% coverage before positioning the duct liner with GI mechanical fastener pins. The pins shall be at 300 mm centres as per manufacturer's recommendations and fitted with washers.

J.4. Under-deck insulation:

Underdeck insulation of roof slabs, as shown in HVAC layout drawings, shall be carried out by the HVAC Tenderer with fire retardant, physically cross linked, closed cell polyolefin foam insulation, 25 kg / M3 density, thermal conductivity of 0.032 W/mK, 25 mm thickness with glass reinforced aluminium foil facing; fire retardant adhesive shall be applied for 100% coverage on the under side of slabs; alternatively, self adhesive type of insulation may be used with factory-applied adhesive; insulation shall be applied to cover all structural

projections such as beams, capitals, sunken slabs etc.

J.5. Acoustic insulation of AHU rooms / plant rooms :

Where specified under the BOQ or drawings, the HVAC Tenderer shall carry out the acoustic insulation of walls of AHU rooms and plant rooms to reduce the noise transmitted from the operating A/C equipment to the adjacent air-conditioned spaces. Such acoustic Insulation of AHU room walls shall be carried out with 50 mm thick unfaced fiberglass insulation, 24 kg / m³ density, in a grid work of 600 mm x 600 mm; grid will be formed with GI sheet metal channels; insulation will be covered with wire mesh & RP tissue and further covered with 24G GI perforated sheet with 6mm dia perforations having 40% free area; GI sheet shall be fixed to the GI channels using aluminium beadings. Suitable cutout provisions shall be made for any wall mounted fixtures such as Electrical Distribution boards, control panels, switches, sockets, thermostats etc.

K. Air Cooled Roof-top Packaged Type Air-conditioning units :

K.1. General :

Capacities, duty conditions and locations shall be as mentioned under Equipment Schedules and drawings.

The packaged units shall comprise of compressors, condenser, evaporator coil with fans, refrigerant piping, electrical components and cabinet enclosure in a single piece. These units shall be factory assembled, internally wired, fully charged with R-22 refrigerant, run tested at the factory and shall be suitable for outdoor installations and mounted on RCC pedestals at site.

The units shall be tested in factory before dispatching to the site.

The units shall be capable to operate from 10 deg C DB to 52 deg C DB ambient temperatures.

The Electrical characteristics of the unit shall be 415V/3phase /50Hz

Each unit shall be capacity tested in the presence of the Engineer after the installation, during the peak summer months.

The overall unit shall be guaranteed for a period of 12 months from the date of commissioning, testing and satisfactory handing over to the client.

K.2. Casing:

Casing shall be made up of hot dip galvanized, (as per JIS-G 3302 or ASTM A525 Specifications) phosphatized steel sheets and then electro statically polyester powder coated and oven baked to provide an extremely tough, scratch resistant and anti-corrosive surface. Powder coating shall be minimum DFT 60 microns.

The entire casing panels shall be designed to be leak proof against rain and ensure prevention of rain water entry into the interior of the units.

Casing shall pass 1000 hours in 5% salt spray testing at 95 deg F (35 deg C) and 95% Relative Humidity as per ASTM B117.

Evaporator section shall be sealed with vinyl gaskets and completely insulated with heavy density, odorless, fiberglass rigid boards faced with black glass tissue (BGT) facing. The insulation shall be minimum 25 mm thick and 48 kg / M³ density with a maximum "k" factor of 0.033 W / M deg K and secured with mechanical fasteners in addition to water resistant adhesives. Insulation shall comply with NFPA90A & 90B requirements for fire resistance. Unit casing shall be provided with access panels for easy service and maintenance of all parts.

The condensate drain pans shall be of stainless steel construction to prevent rusting and insulated to prevent sweating.

K.3. Compressor:

The compressors shall be hermetic scroll, refrigerant gas cooled and equipped with a built-in motor protection device, internal check valve, crank case heater and shall be mounted on Neoprene type anti vibration mounts.

Compressors shall conform to recognized International standards viz., CE, NEC, UL, ARI etc for manufacturing & design.

Compressors shall be of heavy duty and suitable for industrial & commercial applications.

Compressors shall be energy efficient and low noise during operation.

K.4. Air cooled condenser:

K.4.i. Condenser coils:

Condenser coils shall be air cooled with an integral sub cooler and constructed of seamless inner grooved copper tubes 9.5 mm (3/8") OD, mechanically expanded into wavy plate type aluminium fins with maximum 2.1 mm (12 Fins Per Inch) spacing. Lower fin spacing is not permitted to avoid any blockage of coil.

Coil shall conform to ARI-410 standards.

All coils shall be tested at factory against leakage by air pressure of 3100 KPa (450 psig) under water, cleaned and dehydrated before assembly.

