TECHNICAL SPECIFICATIONS FOR ELECTRICAL, WIRELESS AND HVAC WORKS

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The bidder shall provide technical brochures of equipment complying with technical specifications.

1. Brand Names

Equipment and materials specified with brand names have been provided to establish a standard of performance and do not necessarily indicate a preference for a particular manufacturer or material.

The names of manufacturers given below are to indicate the level of quality and performance anticipated by the Employer / Procuring Agency. Other makes may be accepted provided that the quality and performance of such equipment, in the sole opinion of the Employer / Procuring Agency, are at least equal to or better than the equipment offered by the recommended manufacturer listed hereunder.

List of Manufacturers Recommended

The acceptance of equipment/ materials offered by these manufacturers will be subject to compliance with offered models/ materials with the specifications, capacity and/ or performance requirements.

All other items not included in the list hereunder will be approved by the Employer / Procuring Agency in accordance with their compliance with the specifications, capacity and/ or performance requirements.

Onus lies with the Contractor / supplier for establishing the genuineness of any material/ product.

Following are the specifications of material. Bidder can also offer equivalent products, however, adequate documentation in the form of technical data sheets and type test certificates from independent laboratories stating the standards to which the product complies shall be furnished in the support of their being equivalent. The Employer reserves the right to ask the bidder of additional documentation in this regard.

Product	**Standards**	**Recommended Manufacturers**
Telephony Cables (CAT-6 and 100 pair multicore cables)	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ)	Vivanco, Clipsal, 3M, Systemax, or approved equivalent,
Analogue Telephone Set	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ)	Panasonic, Alcatel, Uniden or approved equivalent
IP Telephone Sets	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ) Compatible with HIPATH 4000, V8 PABX	Unify, Cisco, Avaya Panasonic Or approved equivalent
LV Panels, Distribution Boards	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ)	Hussain and Co. Unique Engineering HRA Switchgears RA Engineering OR approved equivalent
LV Circuit Breakers: ACB, MCCB & MCB	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ)	ABB Schneider GE OR approved equivalent
LV Cables	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ) KEMA Certified	Pakistan Cables Fast Cables New Age Cables Pioneer Cables OR approved equivalent
PVC Conduits and Accessories	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ)	Galco Dadex Jeddah Polymer Civic

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		OR approved equivalent
Lighting Fixture	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ)	Fast LED Lights Philips COARTS Britlite OR approved equivalent
Wireless Audio Conference System	As per standards and specifications mentioned in technical specifications and the Bill of Quantities (BOQ)	TOA Bosch Rest moment or approved equivalent

Section – E-01: General Electrical Requirements

FOREWORD:

This document is to describe the minimum requirements for the equipment and installations and to ensure that the Contractor is fully aware of his duties to perform the required works, in accordance with the terms of the Contract.

1.01 SCOPE OF WORK

The works related to the electrical system, which are included in the scope of this Contract, are shown in Bill of Quantities and explained in these specifications. The works shall broadly include but not limited to the following:

All material and equipment supplied by the Contractor shall be new and, in all respects, conform to the high standards of Engineering design, workmanship, performance and function as here in specified and fully meet the quality level and rugged requirements of the specifications.

The Contractor shall also be responsible to supply any other equipment not specifically mentioned in these documents but which is necessary for proper operation of the works / system, shall be considered to have been so specified and accordingly shall be provided by the Contractor as part of the Contract.

The Contractor shall be solely responsible for ensuring proper functional requirements of various equipment and shall also be responsible for furnishing any additional piece of equipment and for making modification in the equipment as desired and / or approved by the Owner or his representative, to achieve proper coordination with various equipment offered in the bid and also those installed by others.

Approval of the Contractor's supplied equipment / installation works shall not relieve the Contractor of any of his obligations or liabilities under the Contract, except insofar as provided under the conditions of the Contract.

1.02 RULES AND REGULATIONS

The entire electrical installation / work shall be carried out by licensed contractor, authorized to undertake such work under the provisions of Electricity Act 1910 and The Electricity Rules 1937 as adopted and modified up to date by the Government of Pakistan.

All works shall be carried out in accordance with the latest edition of the Regulations of the Electrical Equipment of Buildings issued by the Institute of Engineering and Technology (IET), the Contract documents, the Electricity Rules 1937 and bye-laws that are in force from time to time. Any discrepancy between these specifications and any other rules and regulations shall be

brought to the notice of Owner or his representative, and his decision shall be final and conclusive.

The Contractor shall be responsible for completing all formalities and submitting the test certificates as per prevailing rules and regulations and shall have the installation passed by the Government Electric Inspector of that region. All requirements of the Electric Inspector and the Electric Company shall be complied with.

1.03 STANDARDS

The specification recommended practices, official standards and codes the non - restrictive List of which is given below.

- International Electro-technical Commission (IEC)
- British Standards (BS)
- National Electric Code (NEC)
- National Standards
- Local Electric / Utility Supply Company standards
- EN Standards for PAVA System
- NFPA 72
- EIA/TIA Standards for ICT System

In the event of conflict between standards, the most stringent shall prevail.

Whenever the electrical equipment to be installed, does not hold national standards, the Contractor shall take into account the specific standards chosen by the Owner and make sure that the equipment he has to install, meets these standards.

In addition, even if no mention is stipulated in this specification, it is implied that the equipment be tropicalized, if required, by the conditions of the site of installation.

In any case, the standards and codes to be taken into consideration are those in force at the date of delivery.

1.04 INSTALLATION AND SERVICE CONDITIONS:

1.04.1 Site Conditions:

All material and equipment supplied and installed shall be designed, manufactured and tested to meet the following ambient conditions unless specifically stated otherwise for any material / equipment:

a.	Maximum outdoor ambient temperature	:	45 degree C
b.	Minimum Indoor ambient temperature	:	0 degree C
c.	Maximum relative humidity	:	90 %
d.	Minimum relative humidity	:	26 %

1.04.2 Service Conditions:

Equipment shall be designed and built for continuous service with a minimum of supervision and maintenance.

1.05 DOCUMENTS TO BE SUBMITTED:

The contractor shall submit following documents at the time of approval biding or as per instruction of the Engineer:

1. Documents and certificate to be submitted for approval, including:
2. Warranty
3. Packing and delivery
4. Marking
5. Testing, including:
    - Type tests.
    - Routine Tests.
    - Special test.
6. Technical data sheet
7. Maintenance and operation manual
8. Training Program

- END OF SECTION -

Section – E-02: Main Distribution Board

1.1. SUMMARY

Metal-enclosed, low-voltage, power circuit-breaker switchgear rated 1000V and less for use in ac systems.

1.1 Purpose

This section together with its appending documents, covers the minimum requirement for the design, construction and performance of factory built assemblies of LV switchboard.

1.2 Scope of Work

The work under this scope consists of supplying, installation, testing, connecting and commissioning of all material and services of the complete switchboard as specified herein and/ or shown in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with others for exact route, location and positions of electrical lines and equipment.

1.2. STANDARDS

Particular reference shall be made to:

IEC 60027	Letter symbols to be used in Electrical technology.
IEC 60051	Direct setting electrical measuring instruments.
IEC 60073	Color for indicator lights and push bottoms
IEC 60158	LV Switch gear and control gear.
IEC 60185	Current Transformers.
IEC 60186	Voltage Transformers.
IEC 60269	LV fuses.
IEC 60439	Factory built assemblies of LV switch gear and control gear.
IEC 60529	Degree of protection provided by enclosures.
IEC 60617	Graphic symbols for diagrams.
IEC 60947-2	LV Switch gear and Control gear.
BS 951	Earthing Clamps
BS 1433	Hard drawn bare copper conductor for earthing.
BS 2874	Nuts, Bolts, Washers and Rivets for use on copper.
BS 6346	PVC Insulated Cables.

CP 1013	Earthing

Any other standard referred to in above standards or these specifications.

1.3. PRODUCTS

A Ratings:

(a) Nominal System Voltage: 415 V, 3 phase

(b) Fabrication: Factory assembled and tested and complying with IEEE C37.20.1.

(c) Indoor Enclosure: Steel.

(d) Outdoor Enclosure: Galvanized steel.

- Isolators.
- Louvers for air circulation.
- Hinged front door, interior light, and duplex receptacle.
- Weatherproof internal aisle construction, with aisle access doors, space heaters, lights, and duplex receptacles.

(e) Section barriers between main and tie circuit-breaker compartments.

(f) Bus isolation barriers.

(g) Circuit-breaker compartments.

(h) Removable, hinged, rear covers panels.

(i) Auxiliary Compartments:

- Utility metering compartment.
- Bus transition sections.
- Incoming-line pull sections.
- Hinged front panels

1.4. COMPONENTS

A Instrument Transformers:

- Potential transformers.
- Current transformers.

(a) Instruments: Multifunction digital-metering monitor.

(b) Relays.

(c) Surge arresters.

(d) Control Power Supply: Dry-type transformer, 120 V.

(e) Circuit Breakers:

(f) Operating Mechanism: Mechanically and electrically trip-free, stored-energy type.

- Normal closing speed.
- Slow closing speed.
- Stored-Energy Mechanism: [Manually] [Electrically] charged.
- Operation counter.
- Solid-state trip devices.
- Auxiliary contacts.
- Padlocking provisions.
- Operating handle.
- Electric close button.
- Mechanical interlocking.
- Key interlocks.
- Under voltage Trip Devices: [Instantaneous] [Adjustable].
- Shunt-trip devices.
- Fused circuit breakers.
- Indicating lights.

B Circuit-Breaker Removal Apparatus:

- Portable, floor-supported, roller-base carriage.
- Identification: system power riser diagrams.

1.5. FIELD QUALITY CONTROL

Testing: [Contractor].

1.6. Installation and Service Conditions

For general site conditions refer to Section - E- 1, Clause 4.

Switchboard shall be installed indoor. The equipment shall be capable of operation under the prevailing ambient conditions without any deleterious effect of any kind. Switchboard shall be suitable for continuous operation at full load rating under combined variation of both voltage and frequency as stated in Section - E-1, Clause 5.1.

Transient voltage depression down to 80% of rated voltage shall not affect the performance of the equipment and dip voltage must be within permissible limit.

2. MAIN ELECTRICAL CHARACTERISTICS

2.1. Power Supply System

Main characteristics of power supply system applicable to all switchboards are:

- Voltage 400 V $\pm$ 10%
- Phase 3 ϕ, 4 Wire
- Frequency 50 Hz $\pm$ 1 Hz
- Neutral system Solidly grounded
- Peak asymmetrical SCC To be specified by the bidders
- RMS symmetrical SCC To be specified by the bidders

Main characteristics of auxiliary supply system are:

- Control / Command system 24 VDC
- Space heater system 230 VAC

2.2. Ratings

The equipment shall be capable of carrying the specified current on a continuous basis of 24 hours / day, without exceeding the permitted temperature.

The current ratings of all equipment must be guaranteed at the specified design temperature. Equipment shall be fully rated and constructed for withstanding, making and breaking the specified short circuit duty.

3. GENERAL REQUIREMENTS

3.1. Concept

The Switchboard shall be of standard, prefabricated metal clad cubicle(s), floor mounting type, totally enclosed, dead front, dust tight and vermin proof requiring front access only. It shall complete in all respects with material and accessories, factory assembled, tested and finished all according to the specifications and to normal requirements. For indoor installations the international classification shall be IP42.

The Switchboard with all components and accessories shall be suitable for front operation only and shall:

- have a rated service short service breaking capacity, $\mathbf{I_{cs}}$ at 400 VAC, conforming to IEC 60947-2 unless otherwise stated in BOQ

- be provided with adequate clearance from live parts so that flash over cannot be caused by switching, vermin, pests, etc.
- have all components rated for insulation class 600-volt minimum.
- be designed for flush mounting of all instruments on the front side.
- have all incoming or outgoing connections from the top or bottom as required. Have the components mounted so as to facilitate ease of maintenance from the front. Have common lamp test facility for all lamps.
- have wiring diagram on the inside of door of the switchboard. Be labeled with nameplate on the front side of door.
- have arrangements for extension of switchboard in future.

3.2. Accessibility

Switchboard shall preferably be arranged for bottom cable entries. Adequate space must be provided for cable entries and termination. It shall be possible to work easily and safely on cable of a main or control outgoing circuit in OFF position with the remainder of the board alive.

Adequate system shall be provided for installation and clamping of cables inside the cable compartment. Position of terminals and cables shall allow use of clamp ammeter.

Power and Control cable termination shall avoid obstruction to other cable termination and provide easy access for terminating cables. Cable supports shall be provided to avoid undue strain on cable termination. Easily accessible locations shall be reserved in the compartment for measuring transformers.

3.3. Name plates

On the front side, a name plate shall be provided at the top to indicate the name of manufacturer, system voltage and frequency and the current carrying capacity of switchboard.

Each breaker shall have a circuit identification label fitted below the breaker aperture or as suitable.

Drawing indicating the branch circuit names, breaker elements, cable sizes and connecting services shall be placed in a clear plastic pocket provided at the back of the front access.

Labels described shall have block letters 7 mm high on a white back ground, to be made from Traffolite and be fixed with screws.

Each incoming and outgoing circuit shall also be labeled with name plate 75 mm x 15 mm, as described above on the front side of door.

4. MECHANICAL DESIGN

4.1. General Construction

The switchboard shall be fabricated, welded; grinded, finished with angle iron framework and cladded with 14 SWG MS sheet, to form a rigid, free standing, flush mounting fronted assembly.

It shall be suitably divided into panels and compartments for accommodating the required number of circuit components, instruments and accessories. Each compartment shall be fully partitioned from its neighbor both horizontally and vertically, allowing safe cable routing / termination without shutting the switchboard down.

All live parts within cubicles, compartments or modules, which have to accessible during normal maintenance operations, shall be adequately protected and / or barried to ensure protection of works and to avoid accidental contact. Barriers may be rigid, transparent, insulating material fitted with warning labels.

The doors shall be provided with hinges on the left-hand side and locking handles on the right hand side for fastening the door. The front assembly shall be fastened to the enclosure by means of self-locating fasteners for quick and easy fixing. The front and back door will not exhaust fan/louvered, since the main door of electrical room have louvered door so internal room temperature would be maintained.

All holes, cutouts shall be tool or jib manufactured and free from burrs and rough edges. All structural components shall be of standardized design to provide complete uniformity and inter change ability of common parts. Removable gland plated shall be provided at top and / or bottom as required.

The switchboard shall be supplied complete with foundation bolts and other installation materials as recommended by the manufacturer. Proper size cable clamping channels with galvanized steel clamps and brass cable clamps respectively for unarmored and armored cables shall be provided.

The cabling inside the Switchboard shall be suitably numbered and harnessed by means of straps or cords. Wiring to door mounted components shall be in flexible PVC conduit. All indicating, control and selecting equipment shall be suitably arranged and clearly labeled with indelible labels indicating the rating of fuses, switches, etc.

All metal work of the switchboard shall be cleaned down to bare shining metal, phosphate and the surfaces chemically prepared for powder coating. Then these shall be coated with powder of color RAL 7032 and then baked in oven. The thickness of powder coating shall not be less than 120 microns.

4.2. Bus Bars

Bus bars and droppers supported on non - hygroscopic material are to be high conductivity electrolytic tinned copper, completely isolated and mechanically braced and rated to withstand the specified short circuit currents for one second duration.

Bus bars and droppers shall be housed in a separate compartment and shall be clearly marked with their respective colors. Bus bars shall be provided for three phases, neutral and multi - terminal earth. The temperature rise shall not exceed 50 degree centigrade

at rated current. Neutral bus assembly shall consist of outgoing screw terminals with one terminal for every MCCB / MCB.

Neutral Bus bar should be of same ampere rating as phase bar.

Removable metal covers on the bus bar chamber shall be provided with suitably sized labels at regular intervals, fixed with self-tapping screws and warning of live metal work.

All bus connectors shall be tinned plated connections and joints. Horizontal bus bars shall be of the same current rating throughout their length.

4.3. Earthing

A copper earth bar of suitable section for the specified fault level shall extend the entire length of the Switchboard. Provisions shall be made for possible future extensions at both ends.

Earthing facilities shall be provided on each incoming and outgoing unit to permit earthing of the connections.

All metallic non-current carrying parts of the Switchboard shall be bonded together and connected to the Switchboard's earth bar.

Each circuit wiring shall be green / yellow color. Earthing mass continuity between withdrawable parts and fixed frame shall be correctly ensured whatever the withdrawable part position.

Provision shall be made adjacent to cable termination for earthing cable armor to the earth bus bar.

Earthing switch shall be provided wherever mandatory as per rules and regulations / codes and standards and shall be manually operated. An interlocking system shall provide the following locking and safety functions:

- Impossibility of closing the earth switch if the switching device is closed.
- Visual check of earthing switch positions to be possible.
- Possibility of locking the earthing switch operating handle in open and closed position.
- The earthing of the bus bar shall be done manually by the operator without provision of general earthing system.

5. DISTRIBUTION BOARDS

The enclosure of the LV Distribution Board shall be Surface Mounted, fabricated from electro-galvanized / zinc coated sheet steel.

The LV Distribution Board shall be fabricated with 16 SWG sheet steel recess mounting. All components shall be installed on a common component mounting plate made of 14 SWG sheet steel inside the enclosure and protected from the front with screwed sheet steel front plate. The door and dead front covers shall be made of 14 SWG sheet steel. The door shall be fully gasket

with hinges on the left hand side and locking handle on the right hand side for fastening the door. The locking handle should be detachable. The dead / front assembly shall be fastened to the enclosure by means of self - locating fasteners for quick and easy fixing.

The distribution board shall be supplied complete with all installation materials as recommended by the manufacturer. The incoming and outgoing cable connections shall be according to the wiring requirements. If required, an adapter box for accommodating the cables and conduits may be provided. The box shall be of the same material and finish as the Distribution Boards.

An earth bar or terminal strips shall be provided for connection of incoming and outgoing earth conductors. The earth bar or terminals shall be permanently connected to the body of Distribution Boards at two points. Flexible copper strip shall be provided for earthing of the door of Distribution Board.

Neutral bus assembly shall consist of outgoing screw terminals with one terminal for each MCB. All holes, cutouts, etc., shall be tool or jib manufactured and free from burrs and rough edges. Removable gland plates shall be provided at both the top and / or bottom, as required.

The cabling inside the distribution board shall be suitably numbered and harnessed by means of straps or cords. Wiring to door mounted components shall be in flexible PVC conduit. All indicating, control and selecting equipment shall be suitably arranged and clearly labeled with indelible labels indicating the rating of fuses, switches, etc.

All metal work of the distribution board shall be cleaned down to bare shining metal, phosphate and the surfaces chemically prepared for powder coating. Then these shall be coated with powder of color RAL 7032 and then baked in oven. The thickness of powder coating shall not be less than 120 microns.

6. COMPONENTS

The switchboards shall be provided with all components as specified in BOQ as necessary for the satisfactory operation of the Switchboard and of the electrical system. All components should comply with IEC 60947-2. Typical specifications are given hereunder:

6.1. Air Circuit Breaker (ACB)

Air circuit breaker should be three poles / four poles as mentioned in drawing suitable for making and breaking a fault condition. Operating mechanism shall be manually or motor operated charged spring with front drive grip handle. These shall be locally operative. Mechanically operative ON-OFF-OFF indicators positively driven in both directions shall be provided to indicate the position of the unit.

Overload and over current features / relays shall be of an adjustable, manually resettable type, according to manufacturer's standard range.

Each ACB shall have built in tester with the selection of Trip or Non-Trip Functions. Also with the facility of testing the ACB in field from single phase (220VAC) supply only. Each of the above function shall have separate LED Indicators and Alarm switches for trip monitoring of Overload, Short circuit, Pre trip alarm and Ground Fault. ACB shall be having Trip Memory.

The Breaking Capacity of ACB shall be 65KA. ACB breaking capacity shall be; $I_{cu}=I_{cs}=I_{cw}$.

The circuit breaker shall have two normally open and two normally closed auxiliary contacts rated for 10 Amps. 230 VAC. The circuit breaker shall also provide for ON-TRIP-OFF indicating lamps. The circuit breaker shall have specified rupturing capacity without the use of back-up fuses. Auxiliary release and trip coils shall be provided for desired operation and / or interlocking as shown and / or stated on to in BOQ

6.2. Molded Case Circuit Breaker

These shall be three pole 400 / 500 volts rating shown in BOQ. The breakers shall have both time delay over current and instantaneous short circuit protection.

The MCCBs shall be installed such that their switching levers are accessible through the dead front plate for operation. Circuit numbers / designation on all circuits shall be conspicuously marked to facilitate connection and maintenance.

The breaker shall have quick make - quick break toggle mechanism with positive 'ON', 'OFF' and intermediate ' Tripped ' positions.

Trip mechanism shall be trip free on overload or short circuit ensuring that the breaker will not close / remain close even if the close command is given while the circuit breaker has tripped due to short circuit or continuing overload.

6.3. Miniature Circuit Breaker (MCB)

The MCBs with current rating from 3 to 80 amperes shall be conforming to BS EN 60-898 or IEC 60947-2. The circuit breakers shall be suitable for DIN-rail mounting, maintenance-free and fully tropicalized.

The MCBs shall be designed for horizontal or vertical mounting, or reverse feeding, without any adverse effect on electrical performance.

The operating mechanism shall be quick make, quick break type, trip free, with all poles opening and closing simultaneously (except for the neutral pole, which if required shall be of the advance-closing and late-opening type). The operating toggle shall clearly indicate the ON and OFF/TRIP positions.

The individual operating mechanism of each pole of a multiple MCB shall be directly linked within the MCB casing and not by the operating handle.

Each pole of the MCBs shall be provided with bimetallic thermal element for overload protection and a magnetic element for short circuit protection.

6.4. Load Break Switches

Load Break Switches and contractors shall be of AC3 type for motor loads. Air circuit breakers above 630A shall be housed in separate cubicles. Aluminum plate shall be provided for cable entry to ACBs / MCCBs cubicles of 630A and above rating.

7. PARTICULAR COMPONENT REQUIREMENTS

7.1. Current Transformers

Current transformers shall comply with the requirements of IEC 60185 (or equivalent).

Current Transformers shall be polyester resin insulated, ring type, air cooled having transformation ratio as indicated in BOQ. The Current Transformers shall be of suitable burden having accuracy class 1.0. The Current Transformers shall have rated secondary current as per the drawing as required.

Current Transformers shall mechanically and thermally withstand the specified short circuit capacity.

Test terminal blocks shall be provided for current Transformer secondary circuits having short circuiting provisions to allow portable apparatus to be connected.

7.2. Voltage Transformers

Voltage transformers shall comply with the requirements of IEC 60186 (or equivalent) and shall be of the same accuracy class as Current Transformers.

Voltage Transformers shall be equipped with primary fuses with an interrupting capacity of the incoming circuit breakers. Test terminal block shall be provided for each Voltage Transformer system.

