

HVAC TECHNICAL SPECIFICATIONS

PROJECT

**(NEW ACADEMIC BLOCK)
NATIONAL LAW SCHOOL OF INDIA UNIVERSITY
@BANGALORE**

CLIENT

**NATIONAL LAW SCHOOL OF INDIA UNIVERSITY
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SECTION-1. HVAC SYSTEM DESCRIPTION

The Proposed Project building New Academic block at Bangalore is designed to create good thermal comfort and indoor air quality to enhance the comfort of the occupants. The proposed premises comprise of Design is based on the input from the client, architects, entire design team in addition to the applicable codes, standards and best practices of good engineering design.

The key project objectives shall include easy maintenance, simple and energy efficient, environment friendly and sustainable design and compliance to all statutory regulations.

SECTION-2. CODES AND STANDARDS

The installation shall conform in all respects to ASHRAE / Indian Standard Code of Practice for Air conditioning Installation, tender specifications and drawings.

In case of discrepancy among specifications, drawings and other documents, the specifications take precedence over all other documents. In case of discrepancy between specification, drawings etc. and codes & Standards, the bidder shall assume the more stringent of the two.

AIR CONDITIONING EQUIPMENT	
IS 659	Safety Code for air conditioning
IS 660	Safety Code for mechanical refrigeration
IS 3615	Glossary of terms used in refrigeration & air conditioning
IS 5111	Testing of refrigeration compressors
ISHRAE	Data for outside design conditions for air conditioning
IS 11338	Thermostats for use in refrigeration, air conditioners etc.,

NOISE & VIBRATION	
IS 2264	Preferred frequencies for acoustical measurements
IS 3483	Code of practice for noise reduction
IS 3932	Sound level meter for general purpose use
IS 9736	Glossary of terms applicable to acoustics in buildings
IS 9901	Measurement of sound insulation in buildings & building elements

IS 9876	Guide to the measurement of air borne acoustical noise & evaluation of its effects on man
IS 10423	Personal sound exposure meter
IS 11446	Measurement of air borne noise emitted by compressors units intended for outdoor use
IS 12710	Glossary of terms used in acoustic emission testing
IS 4758	Methods of measurement of noise emitted by machines
IS 14280	Mechanical vibrations – balancing – shaft and fitment key convention
IS 12065	Permissible limits of noise level for rotating electrical machines

REFRIGERANT GAS & LUBRICANTS

IS 1447	Method of sampling and test for lubricants
IS 4578	Lubricating oils for refrigeration machinery
IS 10609	Refrigerants – Number – Designation

RELEVANT INTERNATIONAL STANDARDS

ASHRAE Std. 90.1	American Society for Heating Refrigeration and Air conditioning Engineers. Standard for Minimum Efficiency Requirements for Water Chilling Packages.
AHRI 575	Air Conditioning Refrigeration Institute. Standard Method of Measuring Machinery Sound within equipment room. (Basis of all data presented or field testing equipment, with relation to sound
ASME CODE	American Society of Mechanical Engineers. Code for Unfired Pressure Vessels – Section VIII (Design, Construction, testing and certification of Pressure Vessels).
ANSI – B9.1	American National Standards Institute. Safety Code for Mechanical Refrigeration (overall general safety requirements, relief device sizing, etc.)
ANSI – B1.5	American National Standards Institute. Code for Refrigerant Piping.

SECTION-3. DRAWINGS, SPECIFICATIONS AND DEVIATIONS

The drawings and specifications lay down are minimum standards of equipment and workmanship. Should the bidder wish to depart from the provisions of the specifications and drawings either on account of manufacturing practice or for any other reasons, he should clearly draw attention in his tender to the proposed points of departures and submit such complete information. Drawings and specifications will enable the merits of the deviations to be fully appreciated. In the absence of any such deviation list, it will be deemed that the bidder is fully satisfied with the intents of the specifications and the drawings and their compliance with the statutory provisions and local codes. All deviations or departures not brought out to the notice and not get necessary written approval from the client / authorized agency of the client shall be disregarded.

SECTION-4. CONSTRUCTION TOOLS & POWER SUPPLY

All the tools and tackles, crane, scaffolding and staging required for erection and assembly of the installation covered by the contract shall be obtained by the contractor himself and shall meet the EHS requirement. All other material such as foundation bolts, nuts etc, required for the installation of the plant shall be supplied and included in the contract.