The condenser coil shall be provided with an anti-corrosive epoxy coating to prevent corrosion against coastal and saline atmospheres. Any de-rating on the coil performance due to the coating shall be considered while selecting the equipment. Manufacturer shall guarantee the satisfactory performance of such coatings for a minimum period of five years from the date of commissioning / acceptance of the plant by the Client. If any corrosion is observed during this period, the Manufacturer shall be liable for replacement of the condenser coil(s), free of any cost to the Client.

K.4.ii. Condenser Fans :

Condenser fans shall be direct driven, propeller type, discharging air upwards and equipped with aluminium alloy blades, permanently lubricated bearings and inherently corrosion resistant shafts.

Each condenser fan shall be balanced statically & dynamically at the factory.

Complete fan assembly shall be provided with an acrylic coated fan guard.

Motors shall be Totally Enclosed Air Over (TEAO) type with class F insulation, IP-55 grade of protection and factory wired to unit control panel, using wires suitable for high ambient applications.

K.5. Evaporator:

K.5.i. Evaporator coils:

Evaporator coils shall be constructed of seamless inner grooved copper tubes 9.5 mm (3/8") OD, mechanically expanded into wavy plate type aluminum fins with maximum 2.1 mm (12 Fins Per Inch) spacing. Coil depth shall be minimum 4-rows.

Coil shall be complete with headers of seamless copper tubing. Supply headers shall incorporate a distributor, properly sized.

Coil shall be split for each refrigerant circuit independently with an individual thermostatic expansion valve and multi-circuited distributors, providing capacity modulation to match with compressors.

A moisture eliminator shall be incorporated for coil face velocities exceeding 2.5 M / S (500 fpm)

All coils shall be tested at factory against leakage by air pressure of 1720 KPa (250 psig) under water, cleaned and dehydrated before assembly

Coil shall be rated in accordance with ARI-410 standards.

K.5.ii. Evaporator fan :

The evaporator fan shall be forward, Double Inlet Double Width (DIDW), centrifugal type, statically and dynamically balanced.

Dual fans, if incorporated, shall be mounted on a single heavy duty shaft and driven by a single electric motor.

Motors shall be Totally Enclosed Fan Cooled (TEFC), 4-pole, class F insulated and minimum IP-55 grade of protection, rated for continuous operation and wired to the control panel at factory.

Fan shall be belt driven with an adjustable V belt drive as standard. Shaft ends shall insert into oversized, tapered lock self-aligning, long life bearings.

K.6. Air filters:

The packaged unit shall be provided at factory with a filter configuration for flat or vee type filters. Filters shall be 50 mm (2") thick cleanable synthetic media for particle / dust removal with an average arrestance efficiency of 85% as per ASHRAE 52-76 standards.

Similar filters, but of 25 mm thick shall be provided for all fresh air intakes along with access provision.

K.7. Refrigerant piping :

Refrigerant piping shall be of Air-conditioning & Refrigeration (ACR) grade hard drawn seamless copper pipes conforming to ASTM B280 / B88 requirements.

Suction lines shall be insulated with 19 mm thick closed cell foam insulation with a maximum "k" factor of 0.04 W / M deg K.

Pipes shall be properly sized for mass flow rates, pressures and pressure drops encountered in each segment of pipelines. Refrigerant piping shall include filter drier, sight glass, thermostatic expansion valves, solenoid valves, muffler etc. Shut off valves across filter drier shall be provided for isolation.

Refrigerant pipe circuits shall be pressure tested, vacuumised and charged with full operating charge of refrigerant at factory.

K.8. Controls:

Unit shall be provided with an integral control panel of minimum IP-55 grade protection comprising of all starting, operating and safety controls. A dead front panel cover screwed on to the enclosure shall prevent any unauthorized personnel from tampering with controls. Safety and operating controls shall be neatly arranged for easy accessibility.

All wiring shall be sized as per NEC regulations, clauses 430 & 440 or comply to IS requirements. Wiring shall be fully ferruled and labeled for ease of identification.

Control power supply shall be 220-240V / 1ph / 50Hz. An additional built-in 24V fused low voltage transformer shall also be provided for any field supplied 24V thermostat.