7.3. Ammeters and Voltmeters

Indicating instruments shall be semi-flush Switchboard type, digital. The front dimensions shall be 144 x 144 mm for instruments on incoming side and 96 x 96 mm on all outgoing circuits.

Indicating instruments shall be 1.0 class percent of full scale basic accuracy class in accordance with IEC 60051.

The ammeter shall be suitable for connection to 5 Amp. Secondary of Current Transformer or directly through shunt.

7.4. Selector Switches

Ammeter and voltmeter selector switches shall be complete with front plate, grip handle, R-Y-B and OFF position for ammeter and RY-YB-BR-RN and OFF positions for voltmeters.

The selector switches for controls shall be rotary cam type and shall be provided complete with knob and front plate, showing all positions as required.

7.5. Push Buttons

The push buttons shall be momentary make / break contact type (normally open / normally close) and suitable for flush mounting. The push button for ON and OFF switching shall be red and green respectively.

7.6. HRC Fuses

HRC Fuses shall be provided complete with fuse bases, fuse, etc. The fuses shall have a fusing factor as specified for class Ql in accordance with BS 88.

7.7. Pilot Lamps

Switchboard shall be provided with LED type phase indicating pilot lamps. The lamps shall be rated for 250 volts supply and suitable for flush mounting. The front of the lamps shall have colored rosettes for identification of phases.

7.8. Secondary Wiring

All wiring shall be copper conductor, thermoplastic insulated, at least 1.5 sq. mm flexible, neatly arranged and clipped in groups.

Each conductor and its termination are to be identified and marked with numbered ferrules. All live terminals are to be shrouded.

Secondary wiring for Current Transformers shall be carried out with not less than 2.5 sq. mm. Terminals shall be specially marked to avoid opening of the circuit by accident.

8. INSTALLATION

The LV Switchboard shall be installed at location shown on the drawing. The Contractor shall ensure coordination with civil works for providing any openings, holes, etc. to avoid any breakage to completed works. In case the provisions in civil works for the installation of electrical equipment are not made or made incorrect the same shall be rectified by the Contractor at his own cost and to the satisfaction of the Engineer In-charge The Contractor shall provide foundation bolts and grout them in cement concrete floor using non-shrinkable material with the approval of Engineer In-charge

All installation material for physically erecting the Switchboard, such as bolts, nuts, washers, supporting steel, etc., shall be provided and installed by the Contractor. The Switchboard shall be installed upright and in level and shall be firmly and rigidly bolted to the floor and concrete supports.

The switchboard shall be completely erected as per manufacturer's instructions and as approved by the Engineer In-charge Loose parts dispatched by the manufacturer shall be installed and connected as per assembly drawing provided by the manufacturer. Any safety locking provided by the manufacturer for safe transportation shall be released only after the switchboard is erected in position. The incoming and outgoing cables shall be connected as recommended by cable manufacturer. The cable armor shall be connected effectively to ground.

The Switchboard body shall be connected to earth as per instructions given in section “Earthing “of these specifications. The Switchboard shall be tested and commissioned in the presence of the Engineer In-charge The tests to be carried out shall be tested before energizing as per instructions contained in the article " Testing " of General Specifications of Electrical Works, of these specifications.

Note: Shop drawings of Distribution Boards should be submitted for review and approval prior to proceed further.

- END OF SECTION –

Section – E-03: Distribution Boards

1. SUMMARY

Service and distribution switchboards rated 600 V and less.

2. PRODUCTS

A. Manufactured Units: front connected, front accessible with panel-mounted / fixed / individually mounted main device and panel-mounted branches.

B. Manufactured Units: front and side accessible with fixed, individually mounted main device and panel mounted branches.

C. Manufactured Units: front and rear accessible.

i. Main Devices: Fixed, individually, Draw out mounted.

ii. Branch Devices: Panel, individually, fixed and individually compartmented

iii. Nominal Voltage: 230/ 400V

iv. Main-Bus Continuous: 600A

v. Enclosure: Steel, NEMA Compliant

vi. Barriers: Between adjacent switchboard sections.

vii. Insulation and Isolation: Main bus of main section and main and vertical buses of feeder sections.

viii. Isolator.

ix. Utility metering compartment.

x. Bus transition and incoming pull sections.

xi. Removable, hinged rear doors and compartment covers.

xii. Hinged front panels.

xiii. Pull box on top of switchboard.

xiv. Buses and Connections: Three phase, four wire; Copper, Tin plated Copper / Aluminum

xv. Future device provisions.

xvi. Bus-bar insulation.

D. Over current Protective Devices:

1) Molded-Case Circuit Breaker: NEMA Compliant; thermal-magnetic adjustable / instantaneous-trip, electronic trip, current-limiting and integrally fused types.

    i. Lugs: Mechanical, Compression style.
    ii. Ground-Fault Protection: Integrally, Remote mounted.
    iii. Communication Capability: Circuit-breaker-mounted, Universal-mounted, Integral, Din-rail-mounted, communication module.
    iv. Shunt Trip: Set to trip at 55 / 75 percent of rated voltage.
    v. Under voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional (field-adjustable 0.1- to 0.6-second) time delay.
    vi. Key interlock kit.
    vii. Zone-selective interlocking.

2) Enclosed, Insulated-Case Circuit Breaker: Fixed mounting.
    i. Two-step, stored-energy closing.
    ii. Microprocessor-based trip units.
    iii. Remote trip indication and control.
    iv. Integral communication module.
    v. Key interlock kit.
    vi. Zone-selective interlocking.
    vii. Control Voltage: 250V |AC, 110V DC
3) Bolted-Pressure Contact Switch: Rotary-mechanical-bolting action, with auxiliary switches, ground-fault relay, and open-fuse trip device.
4) High-Pressure, Butt-Type Contact Switch: Butt-type contacts, with auxiliary switches, ground-fault relay, and open-fuse trip device.
5) Fused Switch: NEMA Compliant
6) Instrumentation:
7) Instrument Transformers: NEMA and IEEE Compliant
    i. Potential transformers.
    ii. Current transformers.
    iii. Control-power transformers.
    iv. Current transformers for neutral ground and ground-fault current sensing.
    v. Multifunction digital-metering monitor.
    vi. Ammeters, voltmeters, and power-factor meters.
    vii. Instrument switches.

viii. Feeder ammeters.

ix. Watt-hour meters.

x. Recording demand meter.

8) Control Power: 230 V with electrically / mechanically interlocked main and tie circuit breakers].

9) Accessories:

i. Accessory set including tools.

ii. Portable test set.

iii. Circuit-Breaker Removal Mechanism: Portable elevating carriage, Overhead, mounted at top / front of switchboard.

iv. Spare-fuse cabinet.

v. Fungus proofing.

10) Identification: internally affixed schematic diagrams.

3. FIELD QUALITY CONTROL

Testing: Certifications by Principal, Contractor engaged agency, Factory acceptance testing

- END OF SECTION –

Section – E-04: Internal Lighting

1.0 SCOPE OF WORK

The work under this section consists of supplying, installation and commissioning of all material and services of the complete light fixtures as specified herein and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with other services for exact route, location and positions of light fixtures.

The light fixtures with accessories shall also comply with the General Specifications for Electrical Works, and with other relevant provisions of the Tender document.

2.0 GENERAL

The description of light fixtures in given Bill of Quantities, and stated in the BOQs, and relevant material are described in this section. The determination of quality is based on certified photo-metric data covering the coefficient of utilization, light distribution curves, construction material, shape, finish, operation, etc.

The Contractor shall submit two samples of each and every light fixture specified and obtain approval of the Owner before purchasing. The quality and finishes of local make light fixtures (if mentioned in BOQ) shall be same as that of standard manufacturer.

All fixtures shall be finished in standard color schemes as mentioned in the manufacturer's catalogue for respective fixtures, unless specifically stated in the Specifications, or Bill of Quantities or directed by the Engineer In-charge

3.0 STANDARDS

In compliance to following standards where applicable

- IEC 60598 Luminaries.
- IEC 62031 LED modules for general lighting-Safety requirements.
- IEC 62384 DC or AC supplied electronic control gear for LED modules performance requirements.
- BSEN 1838 Emergency Lighting

Any other standard referred in this specification.

4.0 LED Light Fixtures

The light fixture shall be as stated in bill of quantities. The light fixture shall be finished in standard colors unless otherwise stated or directed by Engineer In-charge All LED light fixtures shall be of international standard and quality. The type of fixtures with manufacturer catalogue reference is given on the fixture schedule and in Bill of Quantities. Equivalent fixture may be acceptable provided that the Contractor submits for review all necessary data indicating photo-metric curves to show that the fixture proposed are of the same type, construction and quality.

The lamps for light fixtures shall be Light Emitting Diodes with driver and shall be supplied and installed according to the wattage as indicated in BOQ. The guaranteed life expectancy and performance of all LED lighting fixtures shall conform to L70B20 requirements at 50,000 hours or better. The Color Rendering Index (CRI) shall be Ra >80 or better.

Weather proof light fixture shall comprise of cast aluminum body and gasketed clear glass cover secured to the body by means of galvanized nuts / screws to give a weather proof and water tight fit.

The gasket shall be weather resistance type.

The LED light fixtures shall be supplied complete with driver and all accessories as per light fixture schedule and shall be installed in accordance with manufacturer's recommendations and sound engineering practice.

5.0 INSTALLATION

5.1 General

The mounting heights of light fixtures are indicated in the BOQs, and position of fixtures according to the mentioned scale.

The Contractor must ensure that the light fixtures are installed uniformly with respect to the dimensions of the area. Any modifications due to site conditions may be made with the approval of Engineer In-charge All fixtures shall be carefully aligned before fixing in position. All fixing accessories such as ceiling rose, flexible cord, lamp holder, suspension rod; pipe or chain with suitable canopy, etc., shall be provided and installed.

The wiring between terminal box and the fixture shall be carried out with 3 core 0.75 sq. mm and I sq. mm copper conductor, PVC / PVC cable respectively for circuits protected by 10 amps and 15 / 20 amps MCBs. The wiring inside light fixture body shall be done with heat resistant cables or PVC insulated cable in heat resistant sleeves as approved by the Engineer In-charge

Glasses, shades, reflectors, diffuses, etc., must be in a clear condition after installation.

All light fixtures shall be earthed by an earth wire connected to the earth terminal in the fitting.

5.2 Indoor Light Fixtures

The indoor light fixture shall be installed on the surface of ceiling or wall by means of nylon plugs and galvanized steel screws, such that their back finish flush with the surface for exposed conduits and flush with outlet box for concealed conduit system. Wherever convenient, screws for fixing light fixtures shall be screwed into the holes of the outlet box. The light on false ceiling shall be installed in accordance with manufacturer's recommendations and in coordination with ceiling installation.

5.3 Outdoor Lighting

For illumination around buildings during dark hours, light fittings in various arrangements shall be provided in accordance with these specifications.

The Contractor shall essentially use the standard products of a manufacturer, regularly engaged in the manufacturer of the product and shall meet the requirement of the specifications.

- END OF SECTION –

Section – E-05: Conduits and Pipes

1.01 SUMMARY

The Contractor shall ensure exact location and route of conduit and pipes in coordination with as per site requirements and as directed by the Engineer In-charge

The quality and material for the accessories of conduits and pipes such as sockets, elbows, bushings, bends, inspection / pull boxes, round boxes, etc., necessary for the completion shall be similar to that of conduit or pipes. All the accessories shall be supplied by the Contractor without any extra cost and deemed to have been included in the price of conduits / pipes.

Note: The Contractor shall ensure exact location and access panel in coordination with other services as per site requirements and as directed by the Engineer In-charge

1.02 STANDARDS

In compliance to following standards where applicable

BS 31	Steel Conduit and accessories
BS 1378	Galvanized Iron Pipes and accessories.
BS 3595	PVC Pipes and accessories.
BS 4607	PVC Conduits and accessories.

Any other standard referred to in above standards or these specifications.

- END OF SECTION –

Section – E-06: Low Voltage Cables and Wires

1.01 SCOPE OF WORK

The work under this scope consists of supplying, installation, testing, connecting and commissioning of all material and services of low voltage cables and wires and the accessories as specified herein or and given in the Bill of Quantities.

1.02 GENERAL

All multicore and single core wires for light circuits, socket outlets and circuits operating upto 250 volts shall be 300 / 500 volts grade. All single core sheathed cables shall be of 450 / 750 volt grade and upto 50sqmm and above shall be of 600/1000V. Power cables for main feeders, main to sub main feeders, power equipment, etc. shall be of 600 / 1000 volts grade. Armouring of cables shall be done with appropriate size galvanized steel wire as per codes. Cable should be capable of running 125% of full load current without any damage.

1.03 STANDARDS

Any other standard referred to in above standards or these specifications. Latest editions and amendments of the below mentioned standards and codes:

- IEC 227 : Power and Lighting PVC insulated cable.
- IEC 228 : Conductors of insulated cables
- IEC 502 : Extruded solid dielectric insulated power cables for rated voltages from 1 kV up to 30 kV.
- IEC 331 : Fire resisting characteristics of electrical cables (where specified)
- IEC 332 : Tests on electric cables under fire conditions.
- IEC 811 : Common test methods for insulating and sheathing of electrical cable.
- IEC 287 : Calculation of the continuous current rating of cables.
- BS 4066 : Test on electric cables under fire conditions.
- BS 6346 : PVC insulated cables for electricity supply.
- BS 6004 : PVC insulated cables (non armoured) for electric power and lighting.
- BS 801 : Composition of lead and lead alloy sheaths of electric cables.
- EEMUA 133 : Underground cable protected against solvent penetration and corrosive attack.
- BS 5467 : XLPE insulated armoured cables for electrical supply.

- BS 6724 : XLPE insulated armoured Single Core PVC Insulated Copper Conductor sheathed cables.
- BS 7211 : Single Core PVC Insulated Copper Conductor non armoured cables / wires.
-

1.04 MATERIAL

A. Conductors and Cables:

Conductors: Copper (or Aluminium - only when specifically mentioned in BoQ).

- **Conductor Insulation:**
  - Multi-core cables – XLPE
  - Single-core cables – XLPE (PVC – only when specifically mentioned in BoQ).
  - Single-core building wires up to 6 sq. mm – PVC

- **Single and Multi-conductor Cable:**

  Armoured/ Unarmoured cable, Type AC, Metal-clad cable, Type MC, Mineral-insulated, metal-sheathed cable, Type MI, Nonmetallic-sheathed cable, Type NM, Type SO and Type USE with ground wire.

  A. Connectors and Splices: Factory fabricated.

  B. Sleeves for Raceways and Cables:

     1. Steel pipe sleeves.
     2. Cast-iron pipe sleeves.
     3. PVC and uPVC sleeves
     4. Sleeves for rectangular openings.

     D. Sleeve Seals: EPDM, NBR sealing elements, plastic, carbon-steel, stainless/steel pressure plates, and carbon, stainless/steel connecting bolts and nuts.

B. CONDUCTOR MATERIAL APPLICATIONS

Feeders: Copper, Solid for 4.0 sq. mm and smaller; stranded for 6.0 sq. mm and larger. Branch Circuits: Copper, Solid for 4.0 sq. mm and smaller; stranded for 6.0 sq. mm and larger.

1.05 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Single conductors in raceway, Mineral-insulated, metal-sheathed cable, multi-conductor cable in raceway.

B. Exposed Feeders: Single conductors in raceway, Unarmored cable, Metal-clad cable, Mineral-insulated, metal-sheathed cable, Nonmetallic-sheathed cable.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Single conductors in raceway, Unarmored cable, Metal-clad cable, Mineral-insulated, metal-sheathed cable, Nonmetallic-sheathed cable.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and underground: Single conductors in raceway, Underground feeder cable.

E. Feeders in Cable Tray: Single conductors in raceway, Armored/Unarmored cable, Metal-clad cable, Mineral-insulated, metal-sheathed cable, Nonmetallic-sheathed cable.

F. Exposed Branch Circuits, Including in Crawlspaces: Single conductors in raceway, Unarmored cable, Metal-clad cable, Mineral-insulated, metal-sheathed cable, Nonmetallic-sheathed cable

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Single conductors in raceway, Unarmored cable, Metal-clad cable, Mineral-insulated, metal-sheathed cable, Nonmetallic-sheathed cable.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and underground: Single conductors in raceway, Underground branch-circuit cable.

I. Branch Circuits in Cable Tray: Single conductors in raceway, Unarmored cable, Metal-clad cable, Mineral-insulated, metal-sheathed cable.

J. Cord Drops and Portable Appliance Connections: Hard service cord with strain relief device at terminations to suit application.

K. Class 1 Control Circuits: In raceway.

L. Class 2 Control Circuits: In raceway, Power-limited cable, concealed in building finishes and in raceway/cable tray.

1.06 FIELD QUALITY CONTROL

A. Testing: Contractor is responsible to perform all testing as per applicable standards, mentioned in Testing and Commissioning or required by the Engineer or utility company (K-Electric).

B. Cables for Conduit Wiring: All cables / wiring in concealed or surface mounted PVC Class-D or steel conduits shall be single core PVC insulated of specified grade and size, unless specifically shown in BOQ.

C. Cables on Surface: Cables for distribution system to be installed on surface, in cable ducts, in concrete trenches or on trays shall be single or multicore PVC insulated and PVC sheathed of specified voltage grade and size, unless specifically shown in BOQ.

D. Underground installation: Cables for laying directly underground shall be PVC insulated, PVC sheathed and armoured with galvanized steel wire. Cables fully installed in underground ducts / pipes and mechanically protected from end to end shall be PVC insulated and PVC sheathed unless specifically shown in BOQ.

- END OF SECTION –

SPECIFICATIONS OF LED PANEL LIGHT ;

Recessed/surface mounted LED panel light of size 600 mm × 1200 mm (2 ft × 4 ft) with high efficiency LED technology, suitable for commercial and institutional lighting applications. The luminaire shall provide uniform glare-controlled illumination with low power consumption and long operational life with following minimum specifications:

Type: LED Panel Light

Size: 2 ft × 4 ft (600 × 1200 mm)

Power Consumption: 38–45 Watts

Correlated Color Temperature (CCT): 4000K (Neutral White) or approved as per site requirement

Luminous Flux: minimum 5400 lumens

Color Rendering Index (CRI): ≥ 80

Power Factor: ≥ 0.90

Operating Voltage: 220–240V AC, 50/60Hz

Protection Class: minimum IP20

Housing: powder coated metal body

Life Span: minimum 50,000 operating hours

Warranty: minimum 2 years replacement warrranty

Compliance: IEC 60598 or equivalent international standards

The rate shall include driver, mounting accessories, connectors, suspension/fixing hardware, wiring connections, testing and commissioning, and all associated works required for complete installation and satisfactory operation

SPECIFICATIONS OF COB LED STRIP/COVE LIGHTING

Flexible COB LED strip/cove lighting complete with driver, V-profile aluminium channel and diffuser, suitable for decorative and architectural lighting applications. The LED strip shall provide continuous dot-free illumination with high color consistency and uniform light distribution with following minimum specifications:

Type: Flexible COB LED Strip Light

Color Temperature (CCT): 3000K (Warm White) or approved as per site requirement

Power Consumption: minimum 10–14 W/m

Luminous Flux: minimum 700–1250 lm/m

Color Rendering Index (CRI): ≥ 80

Protection Rating: IP20 or above

LED Type: COB continuous light technology for uniform illumination

Life Span: minimum 50,000 operating hours

Driver: suitable electronic driver/power supply compatible with strip load

Compliance: IEC/Equivalent international standards

Warranty: minimum 2 years replacement warrranty

The scope includes supply of LED strip, driver, aluminium V-profile, diffuser, mounting clips, connectors, soldering, wiring, fixing, testing and commissioning, along with all accessories, consumables and labour required for complete installation and satisfactory operation,

SPECIFICATIONS OF LED PANEL SIZE 1 FT × 4 FT (300 MM × 1200 MM)

Recessed/surface mounted LED panel light of size 1 ft × 4 ft (300 mm × 1200 mm) suitable for office, commercial and institutional lighting applications. The luminaire shall provide uniform, glare-controlled and flicker-free illumination with high energy efficiency and long operational life. The fitting shall meet or exceed the following minimum specifications:

Type: LED Panel Light

Size: 1 ft × 4 ft (300 × 1200 mm)

Power Consumption: 30–40 Watts

Correlated Color Temperature (CCT): 4000K (Neutral White) or approved as per site requirement

Luminous Flux: minimum 3600–4000 lumens

Color Rendering Index (CRI): ≥ 80

Power Factor: ≥ 0.90

Operating Voltage: 220–240V AC, 50/60HzProtection Class: minimum IP20

Mounting: recessed/surface/suspended compatible

Life Span: minimum 50,000 operating hours

Compliance: IEC 60598 or equivalent international standards

Warranty: minimum 2 years replacement warranty

The rate shall include LED driver, mounting accessories, connectors, suspension/fixing hardware, wiring connections, testing and commissioning, and all associated works required for complete installation and satisfactory operation

SPECIFICATIONS OF LED DOWN LIGHT 60WATT ;

High efficiency surface mounted LED downlight suitable for commercial and institutional lighting applications. The luminaire shall provide uniform glare-controlled illumination with high energy efficiency and long operational life. The fitting shall meet or exceed the following minimum specifications:

Type: Surface Mounted LED Downlight

Power Consumption: at least 60 Watts

Correlated Color Temperature (CCT): 4000K (Neutral White) or approved as per site requirement

Luminous Flux: minimum 6600 lumens

Luminous Efficacy: minimum 100 lm/W

Color Rendering Index (CRI): ≥ 80

Power Factor: ≥ 0.90

Input Voltage: 220–240V AC, 50/60Hz

Housing Material: die-cast aluminium body

Protection Rating: minimum IP65

Mounting: surface mounted type

Driver: integral electronic driver/power supply unit

Life Span: minimum 50,000 operating hours (L70B50)

Operating Temperature: -20°C to +40°C

Compliance: IEC 60598 or equivalent international standards

Warranty: minimum 2 years replacement warrranty

The rate shall include supply of luminaire, driver, mounting accessories, fixing hardware, connectors, wiring connections, testing and commissioning, and all associated labour, consumables and accessories required for complete installation and satisfactory operation

SPECIFICATIONS OF LED DOWN LIGHT 12-15WATT ;

Surface mounted LED downlight suitable for commercial and institutional lighting applications. The luminaire shall provide uniform, glare-controlled and flicker-free illumination with high energy efficiency and long operational life. The fitting shall meet or exceed the following minimum specifications:

Type: Surface Mounted LED Downlight

Power Rating: 12–15 Watts

Correlated Color Temperature (CCT): 3000K / 4000K / 6500K

Luminous Flux: minimum 1200 lumens

Color Rendering Index (CRI): ≥ 80

Power Factor: ≥ 0.80

Operating Voltage: 220–240V AC, 50/60Hz

Protection Rating: minimum IP20

Mounting Type: surface mounted

Life Span: minimum 25,000 operating hours

Compliance: IEC 60598 or equivalent international standards

Warranty: minimum 2 years replacement warrranty

The rate shall include LED driver/power supply unit, mounting accessories, connectors, fixing hardware, wiring connections, testing and commissioning, and all associated labour, consumables and accessories required for complete installation and satisfactory operation, complete in all respects as directed by the Engineer In-Charge.