Power will be made available at one point 415 V 3 ph / 230 V single ph, 4 wire, 50 HZ earthed neutral system and all electrical tools / equipment shall be suitable for the above power supply with variation of + / -10 %. All equipment shall operate at this voltage and any equipment operating at other than this power supply shall be provided with necessary transformer. Necessary temporary working control panel with MCCB / MCB, KWh meter, voltmeter, Ammeter, Phase indicator, contactors, relays, earth leakage protection relays etc., to be provided and necessary power cabling between control panel to the working point to be provided by the HVAC contractor and the price shall be covered by the contract. And the cost of the power shall be deducted by the client based on the present power tariff. If needed the HVAC contractor shall provide required power supply for their construction activity on their own cost by providing DG sets etc.,

SECTION-5. SPARE PARTS & MAINTENANCE

The Tender cost shall include all spares recommended by OEM and necessary modification for actual performance of the system for the full warranty / guarantee years of operation for each type of equipment including the necessary labour cost. After the installation & commissioning of the equipment all the major equipment room shall be provided with the laminated chart of size not less than A3, individually showing clearly the Equipment detail, Power supply details, Spare parts details, Maintenance details etc., the tender cost for recommended spares shall be submitted as an annexure to the tender BOQ.

SECTION-6. SHOP DRAWING, INSPECTION AND TESTING

i. Working and construction drawings

The contractor shall prepare shop drawings and all work shall be carried out according to the approved working drawings. Shop drawings shall give all dimensions and shall incorporate the requirements of the Client/Project Managers/Architects. Approval of drawings does not relieve the contractor of his responsibility to meet the intents of the tender specifications. All such drawings for approval shall be submitted in 6 copies for Client/ Project Managers team. In addition, the contractor shall submit manufacturer's details and get them approved prior to ordering. This has to be done whether the materials / equipment is one of the approved makes or not.

ii. Testing and Inspection

The contractor shall carry out tests on different equipment and system in total as specified in various sections of the tender in the presence of Client/ Project Managers in order to enable them to determine whether the plant, equipment and installation in general comply with the requirements of the tender specifications. All equipment shall be tested after carrying out the necessary adjustments and balancing to establish equipment ratings and all other design conditions. The test data shall be submitted in Acceptance Test Form.

iii. Calibration of instruments and meters

The contractor shall furnish instruments required for testing with initial requirements of all consumables. All the instruments, meters etc to be used at site and on the system shall have a valid calibration certificate issued by the competent authority. The contractor shall maintain and make available all such calibration certificates.

iv. Handing over requirements

- 1) All the equipment shall be handed over after satisfactory testing and commissioning along with following documents:
- 2) Detailed equipment data in the approved format.
- 3) Manufacture's maintenance and operating instructions manual.
- 4) Technical data sheet of all the major equipment including accepted & actual power consumption, GA drawings etc.,
- 5) Set of as built drawings, layouts.
- 6) Approved test readings of all equipment and installations.
- 7) Inspection certificates
- 8) Certificates of approval from statutory or Local Authorities for the operation and maintenance of the installations, wherever such approval or certification is required.

This shall include Application filed along with enclosures and receipts of fees paid and deposits made.

- 9) List of recommended spares
- 10) Certificate from the contractor that he has cleared the site of all debris and litter caused by him without violating the EHS norms during the construction. However, contractor has also to periodically clear the site from all the debris, which is generated from his part of scope.
- 11) Undertaking that all the materials supplied by him at site are fully tax paid and shall produce all documentation for satisfaction of Client / Project Managers or taxation authorities.
- 12) Documents required for IGBC rating.
- 13) Submission of the above documentation shall form a precondition for final acceptance of the plant and installation and final payments.

v. Statutory approvals inspection

The contractor shall be fully responsible for meeting all the statutory obligations and local inspectorates wherever applicable to the works carried out by them. The contractor should prepare all working drawings and obtain approval of competent authorities and also have the equipment and installation inspected and got approved. All the original receipts of official fees paid and deposits made against the demand in writing from the appropriate authority shall be submitted to the Client.