Control panel shall include the following components as a minimum :

- Individual contactors for each compressor, condenser fan motor and evaporator fan motor
- Fuses for each condenser and evaporator fan motor as per NEC 430
- Individual over current protection for compressors
- Individual external overload protection for condenser and evaporator fan motor
- Anti recycle timer to prevent rapid cycling and / or short cycling of compressors
- Single phase preventer
- Control disconnect toggle switch
- Control circuit fuses
- Low pressure safety switch

- High pressure safety switch
- 220-240V control power supply with an additional 24V supply to hook up to field-supplied 24V room thermostat
- Power and control circuit terminal blocks
- Head pressure controls by fan cycling (if applicable)
- Liquid line solenoid valves
- Pump down solenoid valve
- Programmable thermostats

K.9. Optional accessories:

Where specified under equipment schedules, one or more of the following features shall also be made available in the packaged units :

- Remote Micro-processor based control panel
- Alternate condenser / evaporator coil fin material viz., copper fins, pre-coated aluminium fins, electro-tinned copper fins
- Condenser coil guard
- Special painting for marine applications
- Electric heaters
- Suction & Discharge pressure gauges
- Run hour meter

L. Packaged, Floor mounted type Air-conditioning Units :

Capacities, duty conditions and locations shall be as mentioned under Equipment Schedules and / or drawings.

The packaged units shall be floor mounted, vertical type and shall comprise of compressors, evaporator coil with fans, thermostatic expansion valves, filters, electrical components, controls and cabinet enclosure in a single piece, located indoors, typically, inside a plant room. The condenser coil and fans shall be housed in a separate unit, located outdoors.

The interconnecting refrigerant piping between the packaged unit and its respective condenser shall be field installed. The control wiring (and power wiring, if required as per manufacturer's design) shall also run along with the refrigerant piping, as per relevant electrical specifications described elsewhere.

Units shall be factory assembled, internally wired, fully charged with R-22 refrigerant, run tested at the factory.

The manufacturer shall supply in loose, as part of the equipment supply, all required refrigerant line accessories including shut off valves, filter drier, sight glass, solenoid valves etc. for installation at site.

All other specifications for individual components shall remain unaltered as described under "Air Cooled Roof-top Packaged Type Air-conditioning units" and shall be applicable and referred for this section also.

M. Split Air-conditioning Units, Ducted type:

Capacities, duty conditions and locations shall be as mentioned under Equipment Schedules and / or drawings.

The split air-conditioning units shall comprise of an indoor fan coil unit either ceiling suspended or floor mounted type and an outdoor condensing unit.

The outdoor unit shall consist of a casing, compressors, condenser coil, condenser fan, motors and a weather proof control panel. The indoor unit shall consist of a casing, evaporator coil, evaporator fan, motor, thermostatic expansion valves and filters.

Both the indoor units and outdoor units shall be factory assembled, internally wired and fully tested.

The interconnecting refrigerant piping between the packaged unit and its respective condenser shall be field installed. The control wiring (and power wiring, if required as per manufacturer's design) shall also run along with the refrigerant piping, as per relevant electrical specifications described elsewhere.

The manufacturer shall supply in loose, as part of the equipment supply, all required refrigerant line accessories including shut off valves, filter drier, sight glass, solenoid valves etc. for installation at site.

All other specifications shall remain unaltered as described under "Air Cooled Roof-top Packaged Type Air-conditioning units" and shall be applicable and referred for this section also.

N. Split Air-conditioning Units, Decorative (ductless) type :

The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The unit shall be completely factory wired, tested and provided with all necessary controls.

The compressor shall be highly efficient rotary / scroll type, as per manufacturer's standards.

The condenser coil shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil. The fins shall be covered by an anti-corrosion resin film to withstand the aggressive weather conditions prevailing in Bahrain. The unit shall be provided with necessary number of direct driven, low noise, propeller type fans arranged for vertical or horizontal discharge. Each fan shall have a safety guard.

The refrigerant circuit shall include liquid & gas shut-off valves and also a solenoid valve. All necessary safety devices including high pressure switch, fuses, overload protection etc. shall be provided to ensure the safe operation of the system. Refrigerant shall be R-22 or other as specified under equipment schedules / drawings.

Indoor units shall have aerodynamically designed fans, statically & dynamically balanced to ensure low noise and vibration during operation. The fan shall be direct driven type. The cooling coil shall be made out of seamless copper tubes with continuous aluminum fins. Filter shall be cleanable type fixed to an integrally moulded plastic / aluminium frame and shall be easily serviceable.

Each unit shall be with a wireless LCD type remote controller. The controller shall be able to start or stop the unit, change temperature settings, fan speeds and angle of swing flap etc. and also shall be provided with timer controls.

Generally the indoor unit shall be any one of the following types :

- Cassette type, 4-way or 2-way blow
- Ceiling type
- Floor standing vertical cabinet type
- Floor type, low height
- Hi-wall type
- Ceiling concealed ducted type, low static
- Ceiling concealed ducted type, high static

O. Air-cooled type :

O.1. General :

Units shall be air cooled, variable refrigerant volume air conditioner consisting of one outdoor unit module and multiple indoor units. Each indoor unit shall have the capability to cool or heat independently based on room requirements.