SPECIFICATIONS OF ELECTRIC DISTRIBUTION PANEL (NAME: P&LDB-1)

Electric Distribution Panel (Name: P&LDB-1) , Wall mounted finished with 16/14 SWG MS sheet, front and back doors, drawing pocket, transparent sheet, powder coated paint of RAL 7032 approved color, moveable & lockable handles of suitable brand, flush type hinged door with Earthling braid consisting of danger plate with handle, complete internal power and control wiring, MCCB Safety Plates as per DB Gauge, fixing material nut bolts, Lugs, glands and with following components:-

Incoming Side 1

- 01 Nos. 100 Amp Three Pole MCCB (Icu=25kA Ics=100% of Icu) adjustable type
- 03 Nos. Indication Lights
- 03 Nos. 2 Amp SP MCB
- 1 No. Multimeter with required CT's Current Measurement on common busbar

Incoming Side 2

- 01 Nos. 80 Amp Three Pole MCCB (Icu=25kA Ics=100% of Icu) adjustable type
- 03 Nos. Indication Lights
- 03 Nos. 2 Amp SP MCB
- 1 No. Multimeter with required CT's Current Measurement on common busbar

Outgoing Side 1

- 20 Nos. 20A TP MCB 10kA
- 16 Nos. 16A DP MCB 10kA

Outgoing Side 2

- 20 Nos. 10A TP MCB 10kA
- 15 Nos. 16A DP MCB 10kA

All cable links/bus bar links must be as per outgoing load. All Circuit Breakers must be compact size, as per specifications and complying with standards, complete in all respect as directed by Engineer In-charge

The vendor must submit shop drawings for approval of the Engineer before the manufacturing of the DB.

SPECIFICATIONS OF ELECTRIC DISTRIBUTION PANEL (NAME: MDB-1)

Electric Distribution Panel (Name: MDB-1) , Wall mounted finished with 16/14 SWG MS sheet, front and back doors, drawing pocket, transparent sheet, powder coated paint of RAL 7032 approved color, moveable & lockable handles of suitable brand, flush type hinged door with Earthling braid consisting of danger plate with handle, complete internal power and control wiring, MCCB Safety Plates as per DB Gauge, fixing material nut bolts, Lugs, glands and with following components:-

Incoming Side

- 01 Nos. 400 Amp Three Pole MCCB (Icu=25kA Ics=100% of Icu) adjustable type
- 03 Nos. Indication Lights
- 03 Nos. 2 Amp SP MCB
- 1 No. Multimeter with required CT's Current Measurement on commmon busbar

Outgoing Side

- 02 Nos. 250A TP MCCB 25kA
- 02 Nos. 100A TP MCCB 25kA
- 02 Nos. 80A TP MCCB 25kA
- 01 Nos. 60A TP MCCB 25kA

All cable links/bus bar links must be as per outgoing load. All Circuit Breakers must be compact size, as per specifications and complying with standards, complete in all respect as directed by Engineer In-charge

The vendor must submit shop drawings for approval of the Engineer before the manufacturing of the DB.

SPECIFICATIONS OF HAND DRYER

automatic electric hand dryer suitable for washroom applications, designed for high-speed and energy-efficient hand drying operation. The unit shall be wall mounted type with durable construction and shall meet or exceed the following minimum specifications:

Type: Automatic sensor-based hand dryer

Operating Voltage: 220–240V AC, 50 Hz

Power Rating: 1500–2000 Watts

Activation: Infrared automatic sensing

Air Speed: high-speed drying performance

Body Material: ABS/metallic corrosion-resistant housing

Noise Level: low noise operation

Safety Features: overheating and overload protection

Mounting: wall mounted complete with fixing accessories

The scope includes fixing, wiring connection from nearby power source, testing, commissioning and all associated accessories, consumables, labour and hardware required for complete installation and satisfactory operation

TECHNICAL SPECIFICATIONS FOR PASSENGER LIFT

Machine Room Less (MRL) passenger lift of 3 stops (Ground + 2) minimum capacity 630Kg, as per EN-81 safety standards, operational on 380-415 Volts, 3-phase, 50 Hz, 3 stops, with following Minimum features:

• Permanent magnet gearless hoisting motor capable of serving Ground + 2 Floors with microprocessor control panel, Car Operating Panels (COP)

• Floor operating panels (FOP) One (01) on each lift lobby equipped with up/down stainless steel call buttons with braille and buzzer, door tracks, sills, door drive mechanism and its complete control system

• Reservation services system inside each car

• Indicator flicker and chime before car arrival (Audible alert system in the car announcing the floor that the car has arrived at)

• Automatic control of the door's operating closing time according to the kind of floor and call.

• Automatic rescue device (ARD)/Emergency Landing Device,

• Full length light curtain, with door closing force limiting device

• Weight overload buzzer

• All safety devices as per safety standards of EN-81

• Telephone intercom system

• Alarm bell

• Voice Prompt System for blind persons indicating each floor reached

• Further equipped with lights, fan, call bell, emergency backup for lights, fan, alarm and intercom

• Operation manual, maintenance manual and circuit diagrams (English Version). Two Hard Copies & One Soft copy in USB.

• In accordance with manufacturer's standard design/drawings and confirming to Technical Specifications and Data. Submission of Shop Drawings after work order and As-Built Drawings after completion

TECHNICAL SPECIFICATIONS FOR SOUND SYSTEM

SPECIFICATIONS OF 2-WAY SURFACE MOUNT SPEAKER SYSTEM

professional 2-way surface mount speaker system suitable for auditorium, public address and background music applications, complete with mounting bracket and all associated accessories. The speaker shall be designed for wall/ceiling mounting and shall provide clear voice intelligibility and high-quality music reproduction. The speaker system shall meet or exceed the following minimum specifications:

Type: 2-way surface mount speaker system

Speaker Size: low frequency driver with high frequency dome tweeter

Continuous Program Power: minimum 150W

Rated Noise Power: minimum 90W

Sensitivity: minimum 91 dB (1W/1m)

Frequency Response: 50 Hz – 20 kHz or better

Dispersion: minimum 100° × 100° coverage or better

Mounting: wall/ceiling mountable with adjustable steel bracket

Construction: heavy-duty enclosure

Operating Temperature: -10°C to +50°C

Certification: EN54-24 certified outdoor/weatherproof version where specified

SPECIFICATIONS OF COMPACT TWO-WAY WALL MOUNT SPEAKER SYSTEM

Compact two-way wall mount speaker system suitable for auditorium, conference and public address applications, designed for wide dispersion, high speech intelligibility and high-quality music reproduction. The speaker shall be complete with mounting bracket and all associated accessories and shall meet or exceed the following minimum specifications:

Type: Two-way bass reflex wall mount speaker

Rated Input: minimum 30 Watts

Power Handling Capacity: minimum 140W continuous program

Rated Impedance: 8 Ohms with 70V/100V line transformer tapping

Sensitivity: minimum 90 dB (1W/1m)

Frequency Response: 80 Hz – 20 kHz (-10 dB)

Input Terminal: push-in terminal type

Enclosure Material: HIPS resin or equivalent high durability enclosure

Mounting: wall/ceiling mountable with adjustable bracket

SPECIFICATIONS OF TWO-WAY WEATHERPROOF MUSIC HORN SPEAKER

Two-way weatherproof music horn speaker suitable for outdoor public address and background music applications, designed for high intelligibility, high efficiency and wide area sound coverage. The speaker system shall be suitable for continuous outdoor operation and shall meet or exceed the following minimum specifications:

Type: Two-way weatherproof music horn speaker

Rated Input Power: 60 Watts minimum

Line Voltage Operation: 70V/100V line transformer type

Sensitivity: minimum 100 dB (1W/1m)

Maximum Sound Pressure Level: minimum 117 dB at rated power

Frequency Response: 100 Hz – 20 kHz or better

Dispersion Angle: minimum 90° horizontal × 80° vertical

Speaker Components:

Low Frequency: minimum 6-inch cone type

High Frequency: dome tweeter type

Dust & Water Protection: minimum IP66 rated

Enclosure Material: weatherproof ABS resin or equivalent

Finish: UV resistant outdoor coating

Suitable for outdoor installations including stadiums, parking areas, corridors and public spaces

SPECIFICATIONS OF WEATHERPROOF HIGH-INTELLIGIBILITY DRIVER UNIT

Weatherproof high-intelligibility driver unit suitable for public address and outdoor announcement applications, designed for use with compatible horn flare assembly. The driver unit shall be suitable for continuous outdoor operation and shall meet or exceed the following minimum specifications:

Type: High impedance driver unit for horn speaker

Rated Input Power: 50 Watts minimum

Line Voltage Operation: 70V/100V line system

Sensitivity: minimum 110 dB (1W/1m)

Frequency Response: 150 Hz – 6 kHz or better

Dust & Water Protection: minimum IP65 rated (with compatible horn assembly)

Impedance Selector: external tap selector arrangement

Construction: corrosion resistant housing with powder coated finish

Horn Coupling: standard threaded coupling suitable for compatible horn flare

Suitable for outdoor public address and announcement systems

SPECIFICATIONS OF WEATHERPROOF LONG HORN SPEAKER SUITABLE FOR OUTDOOR PUBLIC ADDRESS

Weatherproof long horn speaker suitable for outdoor public address, emergency announcement and mass notification applications, designed for high intelligibility and long-distance sound projection. The speaker shall be suitable for continuous outdoor operation and shall meet or exceed the following minimum specifications:

Type: Long horn / reflex horn speaker

Rated Input Power: minimum 30–50 Watts

Line Voltage Operation: 70V/100V line system or equivalent

High sensitivity suitable for long-range coverage

Frequency Response: suitable for speech intelligibility and announcement applications

Weatherproof construction suitable for outdoor installation

Corrosion resistant housing and mounting hardware

Adjustable mounting bracket arrangement

Suitable for continuous duty operation in outdoor environments

SPECIFICATIONS OF PROFESSIONAL MULTICHANNEL DIGITAL POWER AMPLIFIER

Professional multichannel digital power amplifier suitable for auditorium, public address and professional sound reinforcement applications. The amplifier shall be rack mountable and capable of delivering high power output with low distortion and reliable continuous operation. The unit shall meet or exceed the following minimum specifications:

Type: Class-D multichannel digital power amplifier

Channels: 4 independent output channels

Output Power:

Minimum 1000W × 4 channels at 4Ω

Minimum 650W × 4 channels at 8Ω

Bridge Mode: minimum 2000W × 2 channels at 8Ω

Frequency Response: 20 Hz – 20 kHz (±3 dB)

Total Harmonic Distortion (THD): ≤ 0.1%

Signal to Noise Ratio: ≥ 100 dB

Input Impedance: 20kΩ balanced / 10kΩ unbalanced

Input Connectors: XLR-F balanced input

Output Connectors: NL4 Speakon speaker connectors

LED Indicators: Protect, Clip, Signal, Power and level indicators

Cooling System: forced air cooling front-to-rear airflow

Power Supply: 100–240V AC, 50/60 Hz

Power Consumption: maximum 2000W

Mounting: standard 19-inch rack mount type

Construction: heavy-duty metal chassis suitable for professional applications

SPECIFICATIONS OF PROFESSIONAL MIXER POWER AMPLIFIER SUITABLE FOR PUBLIC ADDRESS

Professional mixer power amplifier suitable for public address, auditorium, mosque and background music applications, capable of high-quality speech and music reproduction with multi-input mixing and zone selection facility. The amplifier shall be rack/table mount type and shall meet or exceed the following minimum specifications:

Type: Mixer Power Amplifier

Rated Output Power: 240 Watts minimum

Microphone Inputs: minimum 6 balanced MIC/LINE inputs

AUX Inputs: minimum 5 AUX inputs

Simultaneous Mixing Capability: minimum 9 input sources

Recording Input/Output facility

Speaker Zones: minimum 2 selectable speaker zones

Speaker Output: 100V line and 4–16Ω low impedance output

Frequency Response: 50 Hz – 20 kHz (±3 dB)

Distortion: ≤ 2% at rated output

Signal Processing: provision for equalizer/processor connection

Tone Controls: independent bass and treble controls

Indicators: power, output level and zone selection LED indicators

Input Connectors: XLR/phone jack and RCA type combinations

Cooling: convection/forced air suitable for continuous operation

Power Supply: 220–240V AC, 50/60 Hz

Mounting: rack/table mountable heavy-duty chassis construction

SPECIFICATIONS OF PROFESSIONAL COMPACT DIGITAL/ANALOG AUDIO MIXING CONSOLE

Professional compact digital/analog audio mixing console suitable for auditorium, conference, studio and live sound reinforcement applications. The mixer shall provide high-quality audio processing, multi-channel mixing capability, integrated digital effects and USB audio interfacing for recording and playback applications. The unit shall meet or exceed the following minimum specifications:

Type: Professional compact mixing console

Input Channels: minimum 16 channels comprising:

12 Mic/Line input channels

4 Mic/Stereo-Line input channels

Microphone Preamplifiers: low-noise professional grade preamps

Auxiliary Buses: minimum 6 AUX buses

Effects Processors: dual integrated digital stereo effects processors

Effects Presets: minimum 100 factory presets and 20 user programmable presets

Equalizer: 11-band stereo graphic equalizer

USB Audio Interface: professional 4-in/4-out USB interface

Audio Resolution: minimum 24-bit / 96 kHz

MIDI Interface: integrated MIDI input/output support

Frequency Response: 15 Hz – 70 kHz or better

THD: ≤ 0.01%

Phantom Power: +48V selectable phantom power

Display: OLED/LCD display for effects and system settings

Outputs: balanced XLR master outputs and monitor outputs

Controls: independent channel EQ, AUX, FX and gain controls

Construction: heavy-duty compact chassis suitable for portable and fixed installations

Power Supply: 100–240V AC, 50/60 Hz universal power supply.

SPECIFICATIONS OF PROFESSIONAL DYNAMIC HEADSET MICROPHONE

Professional dynamic headset microphone suitable for speech reinforcement, auditorium, presentation and live sound applications. The microphone shall provide clear voice reproduction, high gain-before-feedback and reliable hands-free operation. The unit shall meet or exceed the following minimum specifications:

Type: Dynamic close-talk headset microphone

Polar Pattern: Cardioid (unidirectional)

Frequency Response: 50 Hz – 15 kHz

Output Connector: 3-pin XLR male balanced output

Output Impedance: 150Ω rated or better

Sensitivity: suitable for professional speech applications

Construction: lightweight adjustable wireframe headset with flexible boom arm

Cable: attached shielded microphone cable minimum 1.2 m length

Accessories: foam windscreen and cable clip

Finish: black or approved equivalent

Operation: no phantom power required

Suitable for indoor speech, stage and presentation applications

SPECIFICATIONS OF 27U FLOOR STANDING PA EQUIPMENT RACK

27U floor standing PA equipment rack fabricated from heavy-duty steel sheet with powder coated finish and front glass door, suitable for housing professional audio and communication equipment. The rack shall be complete with ventilation arrangement, cable management provision, mounting hardware and power distribution unit (PDU). The rack shall meet or exceed the following minimum specifications:

Rack Size: 27U standard 19-inch rack

Construction: heavy-duty MS/CRCA steel sheet

Finish: powder coated anti-corrosive finish

Front Door: lockable toughened glass door

Mounting Rails: adjustable equipment mounting rails

Ventilation: fan mounting/ventilation provision

Accessories: cable manager, shelves and mounting hardware

PDU: rack mountable power distribution unit

Base: floor standing type with levelling arrangement/casters

SPECIFICATIONS OF PROFESSIONAL HANDHELD WIRED DYNAMIC MICROPHONE

Professional handheld wired dynamic microphone suitable for public address, speech and vocal applications, complete with microphone holder, cable and standard accessories. The microphone shall provide clear voice reproduction and reliable performance and shall meet or exceed the following minimum specifications:

Type: Dynamic handheld wired microphone

Polar Pattern: unidirectional/cardioid

Frequency Response: suitable for speech and vocal applications

Output Connector: standard professional audio connector

Construction: rugged metal body suitable for continuous use

Switch: built-in ON/OFF switch

Cable: shielded low-noise microphone cable

Accessories: microphone holder/clip and carrying accessories

SPECIFICATIONS OF PROFESSIONAL IMPORTED MICROPHONE STAND

Professional imported microphone stand suitable for auditorium, conference, public address and recording applications, designed for stable support and flexible positioning of microphones. The stand shall be heavy-duty construction and shall meet or exceed the following minimum specifications:

Type: adjustable floor/table microphone stand

Construction: heavy-duty steel/metal body

Height Adjustment: adjustable

Base: stable tripod or heavy round base type

Finish: black powder coated/mat finish

Thread Compatibility: standard 5/8-inch or equivalent microphone mounting thread

Compatible with standard dynamic and condenser microphones

List of Approved Manufacturers/Sources of Equipment

S. No.	Equipment / Material	Recommended
1	Commercial Hand Dryer	a) Siemens b) Falin c) Alpina d) Airmate e) World Dryer Or Approved Equivalent
2	Distribution Board Panel	a)Hussain And Co. b)Unique Engineering c)Hra Switchgears c)Ra Engineering Taj Engineering d)Pakistan A To Zee, e)Pakistan Karimi Electromech System Or Approved Equivalent
3	Electric Power Cables	Pakistan Cables Fast Cables New Age Cables or approved equivalent Pioneer Cables Or Approved Equivalent

4	Hangers & Supports	A) Hilti B) Inka C) Sikla D) Index or approved equivalent
5	Upvc Piping	a) Nepro, Uae b) Cosmoplast, Uae c) Jeddah Polymer d) Pakarab or approved equivalent
6	Pvc Conduit For Electrical Works (Power, Control & Comminucation Wiring – Concealed / Recessed Application) Gi Conduit For Electrical Works (Power, Control & Communication Wiring – Surfaced / Exposed / Above False Ceiling Application)	a) Hilal, Pakistan b) Premier, Pakistan c) Dadex, Pakistan d) Iil, Pakistan e) Jeddah Polymer f) Pakarab or approved equivalent
7	Circuit Breakers	b) Schneider Electric c) ABB or approved equivalent
8	Lights	A) Philips B) Pierlite C) Osram or approved equivalent
9	Sound System	a. TOA or approved equivalent
10	Passenger Lift	a) Mitsubishi b) Schindler c) Kone d) Suzhou Fuji or approved equivalent

NB: Bidder must submit the technical submittal of each item to the Engineer In-charge for approval before delivery of any material. The Bidder shall fill the name of only one manufacturer for each equipment/material on which the tender is based. He shall be bound to supply the equipment from the same manufacturer. In case, the Bidder gives names of more than one manufacturer against any equipment, the Engineer / Owner can ask the Bidder supply the equipment from any one of them.

* All Equipment/accessories shall be procured from OEM/ OEM Authorized agent.

TECHNICAL SPECIFICATIONS FOR WIRELESS AUDIO CONFERENCE SYSTEM

S.No	Description	Specifications
1	Audio Conference Controller/Central Unit (Wireless)	Fully digital; wireless or infrared system; Connects wireless/wired units;; Individual ID assignment; Supports up to 60 units; multiple mic management modes; External mic input; IEC 60065 compliant.
2	Wireless Chairman Unit	All features of Wireless Delegate microphones; Includes Chairman priority control; IEC 60065 compliant.
3	Wireless Delegate Unit	Cordless system; 2.4GHz+/Infrared technology; battery powered, Individual gain/sensitivity control; Independent ID address and setting; Zero interference from mobile/Bluetooth; IEC 60065 compliant.
4	Power Amplifier	Power rating ≥120W; at least Min. 3 mic inputs (phantom power); Min. 2 Aux/line outputs; Individual mic level controls; Master volume,.
5	Wireless Transmitter/Receiver	Signal range > 6 m; Frequency ~2.4GHz/infrared; 360-degree directional communication; Secure/digitally protected transmission.
6	Battery Charging Unit	Charges at least 6 batteries simultaneously; Easy installation/removal; LED charging indicators. Charging time not more than 5 hours, Voltage 100-240V AC input and 24V DC output with LED indicators
7	Distributor Signal Distributor	Distributor Signal distributor used to expand the number of connectable transmitter/ receiver units For 2-branch distribution
8	Batteries	DC battery, at least 2000mAh, chargeable, maximum charging time 6 hours as per international standards
9	Dual Channel Cordless Microphone	Supply of Dual Channel Cordless Microphone Set with adjustable frequencies at least 2 channels. At least 100m range Includes one dual-channel receiver and two wireless transmitters with RF carrier power management. Causes no interference to Active Mobile Phones & Video Conferencing System
10	Handheld Wireless Microphone	Supply of Handheld Wireless Microphone. Professional wireless handheld microphone with tuner, with power/battery status indicators. No interference from active mobile phones & video conferencing system
11	Ceiling Speaker	Ceiling mounted, PA/BGM use, Rated power: wide frequency 20kHz - 80kHz or higher range; 70V/100V; Sensitivity 89±6dB; flush mount design
12	Audio Rack	Size to accommodate all equipment; Front mirror-locking door; Cooling fan and ventilation; Moveable mechanism.

TECHNICAL SPECIFICATIONS FOR HVAC WORKS

Following are the specifications of material. Bidder can also offer equivalent products, however, adequate documentation in the form of technical data sheets and type test certificates from independent laboratories stating the standards to which the product complies shall be furnished in the support of their being equivalent. **Bidder must submit the technical submittal of each item to the Engineer In-charge for approval before delivery of any material.** The Employer reserves the right to ask the bidder of additional documentation in this regard.