SECTION-7. SCOPE OF WORKS FOR HVAC SYSTEMS

a) Major works

- Submission of complete technical data sheet, full load and part load performance data, curves for all the equipment required for energy modelling and associated component covered in the technical specification.
- Obtaining approval from all the necessary agencies before procurement, manufacturing, and execution.
- Procurement of Equipment as per the tender technical specifications and bill of quantities.
- Procurement of materials within the battery limits as per the schedule given by PMC /Client as per BOQ of the tender document.
- Manufacturing as per standards & details furnished in the specifications
- Assembly
- Testing in Factory prior to delivery
- Inspection
- Insurance up to handing over

- Packing & Forwarding
 - Transportation
 - Co-ordination for safe Installation at Site as per the schedule given by PMC/ Client.
 - Submission of method statements for execution
 - Testing, System balancing and Commissioning in the presence of specialized agency (manufacturer's representative)
 - Performance Guarantee run
 - Handing over Attendance to Defect Liability period
- b) HVAC Contractor shall coordinate provide all foundation details, point load details to the civil contractor through PMC for execution after obtaining the approval on the shop drawing from the consultants.
- c) Coordination with other subcontractors with regard to installation of items in Air Conditioning contractor's scope.
- d) The extent of work services under the contract include all items shown on the drawings, indicated in companion with specifications, notwithstanding the fact that such items have been omitted from the BOQ. All equipment and services, which are required to complete the intent of the contract, shall also be deemed to be within the scope of the contract.
- e) **Mandatory Requirements**
- ◆ HVAC Contactor shall mandatorily visit the site to ensure the logistics approach is viable for safe installation of all HVAC equipment at their designated location and terrace level of the building.
 - ◆ HVAC Contactor shall submit duly filled in technical data sheet under Section: 7 of the Technical Specification.

SECTION-8. BASIS OF DESIGN

Site Location	:	Bangalore
Geographic location	:	12.96 ° North
Altitude	:	3022 ft above mean sea level
Daily Temperature Range	:	18.5°F

Average ambient Design conditions for Bengaluru are considered as per ASHRAE Meteo 2021. For design, 0.4 % values have been considered.

Design Conditions	Dry Bulb		Wet Bulb		RH
	Deg F	Deg C	Deg F	Deg C	%
Summer	93.8	34.3	68	20.0	26
Monsoon	84.4	29.1	74.6	23.7	64

SECTION-9. TECHNICAL SPECIFICATION

In case of any discrepancy between technical specification of this document and BOQ document, it should be brought into consultants' attention immediately. With proper consent of the consultant the latter specification shall be followed.

VARIABLE REFRIGERANT FLOW (VRF) SYSTEM - DX AIR COOLED TYPE

GENERAL

Unit shall be of air cooled type, split type multi-system air conditioner consisting of one outdoor unit and multiple indoor units, each having capability to cool independently for the requirements of the rooms.

Up to 10 different type and capacity indoor-units can be connected to one refrigerant circuit and controlled individually.

Compressor shall be equipped with inverter controller, and capable of changing the rotating speed to follow variations in cooling load.

Outdoor unit shall be suitable for mix-match connection of following models.

- ☐ Ceiling mounted cassette type (Double flow)
- ☐ Ceiling mounted cassette type (Multi flow)
- ☐ Ceiling mounted low silhouette duct type.
- ☐ Ceiling mounted built-in type.
- ☐ Ceiling mounted built-in (Rear suction) type.
- ☐ Ceiling mounted duct type.

- ☐ Ceiling suspended type.
- ☐ Wall mounted type
- ☐ Floor standing type
- ☐ Concealed floor standing type.
- ☐ Ceiling mounted cassette corner type.

The refrigerant piping shall be extended up to 100m with 50m level difference without any oil traps.

OUTDOOR UNIT

The outdoor unit shall be a factory assembled unit housed in a sturdy weather proof casing constructed from rust-proofed mild steel panels coated with a baked enamel finish.

- ☐ The outdoor unit shall have multiple of scroll compressors and be able to operate even in case that one of compressors is out of order.
- ☐ The connectable range of indoor units shall be from 0.8 to 8TR with all outdoor units.
- ☐ The noise level shall not be more than 55 dB(A) at normal operation measured horizontally 1m away and 1.5m above ground.
- ☐ The outdoor unit shall be modular in design and should be allowed for side-by-side installation.

COMPRESSOR

The compressor shall be of highly efficient hermetic scroll type and equipped with inverter control capable of changing the speed in accordance to the cooling load requirement.