Refrigerant shall be R-410a.

The indoor units on any circuit can be of a different type and also shall be controlled Individually. Following types of indoor units shall be available in the range of the VRV system Manufacturer for choice selection by the Architect / Client :

- Ceiling mounted cassette type (360 degrees round)
- Ceiling mounted cassette type (Single or Multi directional)

- Ceiling concealed ducted type - Low static
- Ceiling concealed ducted type - High static
- Ceiling type (exposed cabinet type)
- Hi-wall mounted type
- Floor standing type (vertical cabinet, free standing)
- Floor type (exposed cabinet type)
- Floor concealed type

Compressor installed in each module of the outdoor unit shall be equipped with minimum one inverter type compressor capable of operating at varying speeds. Inverter shall be of IGBT (Insulated Gate Bipolar Transistor) type. For higher than 16HP size, multiple outdoor modules may be combined to act as a single VRV system. The system shall be capable of changing the rotating speed of the inverter compressor by a controller, to follow variations in cooling and heating loads.

Outdoor unit shall be suitable for a mix match type of connection between all types of indoor units as listed above.

The refrigerant piping length between indoor units and outdoor unit shall be extendable up to 175M, one-way, with a permissible level difference of up to 50M, without the need for any oil traps.

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

O.2. Outdoor Units :

The outdoor units shall be factory assembled, with a weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The unit should be completely factory wired, tested with all necessary controls.

Each modular outdoor unit shall be equipped with an inverter scroll type compressor along with a fixed speed scroll compressor or alternatively, with a DC twin rotary compressor.

The outdoor unit should also be provided with the following features :

- suitable for high ambient operation (up to 115 deg F ambient)
- duty cycling between multiple inverter compressors
- modular design shall permit side by side installation
- integral microprocessor control panel
- anti-corrosive base plates
- built-in sub-cooling circuit for the condenser coil
- copper tubes / aluminium condenser coil
- protective coating for the fins of condenser coil against corrosion
- low noise, aerofoil fans for lower noise levels & air pressure drops
- condenser fan motors shall be of the DC inverter type to offer enhanced energy efficiency
- compact, space saving foot print

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

The unit shall have in-built refrigerant stabilization control for proper refrigerant distribution. All necessary safety devices shall be provided to ensure the safely operation of the system, including but not limited to - high pressure switch, fuse, fan drive overload protector, fusible plug, over load relay, overload protection for inverter etc. Unit shall be equipped with an oil recovery system to ensure stable operation over long refrigeration pipe lengths and also an oil balancing circuit to avoid poor lubrication.

O.3. Indoor Units :

Indoor units shall be one of the types listed. Each unit shall have an electronic control valve to control refrigerant flow rate corresponding to load variations of space.

The address of the indoor unit shall be set automatically in case of individual and group control. In case of a centralized control, the same shall be set by a liquid crystal remote

controller.

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

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

Filters shall be of cleanable type fixed to an integrally moulded plastic / aluminium frame.

The filter shall be easily serviceable.

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

or cooling & heating, and of corded or cordless type as desired by the Client. The remote controller shall be capable of self diagnostic features and multiple functions including temperature set point, memorizing the latest malfunction code, change of fan speed, angle of swing flap individually etc.

Cassette units shall have built-in high lift drain pump, fresh air intake provision (if specified), low gas detection system and a single-size decorative panel across all capacities.

O.4. Central remote controller :

Where specified, a multi-functional compact centralized controller shall be supplied. The controller shall have a wide screen, user friendly display, capable of connecting by a non polar 2-wire transmission cable up to a distance of 1000M away from indoor units. Following functions, as a minimum shall be available:

- controls up to 64 groups of indoor units
- start /stop of air-conditioners as a zone or group or individual unit
- temperature set point for each indoor unit or zone
- switch between temperature control modes
- fan speed control
- control of direction of airflow
- enabling/disable of individual remote controller operation
- monitoring of operating status such as operation mode, temperature setting of an individual indoor unit, maintenance information, trouble shooting information etc.
- display of operating history
- auto daily management thru scheduled functions up to a year

P. Refrigerant Pipework:

Refrigerant piping shall be carried out at site to interconnect the outdoor and indoor units. Field refrigerant pipes shall be minimized for fittings and joints; pipes shall be neatly laid out either clamped to walls with purpose made wall clamps or run on GI cable trays and tied with cable ties

Pipe material shall be type L, Air-conditioning & Refrigeration (ACR) grade hard drawn seamless copper pipes conforming to ASTM B280 / B88 requirements. Soft copper tubes in coils may be used for sizes less than 7/8 inches.

Fittings shall be wrought copper solder type fittings suitable for connection with silver solder. All joints shall be made with silver solder. The piping shall be charged with dry nitrogen while constructing the joints.