Technical Specification Sheet for AHU

		AHU-1	**AHU-2**
Placement Location		ROOF TOP	4TH FLOOR
FLOW RATE (CFM)		7200	18000
AIR ON (^{0}F)	DBT	75	75
	WBT	62.5	62.5
AIR OFF (^{0}F)	DBT	55	55
	WBT	54.3	54.3
MINIMUM COOLING COIL CAPACITY	TOTAL MBH	170	443
	SENSIBLE MBH	205.1	515.6
WATER TEMP. ^{0}F	IN	44	44
	OUT	56	56
WATER FLOW	GPM	44.3	103.12
MAX FACE VELOCITY	FPM	500	500
ESP	Pa	500	500
MAX OUTLET VELOCITY	FPM	1,500	1,500
MOTOR WITH VFD	kW	400/3/50	400/3/50

Technical Specification Sheet for Floor Standing Fan Coil Units

FLOW RATE (CFM)			1400
COOLING COIL	AIR ON (**^{0}F**)	DBT	75.00
		WBT	62.50

	AIR OFF (**^{o}F)**	DBT	55.00
		WBT	54.30
	COOLING COIL CAPACITY	TOTAL MBH	48.00
		SENSIBLE MBH	42.00
	WATER TEMP. **^{o}F**	IN	44.0
		OUT	56.0
	WATER FLOW	GPM	9.60
	MAX FACE VELOCITY	FPM	500
FAN	ESP	in	0.25
	MAX OUTLET VELOCITY	FPM	1,000
	MOTOR	kW	
	ELECTRICAL CHARACTERISTICS		220/1/50

NOTES:

1) Contractor to calculate actual external static pressure as per site conditions and submit for engineer's approval
2) All Air Handling Units shall be AHRI /AMCA /Eurovent certified. Provide Proof of certification along with submittals.
3) Room Dimensions for AHU # 02 are 16x9x11 ft. AHU selection must be in compliance with the room dimensions so that the AHU may easily fit in the room keeping the considerations for Ducting and Operation and Maintenance Requirements in view.

Identification for MEP Systems and Equipment

1.1 EQIPMENT IDENTIFICATION PLATES:

1.1.1 The Contractor shall provide engraved signs with screws or adhesive backing, for equipment identification, in colors and sizes approved by the Owner and MEP Works Consultant.

1.1.2 The nameplate shall be 2.5 mm thick 90 mm by 40 mm high with black face and white centre. 5.5 mm high lettering in white.

1.1.3 The terminology should be matched to schedules as closely as possible for equipment designation but capacities shall be as per actual equipment. The following data must be included

- Equipment type,
- Equipment service
- Area/zone served
- Design capacity
- Other design parameters like pressure drop, entering and leaving conditions, speed etc.

1.1.4 Equipment markers shall be installed on or near major mechanical equipment including but not limited to:

- Water softeners, condensate return units, etc.
- Main control and operating valves, including safety devices and hazardous units such as gas outlets.
- Fire department hose valves and hose stations.
- Control System equipment panels.
- Meters, gauges, thermometers, transmitters, and similar units.
- Pumps, compressors, chillers, condensers, and similar motor-driven units.
- Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
- Fans, blowers, primary balancing dampers, and mixing boxes.
- Packaged HVAC central-station and zone-type units, air handlers and condensing units.
- Tanks and pressure vessels.
- Strainers, filters, humidifiers, water-treatment systems, air separators and similar equipment.

1.2 PIPE IDENTIFICATION DEVICES

1.2.1 The Contractor shall provide pre printed snap on type, wrap around or adhesive type pipe markers that shall indicate the service by system and zone, the line contents as well as have arrows indicating the direction of flow.

1.2.2 Pipe identification markers shall be provided in all occupied and unoccupied rooms as well as in all other spaces (such as shafts) in which piping may be viewed.

1.2.3 There should be one set of identification band per pipe in each space.

1.2.4 Pipe markers shall be located in a conspicuous manner at a minimum distance of every 12 mas follows:

- Upstream of each control valve and pressure regulating valve station.
- Downstream of every pressure regulating valve station.
- Near each branch.
- On both sides of a wall, floor, ceiling, or roof within 4 feet of the barrier.
- Near all origination and termination points of all equipment (tanks, pumps, etc.).
- Near the inside and outside of concealed points.
- Outdoors at each major elevation.

1.2.5 The band shallbe printed in black letters of the following sizes:

- For 80 mm pipes and larger : 50 mm high letters
- For 65 mm pipes and smaller : 25 mm high letters

1.2.6 Bands shall have backgrounds of different colours for the various service groups as follows:

	Colour	**Stripe**
Water, Air Cond. Chilled	Blue	Green
Water, Air Cond. Tower, Condensor.	Green	Blue
Condensate (steam) Returns	Green	Orange

Boiler Blow down	Green	Yellow & White
Steam, Low Pressure		
- (under 137.6 kPa/20 psi)	Orange	White
Steam, Medium Pressure		
- (137.6 688 kPa/20 100 psi)	Orange	Green
Steam, High Pressure		
- (over 688 kPa/100 psi)	Orange	Black
Refrigerants	Purple	
Fuel Oils No. 3 to 6	Yellow	
Fuel Oil, Diesel, Kerosene, No. 2	Yellow	Black
Gasoline	Yellow	Orange & Black

1.3 DUCT IDENTIFICATION DEVICES

- The contractor shall provide engraved laminated plastic markers that shall include te direction and quantity of airflow and duct device (supply, return etc.)
- Stamped Letters shall be a minimum of 50mm high

1.3.1 ELECTRCIAL SYSTEM IDENTIFICATION DEVICES

1.3.1.1 Identify and label all electrical, lighting, power telephone/data and security equipment" and wiring. Circuit references shall be provided on all equipment including light fixtures, power sockets, fire alarm and security devices and controllers, etc.

1.3.1.2 Nameplates for distribution boards shall indicate the panel designation and the mains voltage, phase and location of feed.

1.3.1.3 Nameplates for transformers shall indicate the transformer designation, primary and secondary voltages and power sources.

1.3.1.4 Nameplates for disconnect switches, motor Starters and contactors shall indicate the equipment being controlled, the voltage and rating.

1.3.1.5 Nameplates shall be engraved black lamicoid with white letters, at least 19 mm high for switchboards, switchgear, MCC's, transformers and panel boards, and 6 mm high for switches, motor starters, contactors and panel board branch circuits.

1.3.1.6 Nameplates shall be mechanically attached to the equipment with round head screws. Adhesive labels shall not be accepted. All equipment on or in the panels, cabinets, switch gears, controllers, racks and consoles shall be identified by lamicoid nameplates with white letters on a black background.

1.3.1.7 Use labels for feeder conduits, power security, and telephone/data cables and conductors, and telephone/data outlets to indicate their full circuit number or identification.

1.3.1.8 Labels shall be PVC cable markers in carrier types as follows:

- Black lettering on white background, for power, lighting and security conduit and cables.
- Green lettering on white background for telephone/data distribution cables.
- Blue lettering on white background for telephone/data riser cables.

1.3.1.9 Labels shall be located at each end of the run at all junctions and pull boxes and in each termination point/block from panels, controllers, devices, etc.

1.3.1.10 Use colored paint dabs on the inside of outlet boxes and paint interior side of the panel C covers as they are installed. In ceiling spaces, provide color to outside of boxes. Paint color to match system colors as defined in "Finishes". Paint color code shall be as follows:

- Red - Life Safety System
- Pink - Intercom and Public Address System
- Black - Annunciator and Buzzer System
- Green - 220V, 1 PH Circuits
- Purple - Telephone/data Communication System
- Blue - 220 V/380 V Circuits
- Orange - Security Alarm System

1.3.1.11 Use Plastic self-adhesive tape to identify incoming utility sources, feeders, sub-feeders and busbars in each switchboard.

1.3.1.12 Unless otherwise specified, tape color code shall be as follows:

- Red - Red Phase
- Yellow-Yellow Phase
- Blue - Blue Phase
- Black - Neutral

- Green - Earth

1.3.1.13 Complete all panel board and security directories with neat, type written lists of circuit numbers and items controlled. Directories shall be typed in Word or Excel, or similar, to the approval of the Engineer, after review, submit a copy of all directories on disk to the Engineer, in addition to the copies included with the manuals and installed on site.

1.3.1.14 For direct buried cables and duct runs under paved or grassed areas, identify location with concrete markers, flush with grade on 30 m centres, and at changes in direction.

1.3.1.15 All controllers for fire alarm, security intercom lighting completed with connection drawing and riser

PART THREE EXECUTION

2.1 Where identification is to be applied to surfaces that require insulation, painting, acoustical ceiling concealment or other covering or finish, install identification after completion of covering and painting. In addition, provide pipe markers only after each line has been completed, erected, purged, tested, and/or painted.

2.2 Marking shall be placed at each side of any wall, partition or floor, at 10m intervals on all exposed piping and ductwork and at each access panel or door. Marking shall be located so as to be in full view.

2.3 Marking shall be stencilled. Use black stencils on light coloured surfaces, yellow stencils on dark coloured surfaces except for fire lines, which shall be stencilled in accordance with Civil Defence requirements. Stencils shall have distinct edges. Blurred stencils are not acceptable. The name of the service shall be stencilled fully or with abbreviations standard to the industry. Non-standard abbreviations are not acceptable. All markings shall be clearly legible from 1.5m above the adjacent floor or platform.

2.4 Access doors for fire dampers shall be clearly identified.

2.5 As an alternate to stencil, approved type markers by Industrial Safety Supply Co. or approved equivalent shall be acceptable subject to review by the Engineer In-charge

2.6 Clean faces of mechanical identification devices.

MATERIAL

Material for painting shall be of high-grade products of well-known manufacturers, and when

approved, shall be delivered to the site in original unbroken packages, bearing the maker's name and brand. Paints of approved colour only shall be used for each application.

SERVICE CONDITIONS

All finish painting will be done under this Section, except where such pieces of equipment or material are specified to be shop painted or finished by the manufacturer. Clean and leave surfaces ready for Painting.

All exposed piping and equipment to be colour coded painted.

All plants, equipment's, pumps and motors shall be provided with three coats of enamel paint in the factory and shall be carefully cleaned and oiled after installation. In case the original paint has been damaged, fresh coats of enamel paint to match the original shall be given.

Where equipment is delivered with the final paint or finish applied by the manufacturer, repaint or refinish surfaces damaged during erection of shipment, so as to match the original surface and be unobtrusive.

Pre-painted equipment by manufacturer shall be to colors selected by the Engineer from standard finishes.

Equipment items, including pumps, air moving units, un-insulated pressure vessels, unit ventilators and convectors, shall have prime and final paint factory applied. Heat resistant paint shall be used where the conditions require this.

All pumps, motors, fans and all other factory manufactured and assembled apparatus shall be factory coated with one coat of primer and one coat of machinery enamel, and after installation shall be cleaned and touched up to repair any damage incurred during construction.

Coat interior of each outdoor air chamber with two coats of odorless, rust resisting, non-scaling paint**.**

The Contractor shall paint all plants, equipment, ducting, piping, hangers, bracing and other surfaces exposed to air as specified and he shall also be responsible for all finish painting. The minimum numbers of coats are specified herein under but sufficient coats shall be given to achieve desired finish.

All structural steel including hangers, brackets, supports and other ferrous metals shall be shop or factory prime painted. Wherever structural steel including brackets, supports, and other ferrous metal cannot be shop or factory prime painted, wire brush to remove all traces or rust, clean off air traces of dirt, oil and grease, apply one coat of an approved rust inhibiting primer and leave ready to receive finish paint.

All galvanized black iron steel pipe work and steel fittings shall be delivered to site undamaged and free from dirt and rust, and protected by factory applied varnish, lacquer or shop/factory applied prime paint.

Touch up all bolt heads, nuts, threads and previously unpainted connections. Touch up all damaged and abraded areas on pipe work and steel after erection, and wire brush all welds and cut ends. Apply one coat of approved rust inhibiting primer and leave ready to receive finish paint.

Do not prime paint galvanized steel, except in visible locations. Treat all damaged and unprotected surfaces of galvanized steel with a zinc rich paint to a minimum of 50 micron thickness.

Provide a heavy field coat of black asphaltum paint on all steel pipe, cradles, vibration isolating mounts, and the like, that will be encased or partially encased in building construction, set in cement or fill, before items are built into the general construction.

SUBMITTALS

The Contractor shall provide manufacturer's application directions, performance guarantee, literatures and MSDS (Material Safety Data Sheets)

ELECTRIC MOTORS

Unless otherwise specified all motors shall be high efficiency, IE3, squirrel cage induction type with standard drip proof enclosure. Motors installed exposed to the outside shall have IP65 rating. Motors exposed to the outside shall be totally enclosed fan cooled motors. All motors in non-air-conditioned space shall be suitable for 50°C operation.

Unless noted otherwise, all motors shall have Class B (130°C) Insulation and shall be designed for continuous operation at 50°C. Motors with drip-proof enclosure shall have 1.15 service factor, totally enclosed fan cooled motors shall have 1.0 service factor.

Motor connection boxes shall be located on side of motor most easily accessible for maintenance and remote from belts, gears or driven equipment, If boxes are located on, wrong side of motor they shall be relocated.

Each multi-speed motor and associated switching device shall be circuited such that the overload device in the starter protects the motor on each step of the multi-speed switch. As an alternative to this requirement the motor may have integral overload protection.

Material submissions for all electric motors shall be in accordance with the section and article 'Shop drawings' and shall also incorporate the following information.

Horsepower

Voltage

Frequency

Speed

Starting Current and Torque Characteristics

Full Load Current

Class of Insulation

Enclosure Type

Service Factor

Ambient Temperature Reference

Type of Bearings

Locations of Connection Box

Motors 15 hp and larger shall have heat detector protection embedded in the windings for connection into the motor control circuit. Protection shall be Siemens Thermistor: 3UN7 or approved equal. Motors up to 1 hp shall have integral thermal overload protection.

Each electric motor shall be complete with a lamacoid name plate securely fastened in a conspicus place on the motor. The name plate shall be 2.5mm thick laminated phenolic plastic 90mm long x 40mm wide with black face and white center, 5.5mm high letters shall be engraved through to the white lamination with the following:

Motor No.

Mechanical Equipment Driven

Circuit No.

Panel No.

Clean thoroughly all fixtures and equipment from grease, dirt, plaster or any other foreign material. Chrome-plated fittings, piping and trimmings shall be polished upon completion.

The leakage testing of medium pressure ductwork shall comply with the following:

Air testing during erection shall include separate leakage air tests of each complete air riser, each completed horizontal distribution system, and, after all ductwork is installed and the central station apparatus is erected, leakage testing of the pressure side of the whole system up to the inlet of the variable air volume boxes.

The leakage test of the rectangular and conduit ductwork shall be made with pressure in the ductwork maintained at approximately 0.015kg/cm.^{2} (6in), obtained by operation of the air supply fan or, if the fan cannot be operated, by use of the test blower.

OPERATION AND MAINTENANCE INSTRUCTIONS

Three (3) copies (binded) of complete operating and maintenance instructions for all mechanical \ equipment and systems, bound in hard covered manuals, shall be supplied.

Operating instructions shall include:

A general description of the system. Equipment included, and control operation.

Instructions on how to start and stop the plant, noting any safety and/or, sequencing arrangements.

A 'trouble-shooting' table, showing where to look for trouble under various conditions of malfunction.

Operating temperatures at critical points in the systems.

Maintenance schedule shall include:

- A list of all bearings with type and period of lubrication.
- Equipment manufacturer's printed data of care and maintenance of bearings.
- System wiring and control diagrams and detailed descriptions of the operation of control systems.
- The Operating and Maintenance Instructions shall be handed to the Engineer not later than at the end of the commissioning period.

FINAL REPORT

General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing Engineer In-charge Include a list of instruments used for procedures, along with proof of calibration.

Final Report Contents: In addition to certified field-report data, include the following:

Pump curves.
Fan curves.
Manufacturers' test data.
Field test reports prepared by system and equipment installers.
Other information relative to equipment performance; do not include Shop Drawings and product data.

General Report Data: In addition to form titles and entries, include the following data:

Title page.
Name and address of the TAB team.
Project name.
Project location.
Engineer's name and address.
Engineer's name and address.
Contractor's name and address.
Report date.

Signature of TAB supervisor who certifies the report.
Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
Summary of contents including the following:

a. Indicated versus final performance.

b. Notable characteristics of systems.

c. Description of system operation sequence if it varies from the Contract Documents.

Nomenclature sheets for each item of equipment.
Data for terminal units, including manufacturer's name, type, size, and fittings.
Notes to explain why certain final data in the body of reports vary from indicated values.

Test conditions for fans and pump performance forms including the following:

a. Settings for outdoor-, return-, and exhaust-air dampers.

b. Conditions of filters.

c. Cooling coil, wet- and dry-bulb conditions.

d. Face and bypass damper settings at coils.

e. Fan drive settings including settings and percentage of maximum pitch diameter.

f. Inlet vane settings for variable-air-volume systems.

g. Settings for supply-air, static-pressure controller.

h. Other system operating conditions that affect performance.

System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

Quantities of outdoor, supply, return, and exhaust airflows.
Water and steam flow rates.
Duct, outlet, and inlet sizes.
Pipe and valve sizes and locations.
Terminal units.
Balancing stations.
Position of balancing devices.

Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

Unit Data:

a. Unit identification.

b. Location.

c. Make and type.

d. Model number and unit size.

e. Manufacturer's serial number.

f. Unit arrangement and class.

g. Discharge arrangement.

h. Sheave make, size in inches, and bore.

i. Center-to-center dimensions of sheave, and amount of adjustments in inches.

j. Number, make, and size of belts.

k. Number, type, and size of filters.

Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Filter static-pressure differential in inches wg.

f. Preheat-coil static-pressure differential in inches wg.

g. Cooling-coil static-pressure differential in inches wg.

h. Heating-coil static-pressure differential in inches wg.

i. Outdoor airflow in cfm.

j. Return airflow in cfm.

k. Outdoor-air damper position.

l. Return-air damper position.

m. Vortex damper position.

Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.

b. Location.

c. Coil type.

d. Number of rows.

e. Fin spacing in fins per inch o.c.

f. Make and model number.

g. Face area in sq. ft..

h. Tube size in NPS.

i. Tube and fin materials.

j. Circuiting arrangement.

Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.

b. Average face velocity in fpm.

c. Air pressure drop in inches wg.

d. Outdoor-air, wet- and dry-bulb temperatures in deg F.

e. Return-air, wet- and dry-bulb temperatures in deg F.

f. Entering-air, wet- and dry-bulb temperatures in deg F.

g. Leaving-air, wet- and dry-bulb temperatures in deg F.

h. Water flow rate in gpm.

i. Water pressure differential in feet of head or psig.

j. Entering-water temperature in deg F.

k. Leaving-water temperature in deg F.

l. Refrigerant expansion valve and refrigerant types.

m. Refrigerant suction pressure in psig.

n. Refrigerant suction temperature in deg F.

o. Inlet steam pressure in psig.

Fan Test Reports: For supply, return, and exhaust fans, include the following:

Fan Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangement and class.

g. Sheave make, size in inches, and bore.

h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

g. Number, make, and size of belts.

Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Suction static pressure in inches wg.

Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

Report Data:

a. System and air-handling-unit number.

b. Location and zone.

c. Traverse air temperature in deg F.

d. Duct static pressure in inches wg.

e. Duct size in inches.

f. Duct area in sq. ft..

g. Indicated air flow rate in cfm.

h. Indicated velocity in fpm.

i. Actual air flow rate in cfm.

j. Actual average velocity in fpm.

k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

Unit Data:

a. System and air-handling unit identification.

b. Location and zone.

c. Apparatus used for test.

d. Area served.

e. Make.

f. Number from system diagram.

g. Type and model number.

h. Size.

i. Effective area in sq. ft..

Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.

b. Air velocity in fpm.

c. Preliminary air flow rate as needed in cfm.

d. Preliminary velocity as needed in fpm.

e. Final air flow rate in cfm.

f. Final velocity in fpm.

g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

Unit Data:

a. System and air-handling-unit identification.

b. Location and zone.

c. Room or riser served.

d. Coil make and size.

e. Flowmeter type.

Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.

b. Entering-water temperature in deg F.

c. Leaving-water temperature in deg F.

d. Water pressure drop in feet of head or psig.

e. Entering-air temperature in deg F.

f. Leaving-air temperature in deg F.

INSPECTIONS

Initial Inspection:

After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

Check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.

b. Measure water flow of at least 5 percent of terminals.

c. Measure room temperature at each thermostat/temperature sensor. Compare the

reading to the set point.

d. Verify that balancing devices are marked with final balance position.

e. Note deviations from the Contract Documents in the final report.

Final Inspection:

After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer In-charge

The TAB team's test and balance engineer shall conduct the inspection in the presence of Engineer In-charge

Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

If the second final inspection also fails, Engineer may contract the services of another TAB team to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB team's final payment.

Prepare test and inspection reports.

OPERATION AND MAINTENANCE CHARTS

The Contractor shall supply four copies (also provide in soft copies) each of charts indicating schedule of:

- Daily start-up and shut down
- Emergency shut down

- Servicing and Maintenance, As well as charts listing
- Equipment model and serial Nos.
- Conditions of operation
- Normal settings of automatic and safety controls
- Data of accessories
- Motors manufacturer's name and address
- Reference No. of technical and spare part catalogues.

Air Handling Units (AHU)

PART ONE GENERAL

1.1 REFERENCE

1.1.1 Conform to General Requirements and Conditions for MEP Works, Division 1 Section 01 00 00.

1.1.2 Conform to Special Instructions for Mechanical Works Section 23 05 01.

All air handling units shall be ARI, AMCA or Eurovent certified. Provide Proof of certification along with submittals.

PART TWO PRODUCTS

2.1 QUALITY ASSURANCE

Furnish Double skin Central Station Modular Air Handling Units of type, size and capacity as set forth and called for in the equipment schedules. Units shall be constructed to comply with the requirements of material and workmanship according to the latest ASME Codes or equivalent. Units shall be tested before despatch and ready for installation, and their performance certified in accordance with ARI standard 430 or equivalent.

2.2 COMPONENTS

The units shall be complete with insulated casings, water proof insulated drain pan(s), coil(s), fan(s), motor and starter, adjustable motor and fan drives, V-belts, belt guards, filters, dampers as required, access doors, mixing box(es), vibration isolators and all other items necessary for satisfactory operation.

2.3 COORDINATION

The Contractor shall verify and confirm that the dimensions of the units offered by him are suitable for installation in the space available and he shall be responsible for ensuring that the units are capable of being installed in the available space.

2.4 DELIVERY, STORAGE AND HANDLING

Units shall be delivered factory assembled with protective crating and covering and their delivery coordinated in sufficient time to allow movement into building. The unit base shall be supplied with painted lifting lugs located to suit optimum hoisting stability. Units are to be handled as per manufacturer=s written rigging and installation instructions for unloading and moving to final location. Units shall be shipped fully assembled (within freight limitations) on a minimum 10-gauge galvanized steel base rail/ housekeeping pad.

2.5 EXTRA MATERIALS

Furnish extra materials described below that match products offered/installed, are packaged with protective covering for storage, and are identified with labels describing contents.

Fan Belts: One set for each belt-drive fan.

Filters: One set of filters(as specified) for each unit.

Fan Bearing: One set for each AHU.

2.6 COMPONENT FEATURES

2.7

2.8 UNIT CASING

2.9

2.9.1 GENERAL CONSTRUCTION

Unit shall be constructed of a complete frame with removable panels. Removal of side panels must not affect the structural integrity of each module. The casing must be able to withstand up to 6 in. positive or 4 in. negative static pressure. All exterior wall panels shall be made of minimum 18 gauge G90 galvanized steel. Closed- cell foam gasketing shall be provided where modules are joined to ensure that no thermal bridge occurs.