- ☐ The inverter shall be IGBT type to be efficient and quiet operation.
- ☐ The outdoor unit shall have the multi-step of capacity control to meet load fluctuation and indoor unit individual control.

HEAT EXCHANGER

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

- ☐ The aluminium fins shall be covered by anti-corrosion resin film.

REFRIGERANT CIRCUIT

The refrigerant circuit shall include an accumulator, liquid and gas shut off valves and a solenoid valves. All necessary safety devices shall be provided to ensure the safety operation of the system.

SAFETY DEVICES

The following safety devices shall be part of the outdoor unit:

High Pressure Switch, Low Pressure Switch, Fan Motor Safety Thermostat, Inverter Overload Protector, Over Current Relay, Fusible Plugs, Fuses.

OIL RECOVERY SYSTEM

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

INDOOR UNIT

- CEILING MOUNTED DUCTABLE FAN COIL UNITS WITH REFRIGERANT KITS –VRFTYPE

SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of Ceiling Mounted Ductable Fan Coil Units, conforming to these specifications and in accordance with requirements of Drawings and of the Schedule of Equipment.

CAPACITY

The air quantities and coil capacities should be as mentioned in the BOM and in the Schedule of Equipment.

UNIT

The Ductable Unit shall be Ceiling Mounted type. The housing/casing of the Air Unit shall be of double skin construction. The Frame work shall be of Extruded Aluminium Hollow Sections. The entire frame shall be assembled using pressure die cast aluminium joints to make a sturdy, strong & self-supporting framework for various sections.

23±2 mm thick Double Skin panels shall be made of 0.6mm Pre-plasticized GSS Sheet on outside and 0.6mm Galvanized sheet inside with CFC – FREE P.U.F. insulation injected in

between. These panels shall be screwed on to the frame work with soft rubber gasket on aluminium frame to make the joints air tight. Insulation material shall be of 38 Kg./Cum density.

FAN

The fan shall be Centrifugal DIDW Centrifugal / Plug fan Forward/ backward Curved Fan having belt driven three phase motor as specified. The fan shall be in 100% galvanized construction and shall be statically and dynamically balanced. The fans shall carry AMCA Certification.

EVAPORATOR COIL – DX TYPE

Evaporator Coil shall be made of ½” copper tube and aluminium fins firmly bonded together. The coil shall be of 4 RD and the air velocity across the coil shall not exceed 500 feet per minute. Each coil shall be factory tested at 30 Kg. Per sqm. air pressure under water. Tube shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 1 to 13 fins per inch..

The evaporator coil segments shall have a full width, multi sloped drain pan that extends downstream of the coil to provide sufficient amount of space to contain moisture carry-over. The unit design shall not require a drain pan in any downstream section to contain the coil condensate. Drain pan must be accessible for inspection and cleaning.

The evaporator coil drain pan shall be sloped to assure positive condensate drainage with a connection at both ends. The pan shall be of double wall construction with a Stainless Steel liner and have a minimum of 1” of non- compressed insulation. The pan shall have a minimum depth of 2 inches. The drain pan should be coated with anti-microbial coating.

All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. Before jointing any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints through nitrogen bleeding at 1.0kg/sqcm and Subsequently; it shall be thoroughly blown out using nitrogen.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 30Kg per sqm. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum if 700mm hg.

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



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

The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturers specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

REFRIGERANT KIT:

The refrigerant kit shall comprise thermostatic / electronic expansion valve with network of copper refrigerant pipes and controls to integrate the Ceiling suspended type indoor units with VRF type outdoor units.

The refrigerant kit shall be factory assembled in a powder coated cabinet with necessary inlet and outlet copper refrigerant pipe connections.

Refer BOQ for indoor unit capacity, piping details.

The pipe dimensions mentioned in the BOQ are tentative; the actual pipe sizes shall be selected as per the capacities, piping length. The vendor shall select the expansion valve kit suitable to meet the indoor unit capacities mentioned in the BOQ.

FILTER

Filter segments shall accommodate 2" media. Media shall be permanent cleanable. Average Efficiency of the filter shall be of MERV 11 standards. The filter frames shall be constructed of galvanized steel and be built as an integral part of the unit. All filter segments shall be front serviced with an access door on the Mixing box of the unit.

Note:

1) Factory test certificates along with fan selection, cooling coil selection and octave band sound pressure level should be furnished along with duly filled in tender documents for Consulting Engineers' technical evaluation.