After completion of piping, the refrigerant system shall be pressure tested at a pressure of 20 bar (high side) and 10 bar (low side). While the system is being pressure tested, an

electronic leak detector shall be used to check for leaks. Pressure shall be maintained on the system for a minimum of 12 hours. The system shall be evacuated when the surrounding ambient air is not less than 15 degree C.

A minimum vacuum of 2.0 mm of mercury shall be pulled on the system and maintained for 12 hours. The vacuum pressure displacement shall be not less than 9 M³/h. The vacuum shall be checked with an electronic gauge.

Suction lines shall be insulated with 19 mm thick closed cell foam insulation with a maximum "k" factor of 0.04 W / M deg K. ; where running in exposed areas, suction lines shall be further cladded with 24G aluminum sheets.

Q. Condensate Drain Piping :

Condensate drain pipes shall be UPVC pressure pipes to BS 3505 Class E of sizes shown in the drawings, insulated with 12 mm thick closed cell foam insulation with a maximum "k" factor of 0.04 W / M deg K.

A minimum water seal of 75 mm shall be provided in each U-trap of the fan coil unit, with access clean out for cleaning. A minimum slope of 1: 100 shall be provided along the pipe traverse.

R. Exhaust Fans:

Exhaust fans shall be as shown in the drawings. Wall or window mounted extract fans shall be of propeller type and plastic construction.

In line centrifugal fans shall be suitable for operation at any angle and deliver air quantities at the specified static pressures. The fans shall have circular spigots suitable for connection to standard sizes of circular ducts. Fans shall be manufactured from corrosion resistant galvanized steel sheet and powder coated. Fans shall be fitted with non-stalling backward curved impeller and dynamically balanced. Fans shall be supplied with back draught shutters, worm drive duct fixing clamps, wiring junction box and other required accessories. Fans shall be of low noise models, of good quality and to the approval of the Engineer.

All fans shall be supplied with electronic speed controllers.

Fan discharge end shall be with automatic louver shutter and wire mesh.

The operation of the fans shall be by on / off switch (not by pull cord). The operation of the back draught shutter shall be automatic & electrically operated.

S. Approved Manufacturers:

All materials supplied under this contract shall be from one of the Manufacturers listed below. The list is not in any order of preference. Equivalent products / manufacturers are subject to Client's / Consulting Engineer's approval. All proposed materials must comply fully with the local Statutory Authority requirements. Items not listed hereunder shall be subject to Client's / Consulting Engineer's approval. Tenderer shall obtain specific approval from the Consulting Engineer for the proposed products thru technical submittals, even if available within the list of Approved Manufacturers.

APPROVED LIST MATERIALS FOR INTERIOR & CIVIL

<u>S.No.</u>	<u>Material</u>	<u>Approved Make</u>
1	Ceramic tile	Johnsons /Nitco / Asian / Kajaria
2	Vitrified Ceramics	Nitco / RAK / Asian / Johnsons
3	Adhesive	Waber / Bal Endura
4	Door Closers / Floor spring	Dorma / Ozone / Hardwin
5	Gypsum Board	Saint gobain / La gyp
6	Modular Ceiling	Armstrong / Daiken / USG
7	Commercial Plywood	Green / Century / Archid / Mayur
8	Water Resistant Plywood	Green / Century / Archid / Mayur
9	Wood	Burma Teak wood / African Teakwood
10	Modular Furniture	BP Ergo /Featherlite /Godrej/Unicos / Wipro
11	Fabric Protection coating	Scotchgard of “3” M” over upholstery
12	Paints	Asian / Dulux / Nerolac / Berger
13	Laminates	Marino / Green Lam / Euro / Archid
14	Screws (Oxidized)	GKW
15	Furniture Hardware	Efficient Gadgets / Ebco / Ozone / 4C
16	Adhesive	Fevicol SH / Araldite / Vamicol
17	Mortise Locks	Godrej / Ozone / Golden
18	Wood Preservatives	Wood guard / Termisil
19	Chairs	Officemate / Featherlite/ BP Ergo / Transteel / Godrej

20 Cement	Coromandel / L& T/ Zuari / Penna super
21 Door & Window Sections	Jindal / Indal
22 Vertical blinds	Vista / Hunter douglas / MAC
23 Sun Control film	Garware / 3M / Metamark
24 Frosted film	3M / Garware / Metamark
25 Vinyl	3M / LG / Armstrong
26 Pre-laminated Particle Board	Green / Mario / Duratuff
27 Melamine / French Polish	Asian / Berger / ICI
28 Plain and Tinted Glass	Saint Gobain / Asashi / Modi
29 Mirror	Modiguard / Saint Gobain / Aashi
30 Hardware Fittings such as Hinges, knob Handle, Tower Bolts Castors etc.	SS: Garg / Dorma / Ingersoll / Ozone
31 Fire Retardant Flush Door	Uniply / Kutty / Sharon / Green / Anchor