2.9.2 BASE AND FRAME

The unit base and upper frame shall be hot dipped galvanized.

2.9.3 WALL CONSTRUCTION

Units shall be double-wall constructed to prevent fiberglass erosion into the airstream and to allow cleaning of the unit interior. Interior wall shall be a minimum of 1 inch. thick of either 20-gauge solid plate galvanized steel.

Double-wall units shall be factory insulated with insulation of minimum density 12 lb/ft^3 (48 kg/m^3) insulation. The insulation thickness and density is to be selected by the manufacturer to ensure that the following minimum criteria are met:

Heat Transfer Coefficient: 0.20 Btu/h ft^2 ^{o}F (1.15 W/m^2 K)

Noise Attenuation Characteristics: As per table below

Frequency (Hz)	6	12	25	50	1 k	2 k	4 k	8 k	Overal l
SPL (dB)	1	11	15	25	26	27	27	27	<30

No condensation to occur on unit

Exterior when air around unit is at: 100^{o}F and 65% RH

All connecting channels shall be so designed and to insulated create thermal bridge to prevent sweating.

2.10 DRAIN PAN

Units shall have an insulated, double wall stainless steel pan under cooling coil section(s) for drainage of condensate. Minimum insulation requirements for the drain pan are as detailed in the section on >Wall Construction=. Drain connections are to be provided on both sides of the unit.

2.11 ACCESS DOORS AND PANELS

Full sized hinged removable double-wall access doors with two step safety handles shall be provided for quick access to the interior of the unit casing. Doors attached by screws or doors not continuously gasketed are not acceptable. All doors/panels shall be sealed with closed- cell foam gasketing.

2.12 SPACER

Each unit shall be provided with a 6" spacer section installed where scheduled.

2.13 VIEW WINDOW

An 8 x 10 in. view window shall be provided on modules where scheduled.

2.14 MARINE LIGHT

A marine light shall be provided on fan and access modules where scheduled.

2.15 PAINT

Units shall be finished with two coats of baked enamel/powder coating.

2.16 FANS

2.16.1 GENERAL

Fan(s) shall be rated in accordance with AMCA Standard 210. Fan(s) shall be indirectly connected with V-belt drive and selected to produce the capacity required at the static pressure indicated.

2.16.2 TYPE

Fan(s) shall be of the fully enclosed centrifugal type, double width, double inlet, forward curved, Class I; or backward inclined, Class I or II; or airfoil, Class I or II. Fan(s) shall be statically and dynamically balanced.

2.16.3 HOUSING

Fan housing shall be constructed of heavy gauge steel equipped with intake cones designed for smooth air flow. Fan discharge shall be connected to cabinet through a 6 in. deep canvas flexible connection

Housed fan performance shall be certified as complying with ARI Standard 430-89. Centrifugal fans shall be dynamically balanced at the factory as a complete fan assembly (fan wheel, motor, drive and belts). Fan shafts shall not exceed 75 percent of their first critical speed at any cataloged rpm.

2.16.4 DRIVE

Drive assembly shall consist of a solid steel turned, ground, polished and greased shaft with heavy duty, self-aligning, re-lubricatable ball bearings. Bearing grease zerks shall be extended to fan drive side.

V-belt drives shall be designed for not less than 150 percent of the connected driving capacity. Sheaves shall have at least two grooves, selected to drive the fan(s) at the specified RPM. Motor sheave shall be of the fixed (or adjustable) type.

Units of over 20,000 CFM (34,000 m3/h)shall be provided with a totally enclosed galvanized expanded metal belt guard. The belt guard shall be rigidly attached to the bearing support structure and have a two-piece removable front panel. A tach hole shall be provided opposite the fan shaft. The belt guard shall be a universal size to accommodate any applicable drive.

2.16.5 BEARINGS

Fans shall be equipped with self-aligning, anti-friction pillow block bearings with a minimum life of L-50 200,000 hours. Bearings shall be equipped with grease lines allowing for lubrication from one side of the fan.

2.16.6 MOTORS

Fan motors shall be Totally Enclosed Fan Cooled (TEFC) motors, foot mounted (B3) 4 pole, protection class IP54, insulation Class >F= , rated for temperature rise of 176oF,3 phase. Motor terminals to be arranged for DOL starting upto and including 5.5 KW and Star Delta start for sizes 7.5 KW and above.

2.16.7 ACOUSTIC PERFORMANCE

Minimum acceptable fan/AHU acoustic performance shall be as indicated in table below:

Frequency (Hz)	63	12	25	50	1 k	2 k	4 k	8 k	Overa
Fan Lw (dBA)	55	67	75	80	80	78	74	67	85
AHU Lw (dBA)	54	65	69	72	71	65	54	44	76
SPL* (dBA)	43	54	58	61	60	54	43	33	65

* Sound Pressure computed at 3.28 feet (1.0 m), in free field space

2.17 COILS

2.17.1 GENERAL

Coils shall be designed with aluminum plate fins and copper tubes.

Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall be mounted in the unit casing to be accessible for service and can be removed from the unit either through the side or top. Capacities, pressure drops and selection procedure shall be certified in accordance with ARI Standard 410.

2.17.2 WATER COOLING COILS

Water Cooling Coils shall be supplied where scheduled and shall conform to the following minimum specifications:

Coils shall be designed to operate at 250 psig (17.5 bar) design working pressure and up to 300^{o}F Coils shall be tested with 325 psig (22.75 bar) compressed air underwater.

Coil circuiting shall provide free draining and venting when installed, counter flow of air and water, with water velocities not to exceed 7FPS (128 m/min) and without exceeding the water pressure drops scheduled.

All coils shall be enclosed in a coil section. Coil headers and U-bends shall not be exposed. All coils must have same end connections regardless of the number of rows deep.

Coils shall have a supply header to ensure distribution of cold water to each tube of coil. Headers shall be either round copper or cast iron. Steel pipe headers are not acceptable.

Tubes shall be 2 in. or 5/8 in. OD.

2.18 HEAT PIPE /REHEAT COILS

2.18.1 GENERAL

Furnish and install the heat recovery units of the heat pipe air-to-air type as shown in the schedules.

Heat recovery units shall transfer heat between out-going and incoming air streams in counter flow arrangement.

2.18.2 HEAT PIPE HEAT EXCHANGER

Tube core shall be ID seamless, integrally finned aluminum tube with .166 inch (.42 cm) wall thickness.

Fin surface should be integral to the tube wall and should have a minimum of .017 inch (.043 cm) between fin thickness. Fin density is 11, 9, 7 or 5 fins per inch. Fin surface from root to the tip of the fin should have a minimum of .437 inch (1.11 cm) between fin height.

Circumferential capillary wick structure shall be integral to the inside wall of the tube. Capillary structure shall not interfere with the integrity of the wall of the tube.

Working fluid used shall be selected on the basis of heat pipe operating temperature and compatibility with tube and wick materials. Tubes shall be individually processed, charged, hermetically sealed and factory tested.

The exchanger frame shall be fabricated from minimum of 14 gauge galvanized steel. The frame shall be supplied with minimum 2 inches (5.1 cm) wide flanges on all four sides. Intermediate tube supports shall be furnished as required.

A partition shall be provided to isolate the outgoing and incoming air streams; there shall be no cross contamination. The partition shall be at the center unless specified. Partition shall be fabricated from a minimum 18 gauge galvanized steel and shall extend beyond the finned surface with 4 inches (10.2 cm) flanges [2 inches (5.1 cm) to supply side and 2 inches (5.1 cm) to exhaust side]. Both front and back to be flush with the frame.

End covers shall be provided to protect tube ends. Covers shall be fabricated in 18 gauge galvanized steel.

Each individual heat pipe shall be charged and tested at the actual maximum design air temperature before being installed within the frame.

2.18.3 INSTALLATION

2.18.3.1 INSTALLATION OF THE UNIT

The unit should be installed so that both fluids will be drawn up through the recovery cell.

2.18.3.2 LEVELING EXCHANGER

The heat exchangers could be installed with a slight slope, according to the manufacturers specifications..

2.18.3.3 SUPPORTING STRUCTURE

The exchangers should be secured rigidly, not to allow more than 1/8 inch (.32 cm) total deflection. The supply duct must never be fixed directly to the frame.

A support structure could be made to slide the unit for lceaning and installation purposes.

2.18.3.4 ACCESS DOORS:

Access doors should be provided to allow periodic inspection of the exchanger and to facilitate cleaning when necessary.

2.18.3.5 DRAIN PANS:

Sloped drain pans are recommended under the entire exchanger both as a condensed collection system and for cleaning purposes.

2.18.3.6 CODE REQUIREMENTS:

The installation of the exchanger should conform to all codes, laws and regulations applying at the job site.

2.19 FILTERS

2.19.1 GENERAL

Air handling units are to be supplied complete with filters as scheduled, and having the following minimum specifications:

2.19.2 PERMANENT FILTERS

These filters shall be 2 in. thick, efficiency upto 35% all metal viscous imprisonment type, capable of operating up to 600 FPM (182.9) face velocity without loss of filter efficiency and holding capacity. Filter media shall be layers of cleanable wire maze. Filter frame shall be constructed of galvanized steel.

2.19.3 BAG FILTERS

These filters shall be fine fiber, all glass media with spun backing to keep glass fibers from eroding downstream. Stitching method shall permit bag to retain pleat shape

without the use of wire basket support. Bag filters to be furnished with pre-filter to extend life of bag filter. Manufacturer shall supply side access filter rack capable of holding bag filters and 2 in. pre-filters.

Bag Filters are to be provided of 85% efficiency. Efficiency of filter to be determined by ASHRAE Standard 52-76. Filters shall be rated UL Class 2.

2.20 DAMPERS, MIXING BOXES AND PLENUMS

2.20.1 OUTSIDE AIR/RETURN AIR DAMPERS

Outside air/return air dampers shall be provided to modulate the volume of outside and return air. Dampers shall be of airfoil design and shall be either parallel or opposed blade type with metal compressible jamb seals and extruded vinyl blade edge seals on all blades. Blades shall rotate on stainless steel sleeve bearings. Maximum damper blade length shall be 60 in. Leakage rate shall not exceed 5 CFM/ft2 at 1 in. wg and 9 CFM/ft2 at 4 in. wg

2.20.2 FACE AND BYPASS DAMPERS

Face and bypass dampers shall be of airfoil design opposed blade type. Dampers shall have metal compressible jamb seals and extruded vinyl blade edge seals. Both dampers shall rotate on stainless steel sleeve bearings. Dampers shall be jackshaft driven, with both dampers mechanically linked together. Leakage rate shall not exceed 5 CFM/ft2 (0.79 m3/h$m2) at 1 in. wg (25.4 mm Aq.) and 9 CFM/ft2 (1.42 m3/h$m2) at 4 in. wg (101.6 mm Aq.).

2.20.3 MULTI-ZONE DAMPERS

Multi-zone damper section is to be designed as a single assembly with airfoil type blades. Dampers shall have metal compressible jamb seals and extruded vinyl blade edge seals. Dampers shall rotate on stainless steel bearings. Leakage rate shall not exceed 9 CFM/ft^2 (1.42 m^3/h m^2) at 1 in. wg (25.4 mm Aq.).

2.20.4 MIXING BOX

A Mixing Box module as scheduled, shall be provided by the manufacturer engineered to be used with the unit. The mixing box shall meet or exceed cataloged mixing capabilities.

2.20.5 AIR PLENUMS

Air Plenums as scheduled, shall be provided by the manufacturer engineered to be used with the unit. Plenum sections shall be provided for:

Providing an empty spacer section of scheduled length.

Providing an access into the Air handling unit complete with access door on either or both sides as scheduled.

Providing a conversion of the air supply and return configuration from front to bottom.

2.21 HEAT PIPES

Heat Pipes shall be provided to control the humidity (50 – 55 %) of FAHU'S leaving air .

Each individual heat pipe shall be charged and tested at the actual maximum design air temperature before being installed within the frame.

End covers shall be provided to protect tube ends. Covers shall be fabricated in18 gauge galvanized steel.

Working fluid used shall be selected on the basis of heat pipe operating temperature and compatibility with tube materials. Tube shall be individually processed, charged, hermetically sealed and factory tested as per above section 2.17.3.

2.22 COMMISSIONING & TESTING

The unit shall be commissioned and tested as per the Manufacturer's recommendations. Drives shall be adjusted to provide the required air flow rate and valves shall be adjusted for the proper water flows, etc. This Contractor shall be required to carry out tests, on forms to be supplied later by the Consultants, and obtain the Consultant's approval. Suppliers representative to be present during commissioning and testing to certify that units are commissioned as per manufacturers recommendations.

PART THREE EXECUTION

3.1 INSTALLATION

Install equipment in accordance with manufacturers written instructions. Provide letter from manufacturer certifying acceptance of installation.

Provide air-handling units in accordance with air handling unit's schedule.

Submit external static pressure calculations based on actual shop drawings for review before final selection or ordering of units.

Provide neoprene isolators between base of unit and concrete supports.

Pipe condensate pan drain outlet to floor drain complete with minimum 75mm deep seal trap.

Manufacturers authorized representative to certify installation is as per manufacturer's recommendation and assist in testing, balancing and commissioning.

HVAC Ducts and Specialties

PART ONE GENERAL

1.1 REFERENCE

1.1.1 Conform to General Requirements for MEP Works, Division 1 Section 01 00 00.

1.1.2 Conform to Special Instructions for Mechanical Works Section 23 05 01.

1.2 SUMMARY

1.2.1 Metal Ductwork applicable to all indoor supply, return, toilet exhaust, kitchen exhaust, parking exhaust, smoke exhaust and all duct work on roof and in shafts (including supply air, return air, exhaust air and fresh air).

1.3 SUBMITTALS

1.3.1 Shop Drawings: Submit duct fabrication drawings indicating:

- Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
- Duct layout, indicating sizes in plan view.
- Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.
- Manufacturer's Installation Instructions: Submit special procedures for glass fiber ducts.

1.3.2 Record actual locations of ducts and duct fittings. Record changes infitting location and type. Show additional fittings used.

1.4 QUALITY ASSURANCE

1.4.1 Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

1.4.2 Construct ductwork to NFPA 90A and NFPA 96 standards.

1.4.3 For Pre-insulated Ducts, no relevant reduction of insulation, chemical or physical characteristics of the panels to be measurable, when conveying air in the temperature range of –35°C to +110°C and pressure of 1.75kPa.

1.5 ENVIRONMENTAL REQUIREMENTS

1.5.1 Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.

1.5.2 Maintain temperatures during and after installation of duct sealant.

1.5.3 Protect all duct openings from dust and debris during construction.

PART TWO PRODUCTS

2.1 GENERAL

2.1.1 Access doors of adequate size and proper design shall be provided in all ductwork and air chambers to permit inspection and maintenance of valves, controls, dampers, coils, filters and bearings and must be shown on drawings. Access doors to be provided at 3 metre centres in Kitchen exhaust ducts to allow access for regular cleaning.No access ducts or hatches are acceptable in the Lobby area.

2.1.2 Manual volume dampers shall be provided in each branch duct for balancing and must be shown on the drawings.

2.1.3 Instrument test holes shall be provided for balancing.

2.2 MATERIAL

2.2.1 Ducts shall be constructed of galvanised iron unless specifically noted otherwise. conforming to ASTM A-525 and having a minimum coating of 0.275kg/m^2 z-27. The galvanizing shall be carefully done and the sheets shall be of such quality that they may bend flat on themselves with no fracture to the coating or the base metal.

2.2.2 The recommendations of ASHRAE/SMACNA shall be used as a guide for sizing, minimum gauges, bracing and construction details.

2.2.3 Fibreglass ducts, bearing the UL label and constructed in accordance with SMACNA standards, may be considered for use in low pressure systems.

2.2.4 Duct work exposed in B.O.T.H. areas shall be galvanised and not fibreglass.

2.2.5 GI duct work will be applicable for exhaust duct work for parking area.

2.2.6 Provide Welded non-corrosive exhaust ducts in steam areas.

2.2.7 Where duct is acoustically lined, duct dimensions shown are net, clear internal dimensions.

2.2.8 All round ductwork shall be shop or factory fabricated conduit "consisting of helically wound galvanized iron strips with spiral lock seam. Each duct section and fitting shall have a plain end and a belled or swaged end to permit a sliding fit with overlap not less than 100mm. Ninety degrees elbows shall have smooth center line -radius of 1.5 times duct diameter. Alternatively, they may be of five pieces construction. Forty-five degree elbows shall be of three piece construction.

2.2.9 All kitchen exhaust ductwork is welded steel, pitched back toward the hood with cleaning access doors every ten feet and at each elbow. No turning vanes or dampers are allowed. Fire insulation, not less than two-hour rated (or the minimum required by code), is applied to ductwork. Provide the cooking exhaust fan housing with a drain connection at the bottom to allow the cleaning solution to manually drain.

2.2.10 Kitchen range hood duct work shall be constructed of black iron with welded seams and liquid-tight joints. The system shall be designed in full compliance with NFPA-96 and the applicable local codes having jurisdiction. Provide 50 mm foil faced mineral woof

solution around all grease exhaust ducts with 0.8 mm aluminum jacketing and as per Ashrae/NFPA/SMACNA codes. Cleanouts and access shall be provided as per NFPA 96.

2.2.11 Branch duct work from moisture emitting equipment, e.g., dishwashers, pot sinks, etc., and indoor swimming pools, shall be constructed of copper, stainless steel or aluminium, with water-tight joints, pitched back toward the equipment. Electrolytic isolation shall be provided at connections to iron duct work. Fire dampers shall be provided in branches where connections are made to the Kitchen hood exhaust duct work.

2.2.12 Fire dampers shall be installed where required by NFPA-90A and the applicable local codes having jurisdiction and must be shown on the drawings. A schedule of fire dampers is to be provided as part of the maintenance manuals.

2.2.13 Flexible ducts

- Flexible Ducts shall be used as shown on drawings.
- They shall not pass through floors or fire walls and shall not exceed 1.5 m in length. Flexib1e ducts shall not be installed in inaccessible locations, such as above gypsum board ceilings without prior approval from the consultant.
- The flexible duct shall have a flame spread not exceeding 25 and smoke development not exceeding 50 per UL 723 test method.
- Thermal resistance of duct shall be more than R-1.06
- The flexible duct shall have an air leakage not exceeding 0.00151l/s at 11.94kPa static pressure
- The duct shall be rated for a maximum air velocity of 12.5 m/s.
- Flexible insulated ducts shall be UL 181 listed. Exterior jacket shall be metalized polyester vapor barrier with 2 ply black polyester core with aluminium foil exterior finish. Insulation shall be fiberglass, R-0.74 Core shall be double ply polyester laminated with carbon steel wire helix. The flexible duct shall have an inner air barrier factory applied insulation equal 40 mm thick flat insulation

PART THREE EXECUTION

3.1.1 All sheet metal ducts shall be as per size and location on drawings. If changes of size or location of ducts are found necessary because of building construction, these may be done with prior submission to and approval by the consultant.

3.1.2 All laps shall be in the direction of air flow and all edges and slips hammered down so as to leave smooth finished surface inside the ducts.

3.1.3 All ducts shall be braced and stiffened and shall be tight so that they will not breathe, rattle, vibrate or sag. Cross-break or transverse bead all rectangular ducts with heights or widths of 300mm or larger.

3.1.4 Duct sealant by an approved manufacturer shall be used. Brush joints with the compound before and again after assembly. Exposed ducts shall be sealed on the inner surfaces only.

3.1.5 Flexible duct connections shall be by an approved manufacturer andshall be provided at

each building expansion joint, air handling unit and fan duct connection. Connections shall be 20 oz. minimum fire retardant canvas. For fan discharge connections in excess of 1000 Pa or where located outdoors, provide connections of fire retardant glass fibre cloth with a neoprene coating. Connection material shall be reviewed by the Engineer before installation.

3.1.6 Flexible duct connections shall be Class 1, corrugated aluminum flexible duct suitable for 120°C and 1.5 kPa and shall be Underwriters Laboratories listed. Flexible duct connections shall be insulated with 25mm insulation complete with vapor barrier.

3.1.7 Bends in flexible ducts shall have centre line radius of not less than 10 x diameter. Collars to which flexible ducts are attached shall be a minimum of 50mm in depth. Insulation and vapour barriers on factory-fabricated ducts shall be fitted over cone connection and supplementally secured with a drawband.

3.1.8 Where ductwork passes through a wall or floor, other than when a fire damper is required, pack around the duct using a fire resistant material to ensure a sound and air tight joint.

3.1.9 Access ports (32 mm round) at convenient locations in all main ducts and main branch take offs, complete airtight covers and extension sleeves through insulation shall be provided to allow air meter readings.

3.1.10 Manual duct dampers as shown and as required for proper balancing of the system shall be provided and installed. Dampers shall be of galvanized steel 18 U.S. ga: or heavier. Dampers for ducts up to 300mm deep shall be single blade carried on a 10mm square steel rod mounted inside the duct. Dampers for ducts of greater depth than 300mm shall be multi-blade, opposed-acting type and shall have blades mounted in 40mm channel frame, and interconnected for operation from one locking type hand quadrant.

3.1.11 Splitter dampers as shown and as required for proper balancing of the system shall be provided. The splitter shall be made of at least the same thickness of galvanized steel as the duct in which it is installed, down to a minimum of 20 U.S. gauge, and shall be securely hinged at the air leaving edge, and made of two thicknesses, so that the entering edge presents a round nose to the air flow. The length of the splitter shall be at least 1.0 times the width of the smaller branch duct, but in no case less than 300mm long. Splitter hinge shall be attached and hinged to the splitter near the air entering edge, and shall pass through a clamp on the side of the duct which is most accessible far adjustment, to permit positioning and anchoring of the damper.

3.1.12 Gravity backdraft dampers shall be multi-blade louver type, constructed of light grade aluminum. Blades shall be joined with a tie bar and have rust-proof shafts rotating in oil impregnated bronze or plastic bushings.

3.1.13 Motorized dampers for control operation are specified under specification Division 25,Building Management System.

3.1.14 Fire dampers shall be UL listed. Unless otherwise permitted by the Engineer all curtain-type fire dampers shall be Type B with curtain completely clear of the air stream. Fire dampers shall be installed the manner in which they were twisted and shall meet all applicable codes. Fusible links shall be rated for 100°C unless otherwise damper shall have the same fire rating as the wall in which they are installed Fire dampers installed in duct where air flow may still exist during a fire shall be dynamic type.

3.1.15 Access panels as shown on drawings and as required for convenient access shall be

provided at all fire dampers, gravity dampers, motorized dampers, coils, fan' bearings or similar equipment requiring occasional maintenance or inspection. Panels shall be 600mm x 450mm or full width of duct if less than 450mm width. Panels shall be of double wall construction shall be internally insulated on insulated ducts. Frame shall be of structural angle welded corners, gasketted to receive the panel. Panel shall be held in place with 4 win o sash locks. All access doors for fire dampers shall be labeled "Fire Damper and their location shall be indicated on “shop” and ''as-built'' drawings.