2) All CSU's to be provided with additional insulated drip tray below the unit with independent drain point.

Cassette / Hi Wall type / VRF CSU

Each Indoor unit shall be complete with cooling coil, Fan, Filter and control accessories. It shall have electronic control valve which control refrigerant flow rate in respond to load variations of the room. The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation.

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

Ceiling Mounted Cassette / Hi-Wall type Units / FCU:

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

The fan shall be aerodynamically designed diffuser turbo fan type. The fan shall be mounted directly on motor shaft having supported from housing. The fan shaft shall be statically and dynamically balanced. The fan shall be direct driven type.

The cooling coil shall be of seamless copper tubes, and shall have continuous aluminium fins. The tubes shall be staggered in the direction of airflow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The coils shall be tested against leaks.

Unit shall have filter cleanable type of resin net (with mold resistant) fixed to an integrally moulded plastic frame. The filter should be slid away type but neatly inserted.

All visible Units shall have a external attractive panel for supply and return air.

Ceiling Mounted Cassette Unit shall have four-way supply air grilles on sides and return air grille in center. Each unit shall have high lift drain pump, fresh air intake provision and low gas level detection system.

Hide out Fan Coil Units shall have Return Air Plenum with Filter assembly.

Each unit shall have an electronic expansion valve which control refrigerant flow rate in respond to load variations of room. Each unit shall also have a pressure sensor.

The computerized PID control shall be used to maintain a correct room temperature. Each unit shall be provided with microprocessor thermostat for cooling & heating.

Each unit shall be with wired remote controller LCD type. The LCD remote controller shall memorize the latest malfunction code for easy maintenance.

Customized DX type Ceiling Suspended Ductable Unit

GENERAL

The scope of this section comprises the scope, design, supply, materials, installation, testing and commissioning of the Ceiling Suspended type air handling units in the HVAC systems conforming to these specifications and in accordance with the requirements of Drawing and Schedule of Quantities.

SCOPE

The scope of the contractor not limited to but inclusive of Selection, Supply of CSUs, Fan, Motors, Drive set, Washable Filters with MERV 11 rating factory extruded aluminium intake louvers, Mounting frame, Gaskets, fire retardant (Non-Cloth type) flexible connections, lifting, installation, testing, commissioning of the system as per the Indian & International standards etc., All the units should be provided with manufacturer test certificates. The supplier should arrange for the necessary factory inspection in case the project needs the same at their cost.

UNIT

The Ductable Unit shall be Ceiling Mounted type. The housing/casing of the Air Unit shall be of double skin construction. The Frame work shall be of Extruded Aluminium Hollow Sections. The entire frame shall be assembled using pressure die cast aluminium joints to make a sturdy, strong & self-supporting framework for various sections.

23±2 mm thick Double Skin panels shall be made of 0.8mm Pre-coated GSS Sheet on outside and 0.8mm Galvanised sheet inside with CFC – FREE P.U.F. insulation injected in between. These panels shall be screwed on to the frame work with soft rubber gasket on aluminium frame to make the joints air tight. Insulation material shall be of 40±2 Kg. /cum density. Detachable steel drain tray with necessary slope to facilitate quick removal of condensate.

COIL

Heat transfer Coil shall be made of ½" copper tube and aluminium fins firmly bonded together. The coil shall be of minimum 4 RD and the air velocity across the coil shall not exceed 500 feet per minute. Each coil shall be factory tested at 21 Kg. per Sqm Air pressure under water. Tube shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 1 to 13 fins per inch. Cooling coil refrigerant side tube velocity should be between 3 to 5 FPS.

The cooling coil segments shall have a full width, multi sloped drain pan that extends downstream of the coil to provide sufficient amount of space to contain moisture carry-over. The unit design shall not require a drain pan in any downstream section to contain the coil condensate. Drain pan must be accessible for inspection and cleaning.

The cooling coil drain pan shall be sloped to assure positive condensate drainage with a connection at both ends. The pan shall be of double wall construction with a stainless steel liner and have a minimum of 1" of non-compressed insulation. The pan shall have a minimum depth of 2 inches. The drain pan should be coated with anti-microbial coating.

FAN

The fan shall be of direct driven plug type with **aerofoil blade**, non-overloading type blades. The efficiency of the fans shall not be less than 70%. The fan casing, impeller and the blades shall be constructed with heavy gauge galvanized sheet and rigidly reinforced and supported with galvanized angles. The fans shall carry AMCA Certification.