LIST OF APPROVED MATERIALS / MAKES FOR ELECTRICALS

(As Listed Alphabetically)

S.No.	Details of Materials / Equipment	Manufacturer's Name
1.	Final Distribution Board	ABB Hager (L&T) MDS Legrand Siemens Schneider Electric (MG)
2.	Moulded Case Circuit Breaker (MCCB)	ABB (Isomax) Larsen & Toubro (D-Sine) MDS Legrand Schneider Electric (Compact MS) Siemens (3WL)
3.	Miniature Circuit Breakers (MCB)	ABB Hager (L&T) MDS Legrand Schneider Electric (MG) – Multi - 9 Siemens
4.	Residual Current Circuit Breaker (RCCB)	ABB Hager (L&T) MDS Legrand Schneider Electric (MG) Siemens
5.	Power/Aux. Contactor	ABB Larsen & Toubro Schneider Electric (Telemechanique) Siemens
6.	Control Transformer/Potential Transformers	Automatic Electric Gilbert & Maxwell Matrix Pragati Precise
7.	Current Transformer (Epoxy Cast Resin)	Automatic Electric Gilbert & Maxwell Matrix Pragati Precise
8.	Protection Relay a. Numeric Type	ABB Areva Larsen & Toubro Siemens
	b. Electromagnetic Type	ABB Areva Larsen & Toubro

9.	Indicating Lamps LED type and Push Button	Larsen & Toubro (ESBEE) Schneider Electric (MG) Siemens Teknik Vaishno Electrical
10.	Overload relays with built in Single Phase preventer	ABB Larsen & Toubro Schneider Electric (Telemecanique) Siemens`
11.	a. Electronic Digital Meters (A/V/PF/Hz/KW/KWH) with LED Display b. Dual Energy Meter with centralized metering & billing system	ABB L & T Nippen Schneider Electric Schneider Electric Nippen
12.	Static Power Meter & Logger (SPML) With RS 485 port	Ducati IME Larsen & Toubro Nippen Schneider Electric
13.	PVC insulated XLPE aluminium/copper conductor armoured MV Cables upto 1100 V grade	Havells KEI Polycab Rallison Cables
14.	Cable Glands Double Compression with earthing links	Baliga Lighting Comet Cosmos
15.	Bimettalic Cable Lug	Comet Cosmos Dowell's (Biller India) Hax Brass (Copper Alloy India)
16.	PVC insulated copper conductor stranded flexible wires (FRLS) -	Havells KEI Polycab Rallison RR kabel
17.	Mettalic / GI Conduit (ISI approved)	AKG BEC GUPTA NIC Vimco
18.	Accessories for Mettalic /GI Conduit (ISI approved)	Prakash Engineering Works Sharma Sales Corporation Super Sales Corporation
19.	PVC Conduit & Accessories (ISI approved)	AKG BEC D Plast Duraline Polypack Precision

20.	Switch & Socket	Anchor(Viola) Italy MDS Legrand (Mosaic) Wipro North west MK(Blenze) Crabtree (Athena)
21.	Industrial Socket a. Splash Proof	Clipsal Gewiss MDS Legrand Neptune Balls RR-PCE Schneider Electric
	b. Metal Clad	BCH MDS
22.	Selector Switch, Toggle switch	Kaycee Salzer (Larsen & Toubro)
23.	Invertor	Autopro (Professional Lighting) Luminous Megatech Microtek Vivtar Electronics
24.	Cable Trays	Profab Engineer pushbak
25.	Fire Sealant & Fire Retardant Paint	BTHM Engineering Birla 3 M HILTI Promat
26.	Coaxial Cable	Beldon Comm-Scope (US Imported)
27.	Light Fixtures cum lamp	GE / Crompton / Philips / Wipro
28.	Lighting Management system (Occupancy Sensor)	Honeywell, Mk, Legrand, Clipsal, Crompton
S.No.	Items	Makes
	<u>FIRE ALARM SYSTEM</u>	
1.	Fire Sensors & module	ATEIS Bosch Honeywell - Esser Johnson Notifier Siemens
2.	Main Control Panel (Including the emergency voice evacuation, Repeater panel Graphic Display software)	ATEIS Bosch Honeywell - Esser Johnson Notifier Siemens
3.	Manual call stations/ Hooters/ Strobes Multi tap speaker	ATEIS Bosch Honeywell - Esser Johnson Notifier Siemens
4.	Public Address System and All Accessories	Ateis - Switzerland