3.1.16 All ductwork shall be installed securely and in a rigid manner with hangers provided as per schedules below:

1.1.1. *HORIZONTAL RECTANGULAR DUCT*	
Max. Duct Dimension (mm)	**Hanger Construction Dimensions (mm)**
Up to 500	two 25 x 16 U.S. ga. straps on 2400 mm centers with, two screws on side of duct, one on bottom
501 to 1500	25 x 25 x 6 trapeze hanger with two 10 mm rods on 2400 mm centers.
1501 to 3000	50 x 50 x 6 trapeze hanger with two 10 mm rods on -2400 mm centers.
3001 to 6000	63 x 63 x 5 trapeze hanger with two 10 mm rods on 1200 mm centers.

1.1.2. *HORIZONTAL ROUND DUCT if any*	
1.1.3. *Duct Diameter, 41 (mm)*	1.1.4. *Hanger Construction Dimensions (mm)*
up to 150	one 25 x 16 U.S. ga. hanger ring supported from one 25 x 16 U.S. ga hanger strap on 2400 mm centers.
151 to 450	one 25 x 14 U.S. ga. hanger ring supported from one 25 x 14 ga. hanger strap on 2400 mm centers.
451 to 900	one 25 x 12 U.S. ga. hanger ring supported from one 25 x 12 U.S. ga hanger strap on 2400 mm centers
901 to 1200	one 38 x 12 U.S. ga. hanger ring supported from one 38 x 12 U.S. ga. Hanger strap on 2400 mm centers
1201 to 2100	two 38 x 12 U.S. ga. hanger connected to the 32 x 32 x 3 mm angle girth reinforcing of duct, hangers on, 2400 mm centers

3.1.17 All vertical ducts shall be supported at each floor with angles, riveted to the ducts.

3.1.18 Construct low pressure rectangular duct as follows:

Low pressure ducts: duct velocities less than 0.944m^3/s and static Pressures in duct 5.97 kPa or less.

Dimension Longest Side (mm)	Sheet Metal all 4 sides (U.S. g.a.)	Reinforcing Between Joints (Angle)	Joints and Reinforcing at Joints	Height of Standing Leg (mm)
0 to300	24	None	Drive slip(sides only) Plain "S" Slip	25
301-450	24	None	as above	25
451-760	24	25 x 25 x 3 at 1500 centers	Hemmed "S" Slip Bar Slip3040 centres	25
761-1060	22	25 x 25 x 3 at 1500 centers	Alternate or reinforced 25x3 Bar Slip 3040 centres	25
1061-1370	22	38 x 38 x 3 at 1200 centers	Alternate or reinforced 38x3 Bar Slip2400 centres	38
1371-1520	20	38 x 38 x 3 at 1200 centers	Reinforced 38x3 Bar Slip 2400 centres	38
1521-2130	20	38 x 38 x 3 at 600 centers	Reinforced 38x3 Bar slip 1200 centres	38
2131-2430	18	38 x 38 x 3 at 600 centers angles	Companion 38x38x3 at 1200 centres	38
2431-3040	18	50 x 50 x 4 at 600 centers angles	Companion 50x50x4 at 1200 centers	50

3.1.19 Bracing spacing shown above shall be maximum spacing between two bracings or between bracing and joint. Locate bracings mid-way between joints.

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

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

3.1.21 Longitudinal joints shall be Pittsburgh lock seam at edge of duct and grooved seam on face of duct.

3.1.22 Construct medium pressure rectangular ducts as follows:

Max Duct Dimension (mm)	*Sheet Metal (U.S. ga.)*	*Transverse Join Connection and Bracing Dimensions (mm)*
up to 300	*24*	*25 standing seam, 16 welded flange, 1 pocket lock no bracing*
301 to 450	*24*	*25 standing seam, 22 welded flange, 1 pocket lock, bracing 25 x 25 x 16 U.S. ga. at 1200*
451 to 600	*22*	*38 standing seam, 35 welded flange, 28 pocket lock, bracing 25 x 25 x 3 at 1200*
601 to 900	*22*	*38 standing seam, 38 pocket lo'1k, bracing 25 x 25 x at 800*
901 to 1200	*22*	*50 standing seam or 50 flanged joint, bracing 12 x 3 at 760*
1201 to 1500	*20*	*38 standing seam or 38 flanged joint with tie rod in centre, bracing and 50 x 50 x 3 at 600*
1501 to 1800	*20*	*50 standing seam or 38 flanged joint with tie rod in centre, bracing 63 x 63 x 5 at 600*
1801 to 2100	*18*	*50 standing seam or 38 flanged joint with tie rod in centre, bracing 63 x 63 x 5 at 600*
2101 to 2400	*18*	*50 standing seam or 38 langed joint with tie rod In centre, bracing 38 x 38 x 3 at 600, with tie rod in centre*
Over 2400	*18*	*50 standing seam or 50 langed joint with tie rod at 1200, bracing 50 x 50 x 3 at 600 with rod in centre*

3.1.23 Bracing spacing shown above shall be maximum spacing between two bracing or between bracing and joint. Bracings shall be located mid-way between joints.

3.1.24 Longitudinal joints shall be Pittsburgh lock seam at end of duct and grooved seam on face of duct.

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

3.1.26 All ductwork, exposed to view wilt be painted as per Division 1, Section 099000.

HVAC Insulation

PART ONE GENERAL

1.1. Reference

1.1.1. Conform to General Requirements and Conditions for MEP Works, Division 1 Section 01 00 00.

1.1.2. Conform to Special Instructions for Mechanical Works Section 23 05 01.

1.1.3. Refer to detail sheet in the drawing package.

1.2. REFERENCE STANDARDS

1.2.1. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

1.2.2. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

1.2.3. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

- ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- ASTM C168 - Terminology Relating to Thermal Insulation Materials.
- ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- ASTM C553 - Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- ASTM C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
- ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
- ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
- ASTM E84 - Surface Burning Characteristics of Building Materials.
- ASTM E96 - Water Vapor Transmission of Materials.
- ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

- ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- NFPA 255 - Surface Burning Characteristics of Building Materials.
- SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
- UL 723 - Surface Burning Characteristics of Building Materials.
- ASTM E2336 - Standard for Grease Ducts.
- ASTM D5590 - Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay

1.3. QUALITY ASSURANCE

1.3.1. All HVAC items requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.

1.3.2. All insulation required for the work shall be new, of first-class quality and shall be furnished, delivered, erected and finished in every detail, and shall be so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality is specified, a first-class standard article as approved by the Architect shall be provided.

1.3.3. All piping and Ductwork Insulation shall be Rigid Insulation, and must meet Greenhouse Gas and Ozone Depletion Potential: Only use CFC- and HCFC- free products.

1.3.4. Flame Retardants: must be PBDE-free products.

1.3.5. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this Section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

1.3.6. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.

1.3.7. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy Work will not be acceptable.

1.4. SUBMITTALS

1.4.1. Product Data:

1.4.2. Provide product description, list of materials, "k" value, "R" value, mean temperature range, and thickness for each service and location.

1.4.3. Operation and Maintenance Data:

Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type.

Manufacturer's Installation Instructions: Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.

1.5. DELIVERY, STORAGE AND HANDLING

1.5.1. Deliver, store, protect, and handle products to the Project Site under provisions of Division 01.

1.5.2. Deliver materials to Site in original factory packaging, labeled with manufacturer's identification including product thermal ratings and thickness.

1.5.3. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

1.5.4. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.

PART TWO PRODUCTS

2.1. INSULATION SCHEDULE

Insulation shall be as per following schedule:

2.1.1. CHILLED & HOT WATER

Piping below 50mm∅	Elastomeric Foam Insulation 40mm thickness.
Piping above 50mm∅	Elastomeric Foam Insulation 50mm thickness.

2.1.2. CONDENSATE PIPING

Cold Condensate	Elastomeric Foam Insulation 25mm thickness
FCU Condensate	Elastomeric Foam Insulation 25mm thickness

2.1.3. STEAM AND STEAM CONDENSATE PIPING

Piping below 1-1/2" ∅	Glass fiber Insulation 38mm thickness
Piping above 2" ∅	Glass fiber Insulation 75mm thickness

2.1.4. SHEET METAL DUCTWORK

Indoor	Closed Cell Elastomeric Insulation 25mm thickness.
Exposed cold air ducts	Closed cell elastomeric Insulation 50 mm thick.
Outdoor	Closed Cell Elastomeric Insulation 25 mm thick.
Fire Ducts	Rockwool Blanket with GI wire mesh 96 Kg/m^3 density finished insulating cement and painted.
Kitchen Hood Ducts	Calcium silicate block insulation wire mesh and finished with insulating cement and painted.

2.1.5. EQUIPMENT

Material and Finishes

Hot water converters and hot water expansion tanks	50mm thick, 96 kg/m^3 density, rigid board, fibreglass insulation.
Expansion tanks,	25mm thick, Elastomeric Insulation.
Emergency generator exhaust gas flue piping and generator muffler.	50mm thick asbestos free, calcium silicate block insulation.

2.2. ACOUSTIC DUCT LINER

2.2.1. Fibre glass duct liner with fabric on air side, to ASTM C1071 type 2 rigid board type, 48kg / m^3 density; 121°C maximum service temperature: maximum face velocity on fabri side 20.3m/s; non combustible; 25mm thick.

2.2.2. Application: 25mm thick where shown on drawings.

2.3. GLASS FIBER INSULATION

2.3.1. Insulation: ASTM C547; rigid molded, noncombustible.

- 'k' ((btu*in)/(hr*ft²*deg F)) value : ASTM C335

Temperature (degrees F)	Maximum 'k' value (btu*in)/(hr*ft²*deg F))
75	0.23
100	0.24
150	0.25
200	0.28
300	0.34
400	0.42
500	0.51

- Minimum Service Temperature: 0 degrees F.
- Maximum Service Temperature: 1000 degrees F.
- Maximum Moisture Absorption: 0.2% by volume.

2.3.2. Vapor Barrier Jacket

- ASTM C1136, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
- Moisture Vapor Transmission: ASTM E96; 0.02 perms.
- Secure with self-sealing longitudinal laps and butt strips.
- Secure with outward clinch expanding staples and vapor barrier mastic.

2.3.3. Vapor Barrier Lap Adhesive: MIL-A-3316C, Class 2, Grade A compliant. Compatible with insulation. VOC Limit 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3.4. Insulating Cement: ASTM C195; hydraulic setting on mineral wool. VOC Limit 70 g/L (multipurpose construction adhesive).

2.3.5. Fibrous Glass Fabric: Cloth, untreated; 9 oz/sq yd weight with 1.0 lb/cu ft density blanket.

2.3.6. Indoor Vapor Barrier Finish: Vinyl emulsion type acrylic, compatible with insulation, white color. VOC Limit 50 g/L.

2.4. CELLULAR ELASTOMERIC FOAM

2.4.1. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

- 'k' ((btu*in)/(hr*ft2*deg F)) value: ASTM C177 or C518; 0.22 to 0.28 at 60 degrees F.
- Minimum Service Temperature: -20 degrees F.
- Maximum Service Temperature: 180 degrees F.
- Maximum Moisture Absorption: ASTM C209; 0.2 percent by volume.
- Moisture Vapor Transmission: ASTM E96; 0.08 perm inches.
- Maximum Flame Spread: ASTM E84; 25.
- Maximum Smoke Developed: ASTM E84; 50.
- Connection: Waterproof vapor barrier adhesive.
- Provide documentation indicating that product contains no urea formaldehyde.
- Fittings: Pre-fabricated closed cell fittings of like material and thickness as adjacent pipe insulation.
- In all exposed finished areas without jacketing, provide white insulation, otherwise use black.

2.4.2. Elastomeric Foam Adhesive:

- MIL-A-24179A, Type II, Class I, compliant. Air dried, contact adhesive, compatible with insulation. VOC Limit: 50 g/L or less when calculated according to 40 CFR 59, Subpart D.

2.4.3. Foam Hangers:

- Closed-cell, lightweight polymeric rigid, high-compressive strength foam insulating pipe support, that is lined with closed-cell EPDM foam rubber, and encased in a zero-perm, weather-proof, corrosion-proof, EPDM polymer membrane with a high-performance pressure-sensitive closure system.
- Insulation will not compress or crush under loads imposed by active piping systems and their contents resting on the insulation material between the pipe and the pipe hanger.
- Shall provide an anti-abrasion surface for contact with all types of piping materials, and absorb the vibrations associated with operational pipe systems.
- Shall be UV and moisture resistant.

2.4.4. Outdoor Duct Insulation;

- Service temperature range from –60 degrees F to 180 degrees F.
- Meets ASTM C 177 or C 518 and shall have minimum ‘k’ value of 0.27 Btu-in. / hr-ft2-degrees F at minimum density measurement of 3 lb/cu ft.
- The insulation and outside surface must be protected with a flexible clad/membrane system like white Thermo Plastic Rubber Membrane or as approved by consultant, that must be formulated to:

- Be resistant to UV, and ozone, acid rain, and physical elements produced from outdoor weather per ASTM E 96 Procedure A.
- Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.
- Show no evidence of continued erosion, delaminating, cracking, flaking, or peeling when tested in accordance with the test method for erosion resistance in UL181. Be resistant to mold growth resistance, ASTM G 21/C 1338 resistant to fungi, and resistant to bacteria growth per ASTM G 22.

2.5. INSULATION BLANKETS FOR STEAM AND CONDENSATE FLANGED VALVES AND EXPANSION JOINTS

2.5.1. Insulation: Tight-fitting, reusable insulation blanket consisting of high-density insulation (fiberglass, mineral wool, ceramic fiber) covered on outside with coated glass fabric having heavy adjustable straps with buckles. Inside of blanket shall be covered with fabric suitable to specified temperature of stainless steel square mesh woven wire cloth. Insulation shall be a minimum of 1-1/2" thick and shall be suitable for temperatures up to 500 Deg. F.

2.6. JACKETS AND FACINGS

2.6.1. PVC Plastic

- Jacket: ASTM C921, One piece molded type fitting covers and sheet material, white color.

2.6.2. Minimum Service Temperature: 0 degrees F.

- Maximum Service Temperature: 150 degrees F.
- Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
- Maximum Flame Spread: ASTM E84; 25.
- Maximum Smoke Developed: ASTM E84; 50.
- Thickness: 20 mil.
- Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.
- Covering Adhesive Mastic: Compatible with insulation and PVC jacket. VOC Limit 50 g/L according to 40 CFR 59, Subpart D (EPA Method 24).
- Aluminum Jacket: ASTM B209.
- Thickness: 0.040 inch.
- Finish: Smooth.
- Joining: Longitudinal slip joints and 2 inch laps.
- Fittings: PVC pre molded fittings.
- Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART THREE EXECUTION

3.1. EXAMINATION

3.1.1. Verify that piping and ducting has been tested before applying insulation materials.

3.1.2. No installation shall be applied to any surface, until all foreign matter has been removed from the surface to be installed. All insulations shall be applied in a manner consistent with good practice and method.

3.2. INSTALLATION

3.2.1. Install materials in accordance with manufacturer's instructions.

3.2.2. Painting of cellular foam insulation is not allowed.

3.2.3. On exposed piping, locate insulation and cover seams in least visible locations. For cellular foam insulation tape ALL visible seams with tape matching insulation color.

3.2.4. Insulation shall be continuous through floors, walls, partitions, etc. except when otherwise indicated or specified. Where space will not permit application of insulation in wall or slab chase, the chase shall be packed full of 85% magnesium mineral wool asbestos rope, or fiber glass and protected with covers plates as approved by the consultants.

3.2.5. For cold air ducts, fiberglass insulation shall have vapour barrier jacket with approved quality adhesive as specified in Section 2.4 above. Care shall be taken such that vapour barrier is not damage / pierced during installation, and any damage will be repaired with the same quality of vapour barrier. The installation shall be firmly fixed on the ducting / plenums with approved quality adhesive compound recommended by the installation manufacturer's or as specified aboive. Adhesive to be approved by Consultant. The adhesive shall cover at least 25% duct area on the side and top, and 50% area at the bottom. All circumferential and longitudinal joints shall be lapped at least 50 mm and fully sealed with adhesives. Where rectangular ducts are 600 mm in width or greater, the insulation shall further mechanically secured to the ducts, and at least 25 mm wide metal bands shall be applied at the corners so that the mechanical fastener does not pierce the insulation and vapour barrier.

3.2.6. The insulation shall be applied to the full length of the ducts, including portions where internal sound absorber liner etc is fixed.

3.2.7. All access doors and removable panels shall be insulated and jacketed separately. The insulation jacket ends on the duct and door or panel shall be sealed with 50 mm wide PVC vapour seal self-adhesive type tape to prevent damage to the insulation due to use and servicing. External and weather exposed insulated ducting shall be insulated as specified and then protected with a jacket of 20 kg roofing felt, all joints sealed with hot bitumen PBS PB4 or approved equal. The jacket shall be further mechanically secured to the duct with 6 mm wide soft aluminum bands, generally spaced at 450 mm. Indigenous coarse cloth, canvas roofing felt and asphalt impregnated kraft paper of approved quality are to be used.

3.2.8. All cements and adhesives shall be as recommended by the manufacturer of the insulation. Insulation, insulation jacket, canvas and adhesive shall be fire retardant with a flame spread not larger than 25 and a smoke developed rating not larger than 50 11 when tested in accordance with standard E 84-61 of the ASTM. All adhesives must meet the acceptable VOC limits <50 g/L.

3.2.9. Insulation shall be installed in accordance with the manufacturer's printed installation instructions.

3.2.10. Valves and fittings shall be insulated with the same material as the pipe.

3.2.11. At each hanger or support for chilled water piping, the contractor shall install a section of high-density insulation between the pipe protection saddle and the pipe. Only the lower half of insulation, at hanger, will be replaced by an insert of high-density material so the top of pipe insulation and vapour barrier can be continuous. The high-density insulation shall be calcium silicate or a polymeric rigid EPDM foam rubber. Seal with vapour barrier mastic.

3.2.12. Insulation for diesel or gas engine exhaust pipe and muffler shall be 50mm (2") thick calcium silicate. Do not insulate expansion bellows. Insulation shall be protected with 1.0mm aluminum cladding.

3.2.13. Where pipes are exposed to outside or unconditioned exposed spaces, they shall be covered with 0.8 mm thick Aluminium cladding.

3.2.14. Insulation for pipes, duct and other equipment in mechanical rooms and where exposed to weather; shall be enclosed in 0.8mm thick aluminum cladding with all joints sealed and arranged to shed water.

3.2.15. Where thermal insulation is applied to the outside, equipment and plant used to convey, store or generate fluids or gases at temperatures lower than the design ambient dew point temperature a water vapour barrier shall be provided. The vapour barrier shall be applied such that it is continuous and gives protection to the whole surface of the insulation, which it protects. It shall not be pierced or otherwise, damaged by supports or by the application of external cladding. At points of support, means of load distribution shall be provided as necessary.

3.2.16. Apply insulation in strict accordance with manufacturer's recommendation including all seals and adhesive taking care of compatibility of such adhesives with the insulation. Submit manufacturer's data and compatibility recommendations for review.

3.2.17. Fiberglass insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

- Provide vapor barrier jackets, factory applied or field applied.
- Insulate fittings, joints, flanges, unions, strainers, flexible connectors, and valves with molded insulation of like material and thickness as adjacent pipe. PVC or aluminum covers are required in all exposed locations as in mechanical rooms.
- Finish with glass cloth and vapor barrier adhesive.
- Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
- Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

3.2.18. Cellular foam insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

- Insulate fittings, joints, flanges, unions, strainers, flexible connectors, and valves with molded insulation of like material and thickness as adjacent pipe. PVC or aluminum covers are required in all exposed locations as in mechanical rooms.
- Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

- Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- Provide rigid foam hangers as specified above between hanger and pipe.

3.2.19. Fiberglass insulated pipes conveying fluids above ambient temperature:

- Provide vapor barrier jackets, factory applied or field applied.
- Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. PVC covers are required in all exposed locations.
- Finish with glass cloth and adhesive.
- Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
- For hot piping conveying fluids, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- For steam and condensate piping, insulate flanges and unions.

3.2.20. Finish insulation at supports, protrusions, and interruptions.

3.2.21. For pipe exposed below 10 feet above finished floor, finish with PVC jacket and PVC fitting covers.

3.2.22. For piping exposed in mechanical rooms below 10 feet above finished floor, finish with aluminum jacket and aluminum fitting covers.

3.2.23. All valves in insulated systems shall have valve stem extensions. Insulation installer shall notify the contractor and Owner if valves without stem extensions are encountered. All valves without stem extensions in areas where stem extensions are required shall be replaced.

3.2.24. Install insulation blanket on steam and condensate valves.

3.2.25. Provide insulation clearance and access to valves and fittings in hangers and from structure and other equipment. Insulation shall be continuous through all hangers and supports.

3.2.26. Foam or closed cell insulation on black or galvanized iron pipe operating below ambient temperature is not permitted.

Pipes, Fittings and Valves

PART ONE GENERAL

- All chilled water & condenser water piping shall be Seamless Black Steel Schedule 40 conforming to ASTM A53 and shall be provided as per List of Approved Manufacturer.

- Fittings for steel pipes through 2 inches shall be screwed conforming ANSI B16.3 and larger than 2 inches shall be flanged conforming ANSI B 16.9. Welded fittings shall be seam-less, butt welding type, compatible to the schedule of the pipes.

- Flanges shall be slip on type and shall conform to ANSI16.5. All fittings & flanges shall be suitable for 300 psi (20.7 bar) working pressure.

- Condensate drain piping shall be uPVC class E ASTM D1785 or BS3505 with solvent welded fitting for installation inside the building and GI pipe class B (medium) BS1387 with threaded fittings for roof and outside the building installation. Pipe shall be provided as per List of Approved Manufacturer.