CODES & STANDARDS

The design, materials, manufacture, inspection, testing and performance of the CSU's shall comply with all currently applicable statutes, regulations, codes and standards in the locality where the equipment is to be installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility. In particular, the CSU's shall confirm to the latest edition of the following standards:

IS 7613	Methods of Testing panel type Air Filters for Air-Conditioning and Ventilation purposes?
AHRI 430	Central-station air handling units.
AMCA 210	Laboratory methods of testing fans for ratings.
NFPA 90 A	Installation of Air-Conditioning and Ventilation Systems.

DESIGN CRITERIA



All fans shall be rated, tested, and certified in accordance with AMCA standards. Use dielectric unions or flange kits for dissimilar metal connections capable of galvanic corrosion.

Buna-N seals are not allowed on hot water systems, use EPDM or Vinton

Filters shall be tested and certified in accordance with ASHRAE Standard 52.

Units shall be designed in accordance with site seismic requirements.

All instrumentation and controls shall be commercial quality.

CSU panel shall be selected as per the location & connection required as per the drawing and project requirements.

SELECTION CRITERIA

The equipment shall be of factory fabricated only and shall be selected for the given air flow and static pressure at the lowest operating noise level, High efficiency, Capacity ratings, Low power consumption, with operating points clearly indicated, properly balanced shall be submitted and verified at the time of testing and commissioning of the installation.

The fan outlet velocity shall be within 10m/sec.

The noise level at 1m distance from the equipment shall not exceed 60dba.

The face velocity across the pre-filter shall not be exceeding 2.5m/s.

SUBMITTALS

General arrangement of the (GA) drawings of the CSU, fan equipments with parts details, static & operating weight.

Fan Performance curve for the required air quantity and the static pressure loss, indicating the speed of the fan (RPM), total and static efficiency of the fan, fan motor absorbed power, Actual motor capacity, Max. fan speed, Max absorbed power, noise level in dbA at different octave band spectrum from 63 Hz to 8 kHz. Etc.,

Fan total static pressure drop calculation indicating the internal pressure drop and external pressure drop in mm of water column or in Pascal's.

Filter type with filtration data, dimensional data, and installation requirements should be provided for the filters.

CSU noise level calculation using the Fan Inlet & outlet noise level in different octave band spectrum from 63hz to 8 kHz and the attenuation by the cabinet etc.,

Fan total static pressure drop calculation indicating the CSUs internal pressure drop and external pressure drop in mm of water column or in Pascal's.

- Seismic design calculations.
- Factory fan vibration balancing reports.
- Factory performance test certificates.

CONSTRUCTION DETAILS

CABINET:-

The cabinet shall be constructed suitable to accommodate the fan section, drive motor, filters etc., as required. Necessary powder coated GI canopy to be provided for the unit located at outdoor.

The cabinet shall be of airtight construction and sufficiently rigid for the entire capacity of the unit. The cabinet shall be constructed with double skin acoustic panels with minimum 0.8mm thick Pre coated Galvanized sheet outer skin and minimum 0.8mm thick plain galvanized sheet inner skin. All the panels shall be of thickness 23+/-2mm as mentioned in the BOQ. The insulation shall be sandwiched between the inner & outer skin with pressure injected with CFC free Polyurethane Foam (PUF) of density not less than 40+/-2kg/m³ and thermal conductivity K value not exceeding 0.020w/m²K at 0°C as per ASTM-C518.

The CSU panels shall be of modular construction. All the panels shall be detachable. EPDM gaskets and stainless steel screws are only to be used for fastening the panels. The AHU panels to be provided with opening for the electrical cable entry. The Entire panel shall be mounted on aluminium alloy channel of minimum 10mm high. The lifting lugs of minimum 4 Nos. to be provided on the base channels. The entire rigid & corner joint frame shall be of high rigid Extruded Aluminium alloy channels.

The CSU shall be provided with double skin quick opening type panel door for the fan and the motor sections. Protective guard shall be provided behind the access door. The door should be provided with powder coated die-cast aluminium hinges and hard nylon handles. The door should be providing with limit switches for safety interlock. The CSU should be provided with LED light for easy visibility at the time of service.