		Bosch GE Honeywell – Notifire
5.	Sealed maintenance free batteries	Exide GS Batteries (Japan Storage Co Ltd.) Hitachi
6.	Communication Cable - Indegenous	Batra Henlay Finolex Lappkabel Neolex Polycab RR Kabel Technoflex Caliplast
8.	Auto Dialer	Securico
9.	Response Indicator	Agni System Sensor
10.	Personal Computer	Dell Hewlet Packard IBM Wipro
11.	Color Monitor	LG Philips Samtron Samsung
12.	Printer	Hewlet Packard Cannon
13.	Mouse	Dell Logitech Microtek
S.No.	Items	<u>Makes</u>
	<u>CCTV SYSTEM- IP</u>	
1.	NVR & Accessories including software	Axis Bosch CBC NICE Honeywell Siemens
2.	CCTV- Cameras	Axis Bosch CBC NICE Honeywell
3.	Monitor	Axis Bosch CBC NICE Honeywell
4.	Lenses	American Dynamics Axis Bosch CBC NICE

		Honeywell
6.	L2 & L3 Switches	D-Link Cisco Lanbit
7.	Communication Cable/ Signal Cables /Control / power Cables- Indegenous	Finolex Fusion Polymers Lapp kabel Neolex Rajnigandha RR kabel Technoflex Caliplast
9	Metallic Conduits (MS/GI)	AKG BEC NIC Wimco
10.	Personal Computer	Dell Hewlet Packard IBM Wipro
11.	Color Monitor	LG Philips Samtron Samsung
12.	Printer	Hewlet Packard Cannon
13.	Mouse	Dell Logitech Microtek
S.No.	Details of Materials / Equipment	Manufacturer's Name
	<u>ACCESS CONTROL SYSTEM</u>	
1.	Door Controller & Software	American Dynamics Bosch Cardax FT CardKey GE - Casirusco Honeywell – Prowatch Series Kaba Siemens Tyco Nedap
2.	Electric Door Strikes	Kaba Lock netics Miwa Lock Rutherford Trimec
3.	Cards and Card Readers	Cardax GE HID Kaba Nedap
4.	L2 & L3 Switches	D-Link Cisco

		Lanbit
5.	Communication Cable/ Signal Cables /Control / power Cables- Indegenous	Finolex Fusion Polymers Lapp kabel Neolex Rajnigandha RR kabel Technoflex
6.	Communication Cable/ Signal Cables /Control / power Cables- Imported	Belden Comscope- USA Southwest wire & Cable Volex
7.	Metallic Conduits (MS/GI)	AKG BEC NIC Wimco
8.	Personal Computer	Dell Hewlet Packard IBM Wipro
9.	Color Monitor	LG Philips Samtron Samsung
10.	Printer	Hewlet Packard Cannon
11.	Mouse	Dell Logitech Microtek

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS
PLUMBING SYSTEM

(Listed Alphabetically)

S.No.	Details of Materials / Equipment	Manufacturer's Name
1.	a. Vitreous China Sanitaryware	Cera Hindware Neycer Parryware
	b. WC Connectors	Prince Supreme
2.	Bath Tub and Shower Tray	Aquaplust Duravit Kaldewei
3.	Stainless Steel Sink	Kingston Prestige Chilly Nirali
4.	Auto Urinal Flush System	AOS Auto Robo Flushing System Askon Engineers Euronics Toshi UTEK System
5.	Hand Drier	Askon Engineers Blue Circle

		Euronics Kopal UTEC System
6.	Cistern	Geberit Viega
7.	CP Brass Fittings	Aquaplush Crabtree Ess-Ess Gem Jaguar
8	Flow Control Devices	Aquaplush Con-Serv Jaguar RST
9.	Floor Drain Fixture, Rain Water Outlets & Channel Gratings	ACO GMGR Neer
10.	C.P. Grating for Floor Trap	GMGR Chilly Viking
11.	Cast Iron Pipes & Fittings Manhole covers and frames	
	a.As per IS:3989 (Pipes & Fittings)	KALPANSH NECO
	b.As per IS:1729 (Manhole covers and frames)	NECO Raj Iron Foundry Agra
	c.As per IS:1536 (CIClass LA Pipes)	Electro Steel Calcutta IISCO Kesoram Calcutta
	d.D.I. Manhole Covers & Frames	Kartar valves & fittings NECO
	e.CILA fittings	Kartar valves & fittings
	f.Suspended Manhole and Gully Trap	Patel Pattern
12.	Drip Seal	Vinod Cement Co. Chandigarh (PJS-43)
13.	GI / M.S Pipes (IS : 1239 and IS : 3589)	AST pipes Jindal Tata Steel
14.a	GI pipes fittings(Threaded)	Unik Zoloto M
14.b	GI pipes fittings(Welded)	Advani Smith
15	GI pipe sealent	Henkel - LOCTITE 55
16	Pipe clamp & supports	Chilly Euroclamp
17.	D. I. Pipes	Electro Steel Jindal Lanco Kalahasthi
18.	Copper Pipes & Fitting	Flowflex - Rajco IBP - Max flow
19.	UPVC Pipe	Astral Finolex Prince Supreme
20.	CPVC pipes	Ajay