- Copper piping shall be seamless pipe ASTM B88 type K plain ends with wrought copper fitting ANSI B16.22

PIPE SUPPORTS:

General: pipe hangers, brackets, saddles, inserts, clamps and pipe rolls including rods, bolts, turn buckles, bases and protection shields shall conform to standard recommended engineering practice, using stock or production parts wherever possible. Chain, wire, strap or other makeshift devices will not be permitted as hangers or supports.

a) Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and pipe weight load at each equipment connection. Pipe hangers shall be capable of supporting the pipe in all conditions of operations. They shall allow free expansion and contraction of the piping and prevent extra stress resulting from transferred weight being included in the pipe or connected equipment. Hangers shall be supported from beams, clamps, concrete inserts Phillips concrete fasteners, and power actuated drive pins. Concrete inserts when used shall be installed in the exact location prior to the pouring of the concrete.

b)

(a) Suspended Horizontal Piping: shall be supported by adjustable hangers or supports, which shall provide a means of vertical adjustment after erection. Unless otherwise indicated on drawings maximum spacing between pipe

supports for straight runs of pipe shall be in accordance with recommended spacing shown in accordance with recommended spacing shown in the table given below:

c)

Nominal Pipe Size	0.5	0.75	1	1.5	2	2.5	3	4	5	6	8	10
Inches (mm)	13	20	25	40	50	65	75	100	125	150	200	250
Maximum Span Feet (Meters)	5	6	7	9	10	11	12	14	16	17	19	22
	1.5	1.8	2.1	2.7	3	3.3	3.6	4.2	4.8	5.2	5.8	6.7
Rod Size dia. mm.	10	10	10	10	10	13	13	16	16	19	22	22

d)

e) Pipe hangers and supports shall be spaced not over 5 feet (1.5m) apart at heavy fittings and valves.

f)

g) A hanger shall be installed not over 1 foot (0.3m) from each change in direction of piping. Where necessary to prevent vibration transmission, the support closest to the sources of vibration shall be spring cushion, or other approved type of isolation hanger. Where the piping system is subject to shock loads, such as thrusts imposed by the actuation of safety valves, hanger design shall include provision of shock absorbing devices of approved design. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.

h)

(c) Vertical Piping: shall be guided or supported in the center of each riser but not over 15 feet on center and shall be supported at the base of the riser on a base elbow or tee with a pipe stand only where required. For un-insulated brass or copper pipe or tubing, the riser clamp shall be compatible nonferrous or electrolytically coated steel as for hangers.

(d) Piping in trenches: Pipes shall rest on suitable wall floor supports with rollers.

(e) Pipe Sleeves: Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction or afterwards if necessary. Each sleeve shall extend through its respective wall, floor or roof and shall be cut flush with each surface. Sleeves shall be of such size as to provide a minimum of 1/4" all around clearance between bare pipe and sleeve or between jacket over insulation and sleeve. Sleeves in bearing walls shall be steel or cast iron pipe. Sleeves in non-bearing walls, floors, or ceiling may be steel pipe, cast iron pipe or G.I. sheet metal gauge

14, with lock type longitudinal seam. Sleeves in bearing walls shall be steel or cast iron pipe.

INSTALLATION:

(a) General: Chilled water piping shall include all piping and connections between water chillers, pumps and terminal units.

i)

j) All stop valves, check valves, globe valves, (calibrated balancing valves) control valves, drain cocks, expansion joints, compensators, automatic air vents, thermometers, pressure gages, strainers and other specialties required for proper operation of the whole system shall be provided, even if not indicated on the drawings.

Pipes shall be cut accurately to measurements established at the job site and worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping insulation will not be permitted without written approval. Layout drawings required under the title of "APPROVAL OF MATERIAL AND EQUIPMENT" shall show locations of all supports, the load imposed on each fastening or anchor, typical details for special anchorage, and details for special anchorage for supports attached to metal roof decking, for suspended piping, valves, tank, pumps, converters, and other mechanical equipment. Supports shall be attached to metal decking. Where supports are required between structural framing shall be provided and detailed. Pipe shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints and hangers. Changes in direction shall be made with fittings, except that bending of pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks wrinkles, flattening or other mal-formations will not be accepted. All piping shall be installed with sufficient pitch to ensure adequate drainage and venting. Piping connections to equipment shall be provided with unions or flanges. Open ends of pipelines or equipment shall be properly capped or plugged during installation to keep dirt and other foreign matters out of the system.

(b) Screwed joints shall be used on pipes of diameter 2" and below. Screwed joints shall be made with tampered threads properly cut. Joints shall be made tight with a stiff mixture of litharge and glycerin, or polytetrafluoroethylene tape, or approved thread joint compound applied to the male thread only. Not more than three threads shall show after the joint is made up.

(c) Welded joints shall be used on pipes of diameter above 2" Welded joints shall be fusion-welded by metal arc welding method unless otherwise required. Changes in direction of piping shall be made with welding fittings only. Mitering or

notching pipe to form elbows and tees or other similar construction will not be permitted. Branch connections shall be made with welding tees or forged welding tees or forged welding outlets.

k) Field and shop bevels shall be in accordance with the recognized standards and shall be done mechanically by means of flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of scale and oxidation prior to welding.

Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be so aligned that no part of the pipe wall is offset by more than 29% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operation.

Removing and replacing defective welds shall be at no additional cost to the Owner. Repairing of defective welds by adding new material over the defects or by penning will not be permitted. Electrodes shall be stored in a dry heated area and shall be kept free of moisture or dampness during fabrication operations. Electrodes that have lost part of their coating shall be discarded.

(d) Flanges and Unions shall be faced true. Flanges shall be provided with compressed fibre gasket, and made square and tight. Except where copper tubing is used, unions or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment such as coils, pumps, control valves and other similar items.

(e) All Anchors, nuts, bolts, screws, fasteners and rivets shall be of from approve manufacturer's list.

VALVES:

GATE VALVES:

Gate valves upto 2 inches shall be with threaded ends, bronze body, with union bonnet, non-rising stem and wedge disc. Hand wheel nut, packing nut, gland, stuffing box, bonnet, bonnet ring, disc and body shall be of bronze. Hand wheel shall be of malleable iron. Packing shall be graphited asbestos. Stem shall be manganese bronze.

Gate valves 2.5 inches and above shall be cast iron body bronze mounted with flanges ends.

These shall be of solid wedge disc type, with outside screw and yoke. Body and bonnet shall be of cast iron. Wedge shall be of cast iron with bronze disc. Seat rings shall be bronze. Packing gland shall be cast iron. Yoke shall be of cast iron and yoke nuts shall be of bronze. Hand wheel shall be of cast iron.

All valves shall be rated for ANSI 150 Lbs., 300 psig & 200°F working pressure and temperature, shall be provided as per List of Approved Manufacturer.

GLOBE VALVES:

Globe valves up to 2 inches shall be bronze with threaded ends. Body, bonnet, disc holder, stems lock nut; packing nut and disc lock nut shall be of bronze. Hand wheel shall be malleable iron with stem of manganese bronze. Renewable composition disc shall be provided suitable for water & steam. Packing shall be graphited asbestos.

Globe valves 2.5 inches and above shall be cast iron body; bronze faced disc and yoke bonnet, and shall be flanged. Hand wheel, gland, bonnet and body shall be of cast iron. Stem shall be of manganese bronze. Packing shall be graphited asbestos. Stem lock nut, disc and seat ring shall be of bronze. Disc shall be renewable composition type.

All valves shall be rated for ANSI 150 Lbs. 300 psig & 200°F working pressure and temperature, shall be provided as per List of Approved Manufacturer.

SWING CHECK VALVES:

Check valves up to 2 inches shall be with threaded ends Cap, hinge pin, body, hinge, disc nut and disc shall be of bronze.

Check valves larger than 2 inches shall be of cast iron body, including valve cap and disc. Hinge pin, seat ring and disc ring shall be of bronze. Ends shall be flanged.

All valves shall be rated for ANSI 150 Lbs. 300 psig & 200°F working pressure and temperature, and shall be provided as per List of Approved Manufacturer.

BALANCING VALVES:

Calibrated Balancing Valves: shall be furnished & installed where shown on the drawings. The valves shall have NPT connections (Internal Threads) suitable for 362 psig (25 bar) for pipe size 50 mm or below, or flanged connections suitable for 300 psig (20.7 bar) for pipe size 65 mm or above, as required. The Valves shall be suitable sized between 3.0 to 6.0 Pa at fully open position. The balancing valves shall have measuring points for connecting a direct flow rate read-out meter. The measuring points shall be self-sealing type to prevent system fluid loss during balancing/monitoring. The measuring points shall be easily accessible for measuring purpose, especially on the flanged valves; it should be located on the flanged. Each balancing valve shall have a

calibrated digital hand wheel for easy determination of location of the hand wheel by directly reading the number of turns on the top of the hand wheel. Each balancing valve shall have a nameplate to assure specific value settings and shall be constructed with internal spindle seals (EPDM O-rings) to prevent leakage around the rotating element.

Balancing Valves shall be provided as per List of Approved Manufacturer.

Y-STRAINERS:

Strainers shall be "Y" types, with bronze body and threaded ends up to 2 inches. Screen shall be of 20 mesh monel.

Strainers above 2 inches shall have cast iron body with flanged ends. Screen cover shall be provided with blow off taping. Screen shall be of perforated stainless steel, 233 holes per sq. inch, with 0.045 inch diameter holes and 0.016 inch thick screen.

All strainers shall be rated for ANSI 150 Lbs. 300 psig & 200^{o}F working pressure and temperature, shall be provided as per List of Approved Manufacturer.

Fan Coil Units (FCU)

PART 1 – GENERAL

1.1. Section Includes

A. Vertical Fan Coil Units.

1.2. Reference Standards

A. All referenced standards and recommended practices in this section pertain to the most recent publication thereof, including all addenda and errata.
B. AHRI 260 – Standard Sound Rating of Ducted Air Moving and Conditioning Equipment.
C. AHRI 350 – Standard Sound Rating of Non-Ducted Air Moving and Conditioning Equipment.
D. AHRI 410 – Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
E. AHRI 440 – Standard for Performance Rating of Room Fan-Coils.
F. ASHRAE 62.1 – Standard for Ventilation for Acceptable Indoor Air Quality.
G. ASHRAE 79 – Standard Method of Test for Fan-Coil Units
H. ASTM C1338 – Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
I. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
J. ASTM E488/E488M – Standard Test Methods for Strength of Anchors in Concrete Elements.
K. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
L. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association.
M. UL 181 – Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.

1.3. Submittals

N. Product Data shall be provided with data indicating configuration, general assembly, and materials used in fabrication, including catalog performance ratings that indicate airflow, static pressure, sound power levels, electrical characteristics, and connection requirements.
O. Shop Drawings shall indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
P. Manufacturer shall include schedules listing sound power level for each of second through eighth octave bands at the specified static pressures.
Q. Certificates shall be issued to certify that the airflow, coil capacities, pressure drops, and selection procedures meet or exceed specified requirements or fan coils are tested and rated in accordance with AHRI 440.
R. Manufacturer's Installation Instructions shall indicate support and mounting details, installation instructions, recommendations, and service clearances required.
S. Project Record Documents shall record actual locations of units and controls components and locations of access doors.

T. Operation and Maintenance Data shall include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.
U. Manufacturer's warranty shall be submitted and ensure forms have been completed in Owner's name and registered with manufacturer.
V. Maintenance Materials shall be furnished for the Owner's use in maintenance of the project.

1.4. **Quality Assurance**

W. Manufacturer Qualifications shall be specified in this section, with minimum ten years of documented experience.
X. Product Listing Organization Qualifications: The manufacturer shall be listed with an organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and be acceptable to authorities having jurisdiction.

1.5. **Warranty**

Y. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
Z. Provide 18 month manufacturer warranty from date of shipment for air fan coil units, integral sound attenuators, integral heating coils, and integral controls.

PART 2 – PRODUCTS

2.1. **General**

AA. Basis of Design: Price Industries, Inc.
1. Vertical Fan Coil Unit, Concealed: FCVC.
2. Vertical Fan Coil Unit, Exposed, Flat-Top: FCVE
3. Vertical Fan Coil Unit, Exposed, Slope-Top: FCVS

BB. Performance Requirements:
1. Units shall have published sound power level data per AHRI 260 or AHRI 350 depending on production configuration.
2. Unit shall be performance certified with the latest edition of AHRI 440.
3. Units shall be ETL listed in compliance with UL 60335 standards.

2.2. **Vertical Fan Coil Units, Exposed**

CC. General:
1. Furnish and install Price FCVE Fan Coil Units where indicated on the plans and in the specifications.
    a. (**Optional**) Furnish and install Price FCVS Fan Coil Units where indicated on the plans and in the specifications
2. Units shall be completely factory assembled, tested and shipped as a single piece.
3. All units shall be capable of meeting AHRI performance for the scheduled capacities for cooling, heating and air delivery.

4. All unit dimensions for each model and size shall be considered maximums.

DD. Construction:

1. Unit Casing:
   a. The unit casing shall be fabricated of 18-gauge galvanized steel panels with powder coating.
   b. All units shall have a stamped louver discharge.
      ii. (**Optional**) All units shall have a Price 610 series single deflection grille
      iii. (**Optional**) All units shall have a Price LBP linear bar grille
   a. All exterior panels will be uninsulated
   b. All panels of the interior unit downstream of the forward curve fans shall be insulated with 1/2-inch thick insulation.
3. Blower:
   a. The blower shall be a dynamically balanced, forward curved, double width/double inlet (DWDI) centrifugal type, constructed of zinc coated galvanized steel for corrosion resistance.
4. Motor:
   a. The unit shall be supplied with an electronically commutated motor (ECM), complete with a single phase integrated controller/inverter that operates the wound stator and senses motor position to electronically commutate the stator.
   b. The motor rotor shall be permanent magnet type with near zero rotor losses.
   c. The motor shall be permanently lubricated with ball bearings, maintaining a minimum of 70% efficiency over its entire operating range.
   d. The ECM shall be furnished with factory programming:
      1. High Turndown Flow Program
         a. A modulating high turndown flow program shall be provided to allow the ECM to operate with constant torque to vary the airflow with fluctuations in external static pressure
5. Motor Controller:
   e. (**Optional**): The motor shall be supplied complete with a manual fan speed controller for field adjustment of fan air flow set-point.
      1. The speed controller shall accept as standard a [0-10VDC], or [4-20mA] signal for remote fan adjustment from a building automation system.
   f. (**Optional**): The motor shall be supplied complete with a 3-speed fan speed controller for field adjustment of fan air flow set-point.
      1. The speed controller shall accept as standard low voltage 3-speed thermostat signal [24 VAC] for energizing one of the three speeds.
6. Drain Pans:
   a. All units shall be supplied with primary and auxiliary condensate drain pans with single wall, galvanized steel for corrosion resistance.
   b. The primary drain pan shall extend under the entire cooling coil
   c. The auxiliary drain pan shall be mounted to for condensate from the primary drain pan and optional piping packages. The
   d. Drain pans shall be of one-piece construction and be positively sloped for condensate removal.
   e. Drain pans shall be externally insulated with fire retardant foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating

per ASTM E84 and UL 723 and an Antimicrobial Performance Rating of zero with no observed growth per UL 181.

f. (**Optional**): Provide primary and auxiliary drain pan with type 304 stainless steel construction for superior corrosion resistance. Stainless steel drain pans shall be externally insulated and meet or exceed the requirements stated above.

g. (**Optional**): Provide a secondary drain connection on the auxiliary drain pan for condensate overflow.

7. Filters:
   i. All units shall be furnished with a minimum two inch thick nominal pleated filter.
   ii. The filter shall have a Minimum Efficiency Reporting Value (MERV) of MERV8.
   iii. (**Optional**): The units shall be furnished with a two inch pleated [MERV13] filter.
8. Electrical:
   a. Units shall be furnished with single point power connection.
   b. Units shall be furnished with a NEMA 250, Type 1 electrical enclosure.
9. Unit Options and Accessories:
   b. Water Cooling and Heating Coils:
      1. All water coils shall be tested with the assembly, rated and certified in accordance with the current edition of AHRI 440 and AHRI 410, and shall bear the AHRI seal on the unit casing.
      2. All cooling and heating coils shall optimize rows and fins per inch to meet the specified capacity.
      3. Coils shall have seamless copper tubes and shall be mechanically expanded to provide an efficient, permanent bond between the tube and fin.
      4. Fins shall have high efficiency aluminum surface optimized for heat transfer, air pressure drop and carryover.
      5. All water coils shall be hydrostatically tested to a minimum 390 pounds per square inch, with a minimum burst pressure of 1800 pounds per square inch at ambient temperature. All water coils are rated for a maximum of 300 pounds per square inch working pressure at 200 degrees Fahrenheit.
   c. Liners (**select one**):
      1. Fiberglass Liner – FG:
         a. Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84 and NFPA 90A. The insulation shall comply with Antimicrobial Performance Rating of 0 with no observed growth, per UL181.
            1. The insulation shall be secured with adhesive.
            2. Insulation edges exposed to the airstream shall be coated with NFPA approved sealant.
      2. Closed Cell Polymeric Foam Insulation – FF
         a. Insulation shall conform to UL 181 (erosion) and NFPA 90A for fire, smoke and melting, and comply with a 25/50 Flame Spread and Smoke Developed Index per ASTM E84 or UL 723.
         b. The insulation shall be secured with adhesive.
   a. Unit Mounting:

1. The unit shall be mounted with the use of wall anchors supplied by others. The manufacturer shall supply anchor holes on the 20-gauge zinc coated back panel

PART 3 – EXECUTION

3.1. **Installation**

EE. Install the fan coil units in accordance with the manufacturer's instructions.
FF. See drawings for the size(s) and duct location(s) of the fan coil units.
GG. Support the fan coil units individually from the structure.
HH. Embed anchors in concrete in accordance with ASTM E488/E488M.
II. Do not support the fan coils from the ductwork.
JJ. Install heating coils in accordance with Section 23 82 00.
KK. Verify that electric power is available and of the correct characteristics.

List of Approved Manufacturers/Sources of Mechanical Equipment

* All Equipment shall be procured from Principal Authorized agents / distributors / resellers

Bidder must submit the technical submittal of each item to the Engineer In-charge for approval before delivery of any material. The Bidder shall fill the name of only one manufacturer for each equipment/material on which the tender is based. He shall be bound to supply the equipment from the same manufacturer. In case, the Bidder gives names of more than one manufacturer against any equipment, the Engineer / Owner can ask the Bidder supply the equipment from any one of them.

During the execution stage if the material from any supplier is found defective / substandard the Engineer / Owner reserves the right to ask the successful bidder to replace his choice of manufacturer / supplier for that particular equipment.

Any change in manufacturer / supplier shall only be entertained if there is sufficient reason that adhering to the original choice of manufacturer / supplier shall be detrimental to either the project quality or project timeline. Proper approval shall have to be sought for change in the choice manufacturer / supplier at least 1 month before the equipment is to be procured.

S.NO.	EQUIPMENT / MATERIAL	RECOMMENDED MANUFACTURERS
1	Thermometers / Pressure Gages	Trerice, Weksler, Weiss (USA)
2	Air Handling Units	Carrier, York, Samsung, LG, Daikin, Trane
3	Gate Valves, Globe Valves, Strainers, Check Valves, Ball Valves	Kitz Japan Crane UK Tour Andersson USA Hattersley UK
4	GI SHEET FOR DUCTS	a) PAKISTAN STEEL, PAKISTAN b) ISL, PAKISTAN
5	FLEXIBLE DUCT CONNECTOR	a) DURODYNE b) DUCTMATE
6	XLPE FOAM INSULATION SHEET	a) AEROFOAM b) GULF-O-FLEX c) DURKFLEX d) INCOFLEX - WEITINAM

7	AIR DISTRIBUTION OUTLETS	a) MEHRAN b) THERMEC c) STEEL CRAFT d) ENGINEERING AIR PRODUCTS (EAP)
8	VOLUME DAMPERS	a) MEHRAN b) THERMEC c) STEEL CRAFT e) ENGINEERING AIR PRODUCTS (EAP)
9	FIRE DAMPERS	a) MEHRAN b) THERMEC c) STEEL CRAFT e) ENGINEERING AIR PRODUCTS (EAP)
10	CLOSED CELL FOAM INSULATION (NBR)	a) AEROFLEX b) GULF-O-FLEX c) DURKFLEX d) INCOFLEX - WEITINAM
11	HANGERS & SUPPORTS	a) HILTI b) INKA c) SIKLA d) INDEX
12	MOTOR CONTROL CENTER (MCC), DISTRIBUTION BOARD (DB)	HUSSAIN AND CO. UNIQUE ENGINEERING HRA SWITCHGEARS RA ENGINEERING TAJ ENGINEERING, PAKISTAN A TO ZEE, PAKISTAN KARIMI ELECTROMECH SYSTEM OR APPROVED EQUIVALENT
13	ELECTRIC POWER CABLES	PAKISTAN CABLES FAST CABLES NEW AGE CABLES PIONEER CABLES

		OR APPROVED EQUIVALENT
14	Chilled Water Piping	a) Huffaz Pakistan b) Lontrin China c) Protek China d) Hebei China
15	UPVC PIPING FOR CONDENSATE	g) NEPRO, UAE h) COSMOPLAST, UAE i) JEDDAH POLYMER
16	PVC CONDUIT FOR ELECTRICAL WORKS (POWER, CONTROL & COMMINUCATION WIRING – CONCEALED / RECESSED APPLICATION) GI CONDUIT FOR ELECTRICAL WORKS (POWER, CONTROL & COMMUNICATION WIRING – SURFACED / EXPOSED / ABOVE FALSE CEILING APPLICATION)	GALCO DADEX JEDDAH POLYMER OR APPROVED EQUIVALENT
17	VIBRATION ISOLATOR	a) KINETICS, USA b) MASON, USA
18	ADHESIVE AND SEALENT	a) ZAHABIYA b) CLARIANT c) DUCTMATE
19	REINFORCED UL LISTED FSK FACING ALUMINIUM FOIL TAPE	a) ABRO b) 3M c) NASHUA d) SCAPA
20	SHUTT OFF VALVE	a) DANFOSS, DENMARK

SPECIFICATIONS OF LED PANEL LIGHT ;

Recessed/surface mounted LED panel light of size 600 mm × 1200 mm (2 ft × 4 ft) with high efficiency LED technology, suitable for commercial and institutional lighting applications. The luminaire shall provide uniform glare-controlled illumination with low power consumption and long operational life with following minimum specifications:

Type: LED Panel Light

Size: 2 ft × 4 ft (600 × 1200 mm)

Power Consumption: 38–45 Watts

Correlated Color Temperature (CCT): 4000K (Neutral White) or approved as per site requirement

Luminous Flux: minimum 5400 lumens

Color Rendering Index (CRI): ≥ 80

Power Factor: ≥ 0.90

Operating Voltage: 220–240V AC, 50/60Hz

Protection Class: minimum IP20

Housing: powder coated metal body

Life Span: minimum 50,000 operating hours

Warranty: minimum 2 years replacement warrranty

Compliance: IEC 60598 or equivalent international standards

The rate shall include driver, mounting accessories, connectors, suspension/fixing hardware, wiring connections, testing and commissioning, and all associated works required for complete installation and satisfactory operation

SPECIFICATIONS OF COB LED STRIP/COVE LIGHTING

Flexible COB LED strip/cove lighting complete with driver, V-profile aluminium channel and diffuser, suitable for decorative and architectural lighting applications. The LED strip shall provide continuous dot-free illumination with high color consistency and uniform light distribution with following minimum specifications:

Type: Flexible COB LED Strip Light

Color Temperature (CCT): 3000K (Warm White) or approved as per site requirement

Power Consumption: minimum 10–14 W/m

Luminous Flux: minimum 700–1250 lm/m

Color Rendering Index (CRI): ≥ 80

Protection Rating: IP20 or above

LED Type: COB continuous light technology for uniform illumination

Life Span: minimum 50,000 operating hours

Driver: suitable electronic driver/power supply compatible with strip load

Compliance: IEC/Equivalent international standards

Warranty: minimum 2 years replacement warrranty

The scope includes supply of LED strip, driver, aluminium V-profile, diffuser, mounting clips, connectors, soldering, wiring, fixing, testing and commissioning, along with all accessories, consumables and labour required for complete installation and satisfactory operation,

SPECIFICATIONS OF LED PANEL SIZE 1 FT × 4 FT (300 MM × 1200 MM)

Recessed/surface mounted LED panel light of size 1 ft × 4 ft (300 mm × 1200 mm) suitable for office, commercial and institutional lighting applications. The luminaire shall provide uniform, glare-controlled and flicker-free illumination with high energy efficiency and long operational life. The fitting shall meet or exceed the following minimum specifications:

Type: LED Panel Light

Size: 1 ft × 4 ft (300 × 1200 mm)

Power Consumption: 30–40 Watts

Correlated Color Temperature (CCT): 4000K (Neutral White) or approved as per site requirement

Luminous Flux: minimum 3600–4000 lumens

Color Rendering Index (CRI): ≥ 80

Power Factor: ≥ 0.90

Operating Voltage: 220–240V AC, 50/60HzProtection Class: minimum IP20

Mounting: recessed/surface/suspended compatible

Life Span: minimum 50,000 operating hours

Compliance: IEC 60598 or equivalent international standards

Warranty: minimum 2 years replacement warranty

The rate shall include LED driver, mounting accessories, connectors, suspension/fixing hardware, wiring connections, testing and commissioning, and all associated works required for complete installation and satisfactory operation

SPECIFICATIONS OF LED DOWN LIGHT 60WATT ;

High efficiency surface mounted LED downlight suitable for commercial and institutional lighting applications. The luminaire shall provide uniform glare-controlled illumination with high energy efficiency and long operational life. The fitting shall meet or exceed the following minimum specifications:

Type: Surface Mounted LED Downlight

Power Consumption: at least 60 Watts

Correlated Color Temperature (CCT): 4000K (Neutral White) or approved as per site requirement

Luminous Flux: minimum 6600 lumens

Luminous Efficacy: minimum 100 lm/W

Color Rendering Index (CRI): ≥ 80

Power Factor: ≥ 0.90

Input Voltage: 220–240V AC, 50/60Hz

Housing Material: die-cast aluminium body

Protection Rating: minimum IP65

Mounting: surface mounted type

Driver: integral electronic driver/power supply unit

Life Span: minimum 50,000 operating hours (L70B50)

Operating Temperature: -20°C to +40°C

Compliance: IEC 60598 or equivalent international standards

Warranty: minimum 2 years replacement warrranty

The rate shall include supply of luminaire, driver, mounting accessories, fixing hardware, connectors, wiring connections, testing and commissioning, and all associated labour, consumables and accessories required for complete installation and satisfactory operation

SPECIFICATIONS OF LED DOWN LIGHT 12-15WATT ;

Surface mounted LED downlight suitable for commercial and institutional lighting applications. The luminaire shall provide uniform, glare-controlled and flicker-free illumination with high energy efficiency and long operational life. The fitting shall meet or exceed the following minimum specifications:

Type: Surface Mounted LED Downlight

Power Rating: 12–15 Watts

Correlated Color Temperature (CCT): 3000K / 4000K / 6500K

Luminous Flux: minimum 1200 lumens

Color Rendering Index (CRI): ≥ 80

Power Factor: ≥ 0.80

Operating Voltage: 220–240V AC, 50/60Hz

Protection Rating: minimum IP20

Mounting Type: surface mounted

Life Span: minimum 25,000 operating hours

Compliance: IEC 60598 or equivalent international standards

Warranty: minimum 2 years replacement warrranty

The rate shall include LED driver/power supply unit, mounting accessories, connectors, fixing hardware, wiring connections, testing and commissioning, and all associated labour, consumables and accessories required for complete installation and satisfactory operation, complete in all respects as directed by the Engineer In-Charge.

SPECIFICATIONS OF ELECTRIC DISTRIBUTION PANEL (NAME: P&LDB-1)

Electric Distribution Panel (Name: P&LDB-1) , Wall mounted finished with 16/14 SWG MS sheet, front and back doors, drawing pocket, transparent sheet, powder coated paint of RAL 7032 approved color, moveable & lockable handles of suitable brand, flush type hinged door with Earthling braid consisting of danger plate with handle, complete internal power and control wiring, MCCB Safety Plates as per DB Gauge, fixing material nut bolts, Lugs, glands and with following components:-

Incoming Side 1

• 01 Nos. 100 Amp Three Pole MCCB (Icu=25kA Ics=100% of Icu) adjustable type

• 03 Nos. Indication Lights

• 03 Nos. 2 Amp SP MCB

• 1 No. Multimeter with required CT's Current Measurement on common busbar

Incoming Side 2

• 01 Nos. 80 Amp Three Pole MCCB (Icu=25kA Ics=100% of Icu) adjustable type

• 03 Nos. Indication Lights

• 03 Nos. 2 Amp SP MCB

• 1 No. Multimeter with required CT's Current Measurement on common busbar

Outgoing Side 1

- 20 Nos. 20A TP MCB 10kA
- 16 Nos. 16A DP MCB 10kA

Outgoing Side 2

- 20 Nos. 10A TP MCB 10kA
- 15 Nos. 16A DP MCB 10kA

All cable links/bus bar links must be as per outgoing load. All Circuit Breakers must be compact size, as per specifications and complying with standards, complete in all respect as directed by Engineer In-charge

The vendor must submit shop drawings for approval of the Engineer before the manufacturing of the DB.

SPECIFICATIONS OF ELECTRIC DISTRIBUTION PANEL (NAME: MDB-1)

Electric Distribution Panel (Name: MDB-1) , Wall mounted finished with 16/14 SWG MS sheet, front and back doors, drawing pocket, transparent sheet, powder coated paint of RAL 7032 approved color, moveable & lockable handles of suitable brand, flush type hinged door with Earthling braid consisting of danger plate with handle, complete internal power and control wiring, MCCB Safety Plates as per DB Gauge, fixing material nut bolts, Lugs, glands and with following components:-

Incoming Side

- 01 Nos. 400 Amp Three Pole MCCB (Icu=25kA Ics=100% of Icu) adjustable type
- 03 Nos. Indication Lights
- 03 Nos. 2 Amp SP MCB
- 1 No. Multimeter with required CT's Current Measurement on commmon busbar

Outgoing Side

- 02 Nos. 250A TP MCCB 25kA
- 02 Nos. 100A TP MCCB 25kA
- 02 Nos. 80A TP MCCB 25kA
- 01 Nos. 60A TP MCCB 25kA

All cable links/bus bar links must be as per outgoing load. All Circuit Breakers must be compact size, as per specifications and complying with standards, complete in all respect as directed by Engineer In-charge

The vendor must submit shop drawings for approval of the Engineer before the manufacturing of the DB.

SPECIFICATIONS OF HAND DRYER

automatic electric hand dryer suitable for washroom applications, designed for high-speed and energy-efficient hand drying operation. The unit shall be wall mounted type with durable construction and shall meet or exceed the following minimum specifications:

Type: Automatic sensor-based hand dryer

Operating Voltage: 220–240V AC, 50 Hz

Power Rating: 1500–2000 Watts

Activation: Infrared automatic sensing

Air Speed: high-speed drying performance

Body Material: ABS/metallic corrosion-resistant housing

Noise Level: low noise operation

Safety Features: overheating and overload protection

Mounting: wall mounted complete with fixing accessories

The scope includes fixing, wiring connection from nearby power source, testing, commissioning and all associated accessories, consumables, labour and hardware required for complete installation and satisfactory operation

TECHNICAL SPECIFICATIONS FOR PASSENGER LIFT

Machine Room Less (MRL) passenger lift of 3 stops (Ground + 2) minimum capacity 630Kg, as per EN-81 safety standards, operational on 380-415 Volts, 3-phase, 50 Hz, 3 stops, with following Minimum features:

• Permanent magnet gearless hoisting motor capable of serving Ground + 2 Floors with microprocessor control panel, Car Operating Panels (COP)

• Floor operating panels (FOP) One (01) on each lift lobby equipped with up/down stainless steel call buttons with braille and buzzer, door tracks, sills, door drive mechanism and its complete control system

• Reservation services system inside each car

• Indicator flicker and chime before car arrival (Audible alert system in the car announcing the floor that the car has arrived at)

• Automatic control of the door's operating closing time according to the kind of floor and call.

• Automatic rescue device (ARD)/Emergency Landing Device,

• Full length light curtain, with door closing force limiting device

• Weight overload buzzer

• All safety devices as per safety standards of EN-81

• Telephone intercom system

• Alarm bell

• Voice Prompt System for blind persons indicating each floor reached

• Further equipped with lights, fan, call bell, emergency backup for lights, fan, alarm and intercom

• Operation manual, maintenance manual and circuit diagrams (English Version). Two Hard Copies & One Soft copy in USB.

• In accordance with manufacturer's standard design/drawings and confirming to Technical Specifications and Data. Submission of Shop Drawings after work order and As-Built Drawings after completion

TECHNICAL SPECIFICATIONS FOR SOUND SYSTEM

SPECIFICATIONS OF 2-WAY SURFACE MOUNT SPEAKER SYSTEM

professional 2-way surface mount speaker system suitable for auditorium, public address and background music applications, complete with mounting bracket and all associated accessories. The speaker shall be designed for wall/ceiling mounting and shall provide clear voice intelligibility and high-quality music reproduction. The speaker system shall meet or exceed the following minimum specifications:

Type: 2-way surface mount speaker system

Speaker Size: low frequency driver with high frequency dome tweeter

Continuous Program Power: minimum 150W

Rated Noise Power: minimum 90W

Sensitivity: minimum 91 dB (1W/1m)

Frequency Response: 50 Hz – 20 kHz or better

Dispersion: minimum 100° × 100° coverage or better

Mounting: wall/ceiling mountable with adjustable steel bracket

Construction: heavy-duty enclosure

Operating Temperature: -10°C to +50°C

Certification: EN54-24 certified outdoor/weatherproof version where specified

SPECIFICATIONS OF COMPACT TWO-WAY WALL MOUNT SPEAKER SYSTEM

Compact two-way wall mount speaker system suitable for auditorium, conference and public address applications, designed for wide dispersion, high speech intelligibility and high-quality music reproduction. The speaker shall be complete with mounting bracket and all associated accessories and shall meet or exceed the following minimum specifications:

Type: Two-way bass reflex wall mount speaker

Rated Input: minimum 30 Watts

Power Handling Capacity: minimum 140W continuous program

Rated Impedance: 8 Ohms with 70V/100V line transformer tapping

Sensitivity: minimum 90 dB (1W/1m)

Frequency Response: 80 Hz – 20 kHz (-10 dB)

Input Terminal: push-in terminal type

Enclosure Material: HIPS resin or equivalent high durability enclosure

Mounting: wall/ceiling mountable with adjustable bracket

SPECIFICATIONS OF TWO-WAY WEATHERPROOF MUSIC HORN SPEAKER

Two-way weatherproof music horn speaker suitable for outdoor public address and background music applications, designed for high intelligibility, high efficiency and wide area sound coverage. The speaker system shall be suitable for continuous outdoor operation and shall meet or exceed the following minimum specifications:

Type: Two-way weatherproof music horn speaker

Rated Input Power: 60 Watts minimum

Line Voltage Operation: 70V/100V line transformer type

Sensitivity: minimum 100 dB (1W/1m)

Maximum Sound Pressure Level: minimum 117 dB at rated power

Frequency Response: 100 Hz – 20 kHz or better

Dispersion Angle: minimum 90° horizontal × 80° vertical

Speaker Components:

Low Frequency: minimum 6-inch cone type

High Frequency: dome tweeter type

Dust & Water Protection: minimum IP66 rated

Enclosure Material: weatherproof ABS resin or equivalent

Finish: UV resistant outdoor coating

Suitable for outdoor installations including stadiums, parking areas, corridors and public spaces

SPECIFICATIONS OF WEATHERPROOF HIGH-INTELLIGIBILITY DRIVER UNIT

Weatherproof high-intelligibility driver unit suitable for public address and outdoor announcement applications, designed for use with compatible horn flare assembly. The driver unit shall be suitable for continuous outdoor operation and shall meet or exceed the following minimum specifications:

Type: High impedance driver unit for horn speaker

Rated Input Power: 50 Watts minimum

Line Voltage Operation: 70V/100V line system

Sensitivity: minimum 110 dB (1W/1m)

Frequency Response: 150 Hz – 6 kHz or better

Dust & Water Protection: minimum IP65 rated (with compatible horn assembly)

Impedance Selector: external tap selector arrangement

Construction: corrosion resistant housing with powder coated finish

Horn Coupling: standard threaded coupling suitable for compatible horn flare

Suitable for outdoor public address and announcement systems

SPECIFICATIONS OF WEATHERPROOF LONG HORN SPEAKER SUITABLE FOR OUTDOOR PUBLIC ADDRESS

Weatherproof long horn speaker suitable for outdoor public address, emergency announcement and mass notification applications, designed for high intelligibility and long-distance sound projection. The speaker shall be suitable for continuous outdoor operation and shall meet or exceed the following minimum specifications:

Type: Long horn / reflex horn speaker

Rated Input Power: minimum 30–50 Watts

Line Voltage Operation: 70V/100V line system or equivalent

High sensitivity suitable for long-range coverage

Frequency Response: suitable for speech intelligibility and announcement applications

Weatherproof construction suitable for outdoor installation

Corrosion resistant housing and mounting hardware

Adjustable mounting bracket arrangement

Suitable for continuous duty operation in outdoor environments

SPECIFICATIONS OF PROFESSIONAL MULTICHANNEL DIGITAL POWER AMPLIFIER

Professional multichannel digital power amplifier suitable for auditorium, public address and professional sound reinforcement applications. The amplifier shall be rack mountable and capable of delivering high power output with low distortion and reliable continuous operation. The unit shall meet or exceed the following minimum specifications:

Type: Class-D multichannel digital power amplifier

Channels: 4 independent output channels

Output Power:

Minimum 1000W × 4 channels at 4Ω

Minimum 650W × 4 channels at 8Ω

Bridge Mode: minimum 2000W × 2 channels at 8Ω

Frequency Response: 20 Hz – 20 kHz (±3 dB)

Total Harmonic Distortion (THD): ≤ 0.1%

Signal to Noise Ratio: ≥ 100 dB

Input Impedance: 20kΩ balanced / 10kΩ unbalanced

Input Connectors: XLR-F balanced input

Output Connectors: NL4 Speakon speaker connectors

LED Indicators: Protect, Clip, Signal, Power and level indicators

Cooling System: forced air cooling front-to-rear airflow

Power Supply: 100–240V AC, 50/60 Hz

Power Consumption: maximum 2000W

Mounting: standard 19-inch rack mount type

Construction: heavy-duty metal chassis suitable for professional applications

SPECIFICATIONS OF PROFESSIONAL MIXER POWER AMPLIFIER SUITABLE FOR PUBLIC ADDRESS

Professional mixer power amplifier suitable for public address, auditorium, mosque and background music applications, capable of high-quality speech and music reproduction with multi-input mixing and zone selection facility. The amplifier shall be rack/table mount type and shall meet or exceed the following minimum specifications:

Type: Mixer Power Amplifier

Rated Output Power: 240 Watts minimum

Microphone Inputs: minimum 6 balanced MIC/LINE inputs

AUX Inputs: minimum 5 AUX inputs

Simultaneous Mixing Capability: minimum 9 input sources

Recording Input/Output facility

Speaker Zones: minimum 2 selectable speaker zones

Speaker Output: 100V line and 4–16Ω low impedance output

Frequency Response: 50 Hz – 20 kHz (±3 dB)

Distortion: ≤ 2% at rated output

Signal Processing: provision for equalizer/processor connection

Tone Controls: independent bass and treble controls

Indicators: power, output level and zone selection LED indicators

Input Connectors: XLR/phone jack and RCA type combinations

Cooling: convection/forced air suitable for continuous operation

Power Supply: 220–240V AC, 50/60 Hz

Mounting: rack/table mountable heavy-duty chassis construction

SPECIFICATIONS OF PROFESSIONAL COMPACT DIGITAL/ANALOG AUDIO MIXING CONSOLE

Professional compact digital/analog audio mixing console suitable for auditorium, conference, studio and live sound reinforcement applications. The mixer shall provide high-quality audio processing, multi-channel mixing capability, integrated digital effects and USB audio interfacing for recording and playback applications. The unit shall meet or exceed the following minimum specifications:

Type: Professional compact mixing console

Input Channels: minimum 16 channels comprising:

12 Mic/Line input channels

4 Mic/Stereo-Line input channels

Microphone Preamplifiers: low-noise professional grade preamps

Auxiliary Buses: minimum 6 AUX buses

Effects Processors: dual integrated digital stereo effects processors

Effects Presets: minimum 100 factory presets and 20 user programmable presets

Equalizer: 11-band stereo graphic equalizer

USB Audio Interface: professional 4-in/4-out USB interface

Audio Resolution: minimum 24-bit / 96 kHz

MIDI Interface: integrated MIDI input/output support

Frequency Response: 15 Hz – 70 kHz or better

THD: ≤ 0.01%

Phantom Power: +48V selectable phantom power

Display: OLED/LCD display for effects and system settings

Outputs: balanced XLR master outputs and monitor outputs

Controls: independent channel EQ, AUX, FX and gain controls

Construction: heavy-duty compact chassis suitable for portable and fixed installations

Power Supply: 100–240V AC, 50/60 Hz universal power supply.

SPECIFICATIONS OF PROFESSIONAL DYNAMIC HEADSET MICROPHONE

Professional dynamic headset microphone suitable for speech reinforcement, auditorium, presentation and live sound applications. The microphone shall provide clear voice reproduction, high gain-before-feedback and reliable hands-free operation. The unit shall meet or exceed the following minimum specifications:

Type: Dynamic close-talk headset microphone

Polar Pattern: Cardioid (unidirectional)

Frequency Response: 50 Hz – 15 kHz

Output Connector: 3-pin XLR male balanced output

Output Impedance: 150Ω rated or better

Sensitivity: suitable for professional speech applications

Construction: lightweight adjustable wireframe headset with flexible boom arm

Cable: attached shielded microphone cable minimum 1.2 m length

Accessories: foam windscreen and cable clip

Finish: black or approved equivalent

Operation: no phantom power required

Suitable for indoor speech, stage and presentation applications

SPECIFICATIONS OF 27U FLOOR STANDING PA EQUIPMENT RACK

27U floor standing PA equipment rack fabricated from heavy-duty steel sheet with powder coated finish and front glass door, suitable for housing professional audio and communication equipment. The rack shall be complete with ventilation arrangement, cable management provision, mounting hardware and power distribution unit (PDU). The rack shall meet or exceed the following minimum specifications:

Rack Size: 27U standard 19-inch rack

Construction: heavy-duty MS/CRCA steel sheet

Finish: powder coated anti-corrosive finish

Front Door: lockable toughened glass door

Mounting Rails: adjustable equipment mounting rails

Ventilation: fan mounting/ventilation provision

Accessories: cable manager, shelves and mounting hardware

PDU: rack mountable power distribution unit

Base: floor standing type with levelling arrangement/casters

SPECIFICATIONS OF PROFESSIONAL HANDHELD WIRED DYNAMIC MICROPHONE

Professional handheld wired dynamic microphone suitable for public address, speech and vocal applications, complete with microphone holder, cable and standard accessories. The microphone shall provide clear voice reproduction and reliable performance and shall meet or exceed the following minimum specifications:

Type: Dynamic handheld wired microphone

Polar Pattern: unidirectional/cardioid

Frequency Response: suitable for speech and vocal applications

Output Connector: standard professional audio connector

Construction: rugged metal body suitable for continuous use

Switch: built-in ON/OFF switch

Cable: shielded low-noise microphone cable

Accessories: microphone holder/clip and carrying accessories

SPECIFICATIONS OF PROFESSIONAL IMPORTED MICROPHONE STAND

Professional imported microphone stand suitable for auditorium, conference, public address and recording applications, designed for stable support and flexible positioning of microphones. The stand shall be heavy-duty construction and shall meet or exceed the following minimum specifications:

Type: adjustable floor/table microphone stand

Construction: heavy-duty steel/metal body

Height Adjustment: adjustable

Base: stable tripod or heavy round base type

Finish: black powder coated/mat finish

Thread Compatibility: standard 5/8-inch or equivalent microphone mounting thread

Compatible with standard dynamic and condenser microphones

List of Approved Manufacturers/Sources of Equipment

S. No.	Equipment / Material	Recommended
1	Commercial Hand Dryer	f) Siemens g) Falin h) Alpina i) Airmate j) World Dryer Or Approved Equivalent
2	Distribution Board Panel	a)Hussain And Co. b)Unique Engineering c)Hra Switchgears c)Ra Engineering Taj Engineering d)Pakistan A To Zee, e)Pakistan Karimi Electromech System Or Approved Equivalent

3	Electric Power Cables	Pakistan Cables Fast Cables New Age Cables or approved equivalent Pioneer Cables Or Approved Equivalent
4	Hangers & Supports	A) Hilti B) Inka C) Sikla D) Index or approved equivalent
5	Upvc Piping	j) Nepro, Uae k) Cosmoplast, Uae l) Jeddah Polymer m) Pakarab or approved equivalent
6	Pvc Conduit For Electrical Works (Power, Control & Comminucation Wiring – Concealed / Recessed Application) Gi Conduit For Electrical Works (Power, Control & Communication Wiring – Surfaced / Exposed / Above False Ceiling Application)	d) Hilal, Pakistan e) Premier, Pakistan f) Dadex, Pakistan d) Iil, Pakistan n) Jeddah Polymer o) Pakarab or approved equivalent
7	Circuit Breakers	b) Schneider Electric c) ABB or approved equivalent
8	Lights	D) Philips E) Pierlite F) Osram or approved equivalent
9	Sound System	b. TOA or approved equivalent
10	Passenger Lift	e) Mitsubishi f) Schindler g) Kone h) Suzhou Fuji or approved equivalent

NB: Bidder must submit the technical submittal of each item to the Engineer In-charge for approval before delivery of any material. The Bidder shall fill the name of only one manufacturer for each equipment/material on which the tender is based. He shall be bound to supply the equipment from the same manufacturer. In case, the Bidder gives names of more than one manufacturer against any equipment, the Engineer / Owner can ask the Bidder supply the equipment from any one of them.

* All Equipment/accessories shall be procured from OEM/ OEM Authorized agent.