The fan & motor to be mounted on the high grade aluminium extruded slide rail base frame. It should be isolated from the main casing using high quality vibration isolators (spring). The fan outlet shall be connected to the main casing, using high quality fire and moisture resistant flexible connection to avoid vibration transmittance.

DX TYPE COOLING COIL SECTION:-

The Cooling DX Type Coil shall be suitable for refrigerant flow. The number of rows of cooling coil shall be as per BOM or as per the manufacturer selection whichever is greater.

Contractor shall submit the computerised coil selection as per the above VRF conditions for consultant review and approval.

The Air velocity across the coil shall not to be exceeding 2.5m/sec (500 fpm).

The coils shall be mounted over an adequately sized condensate drain pan. Particular, care shall be taken to ensure that condensate is drained totally without leaving any stagnant pools anywhere in the unit. The drain pan shall be of stainless steel construction of thickness not less than 1.2 mm and of grade not less than SS 304 and shall be insulated for thermal protection with of not less than 25mm thick Nitrile rubber or equivalent insulation (refer insulation part for specification) to avoid any surface condensation.

FAN & MOTOR SECTION:-

All fans shall be of factory fabricated only and shall be selected for the lowest operating noise level. High efficiency, Capacity ratings, Low power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

The fan shall be of direct driven plug type with **aerofoil blade**, non-overloading type blades. The efficiency of the fans shall not be less than 70%. The fan casing, impeller and the blades shall be constructed with heavy gauge galvanized sheet and rigidly reinforced and supported with galvanized angles.

The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy-duty ball bearings. Bearings shall be self-aligning; pillow block type selected for an average life of 200,000 hours at design operating conditions and shall be provided with grease line extending to outside of the AHU Casing. The impeller & blades shall be selected / designed for quiet - running. The fan assembly shall be statically & dynamically balanced. Multiple impellers for the entire flow rate specified for the unit is preferred to provide redundancy. Blanking sheets to be provided in front of each fan section to isolate and prevent backflow during maintenance or non-operation times.

The motors should be of TEFC squirrel gage induction class F insulated motor with minimum IP 55 protection and suitable for 3phase, 415volts, 50 Hz power operation. The motor should be of High efficiency (**IE3**) and should have efficiency of not less than 85%. The motor should be suitable for the Variable frequency drive (VFD) operation wherever required. The motor rpm shall not exceed 1450. Motor name plate horsepower shall exceed brake horsepower by a minimum of 15%. Any power transmission loss from motor to the fan, efficiency loss of motor, necessary safety factor of not less than 5%, all to be added at motor rating selection. The starting torque of the motor is also to be taken care while selecting.

FILTER SECTION:-

The filtration are classified as per the standards of ASHRAE 52.2, DIN 24185, ISO 16890, EN1822 based on the efficiency of filtration as a function of specific particle sizes

The CSUs shall be provided with Pre filter (MERV-11) as mentioned in the BOQ and requirements. These filters should be fixed on the modular type mounting frames made of heavy gauge Powder coated GI or anodized aluminium. The filters shall be with Neoprene / felt gasket to be used for airtight fixing of the filters. These filters should be provided with handles for easy removable. The Pre filters shall be provided at the inlet side of the fan section.

ELECTRIC HEATING:

The air handling units shall be with strip heater (Only if asked in the BOQ) upstream to the cooling coil, complete with safety thermostat for manual resetting to cut off the power supply and trigger the alarm in the event of overheating. The heating should have dual purpose;

1. Heating the air in order to reach and maintain the set point.
2. Reheating in the dehumidifying phase so as to restore the air temperature to the set point.

FACTORY TESTS

The Contractor / manufacturer shall describe the tests that will be conducted at their works on the Ceiling Suspended Fresh Air Units. They shall furnish a test certificate /certificates to the effect that such tests have been duly performed on the CSUs.

INSTALLATION

A manufacturer's representative for the fans shall be provided as necessary to assist the Subcontractor during installation, and to provide written certification that the equipment has been installed complete as specified and in accordance with the manufacturer's directions as approved.

All the CSUs to be suspended from the ceiling shall be provided with G.I. base channels, threaded rods, anchor fasteners, adequately sized vibration isolation spring hangers (sized as per operating weight of the CSU), rubber bush to prevent swing of the CSU, hot dipped galvanized bolts, washers (plate & spring) and nuts to eliminate vibration transmittance from CSUs.