		Ashirwad Astral Prince
21.	HDPE Pipe	Duraline Kimplas Reliance
22.	RCC Pipe	K K Local & Approved Pranali
23.	Stoneware Pipes, Gully Traps	Perfect Potteries, JABALPUR Rajura
24.	SS Pipes	Remi Viega
25.	GM / Forged Brass Valves	Danfoss cim Sant Zoloto
26.	Sluice Valves	Indian Valve Company Kirloskar
27.	Butterfly Valve	Audco Danfoss Honeywell Sant
28.	Check Valve - WaferType	Advance Danfoss Sant Kirlosker
29.	Check Valve - Dual Plate	ADVANCE
S.No.	Details of Materials / Equipment	Manufacturer's Name
	<u>EPABX</u>	
1	PBX	NEC SIEMENS AVAYA CORAL
2	2 PAIR CABLE & 50 PAIR RAISER CABLE	FINOLEX
3	IO & FACEPLATE	MOLEX, KRONE,AMP
4	MDF	KRONE
5	SINGLE LINE TELEPHONE	PANASONIC,BEETEL

NOTE; PREFERENCE OF MAKES, SUPPLY OF ITEMS SHOULD BE CONSULTED
WITH CLIENT/CONSULTANT BEFORE EFFECTING OF SUPPLY

APPROVED LIST MATERIALS FOR AIRCONDITIONING WORKS

1. Air-conditioning Equipment:
 - a) Carrier/ Daikin / Blue Star / Voltas
OGeneral / Hitachi
2. Pipes:
 - a) Refrigerant pipes (Copper): Mueller Brass / Otokompu / Mandeerv
Tubes /Shree Shyam / Mehta Tubes / Totaline
 - b) UPVC (for drain piping) : Wavin / Surya / Polypack / Prakash
3. Refrigerant piping
 - a) Line Accessories: Sporlan / Emerson / Danfoss / Henry
 - b) Fittings: Mueller Brass / Totaline
 - c) Refrigerant gas : Honeywell / Dupont
 - d) Brazing rods : Harris
4. Ducting & accessories :
 - a) GI Sheets for ducting : Tata / SAIL / Jindal / Nippon
 - b) Factory fabricated ducts : Seven Star / Rolastar / Radiant / Zeco /
Western Air Ducts / Voltas
 - c) Duct Accessories : Durodyne / Weicco
 - d) Self adhesive gaskets : Trocellyne / Primacool / Durodyne
 - e) Flexible ducts : Seven Star / Atco / Caryaire / Supaflex
 - f) Volume Control Dampers, GI : Airmaster / Caryaire / Ravistar / Cosmos
 - g) Pressure Relief Dampers : -doh)
Non Return Dampers : -doi)
Fire Dampers : Airmaster / Caryaire / Ravistar / Ruskin /
Dynacraft / Greenheck / Aldes
 - j) Fire & Smoke Dampers : Ruskin / Greenheck / Colt
 - k) Sound Attenuators : Aldes / Caryaire / Ravistar
 - l) Air Terminals (Grilles & Diffusers): Airmaster / Aldes / Ravistar / Caryaire /
Dynacraft /Cosmos
5. Insulation :
 - a) Fibreglass : U P Twiga / Kimmco / Owens Corning
 - b) Expanded polystyrene, TF quality : Beardsell / Lloyd / Coolite
 - c) Nitrile rubber : Armaflex / K-flex / Aeroflex / Superlon
 - d) Closed cell polyolefin foam, cross linked : Thermobreak / Trocellyne
6. Adhesives, Coatings & Sealants :
Foster / Childers / Miracle / Ideal /Kingspan
7. Vibration Isolators & Expansion joints:
Resistoflex / Dunlop / Emerald / Weicco /Cori /Mason

8. Duct & Pipe Supports :

Grinnel / Mupro / Flamco / Isofix /Weicco

9. Air Filters :

Thermodyne / Aerosol / Purolator / John Fowler /Spectrum / AAF / Trox

10. Electrical Equipment :

a) Cables & Wires : CCI / Universal /Grandlay / KEI / Finolex/ Havells/
Polycab / Gloster / National / Matez /Incab