All fan equipment shall be verified by field vibration tests that factory balance has been maintained during shipment and erection. Field rebalances if required.

Note: All CSU's to be provided with additional insulated drip tray below the unit with independent drain point.

Control

Computerized PID control shall be used to maintain a correct room temperature. Unit shall be equipped with a self-diagnosis for easy and quick maintenance and service.

The LCD (Liquid Crystal Display) remote controller shall memorize the latest malfunction code for easy maintenance.

☐ It shall be able to control up to 16 indoor units and change fan speed and angle of swing flap individually in the group.

CEILING SUSPENDED CHILLED WATER TREATED FRESH AIR UNITS - VRF TYPE

CEILING SUSPENDED CHILLED WATER TREATED FRESH AIR UNITS - VRF TYPE

GENERAL

The scope of this section comprises the scope, design, supply, materials, installation, testing and commissioning of the Ceiling Suspended type air handling units in the HVAC systems conforming to these specifications and in accordance with the requirements of Drawing and Schedule of Quantities.

SCOPE

The scope of the contractor not limited to but inclusive of Selection, Supply of TFA, Fan, Motors, Drive set, Washable Filters with MERV 11 rating factory extruded aluminium intake louvers, Mounting frame, Gaskets, fire retardant (Non-Cloth type) flexible connections, lifting, installation, testing, commissioning of the system as per the Indian & International standards etc., All the units should be provided with manufacturer test certificates. The supplier should arrange for the necessary factory inspection in case the project needs the same at their cost.

UNIT

The TFA Unit shall be Ceiling Mounted type. The housing/casing of the Air Unit shall be of double skin construction. The Frame work shall be of Extruded Aluminium Hollow Sections. The entire frame shall be assembled using pressure die cast aluminium joints to make a sturdy, strong & self-supporting framework for various sections.

23±2 mm thick Double Skin panels shall be made of 0.8mm Pre-coated GSS Sheet on outside and 0.8mm Galvanised sheet inside with CFC – FREE P.U.F. insulation injected in between. These panels shall be screwed on to the frame work with soft rubber gasket on aluminium frame to make the joints air



tight. Insulation material shall be of 40 ± 2 Kg. /cum density. Detachable steel drain tray with necessary slope to facilitate quick removal of condensate.

COIL

Heat transfer Coil shall be made of $\frac{1}{2}$ " copper tube and aluminium fins firmly bonded together. The coil shall be of minimum 4 RD and the air velocity across the coil shall not exceed 500 feet per minute. Each coil shall be factory tested at 21 Kg. per Sqm Air pressure under water. Tube shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 1 to 13 fins per inch. Cooling coil refrigerant side tube velocity should be between 3 to 5 FPS.

The cooling coil segments shall have a full width, multi sloped drain pan that extends downstream of the coil to provide sufficient amount of space to contain moisture carry-over. The unit design shall not require a drain pan in any downstream section to contain the coil condensate. Drain pan must be accessible for inspection and cleaning.

The cooling coil drain pan shall be sloped to assure positive condensate drainage with a connection at both ends. The pan shall be of double wall construction with a stainless steel liner and have a minimum of 1" of non-compressed insulation. The pan shall have a minimum depth of 2 inches. The drain pan should be coated with anti-microbial coating.

FAN

The fan shall be of direct driven plug type with **aerofoil blade**, non-overloading type blades. The efficiency of the fans shall not be less than 70%. The fan casing, impeller and the blades shall be constructed with heavy gauge galvanized sheet and rigidly reinforced and supported with galvanized angles. The fans shall carry AMCA Certification.

CODES & STANDARDS

The design, materials, manufacture, inspection, testing and performance of the TFA's shall comply with all currently applicable statutes, regulations, codes and standards in the locality where the equipment is to be installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility. In particular, the TFA's shall confirm to the latest edition of the following standards:

IS 7613	Methods of Testing panel type Air Filters for Air-Conditioning and Ventilation purposes
AHRI 430	Central-station air handling units.
AMCA 210	Laboratory methods of testing fans for ratings.
NFPA 90 A	Installation of Air-Conditioning and Ventilation Systems.

DESIGN CRITERIA

All fans shall be rated, tested, and certified in accordance with AMCA standards. Use dielectric unions or flange kits for dissimilar metal connections capable of galvanic corrosion.

Buna-N seals are not allowed on hot water systems, use EPDM or Vinton

Filters shall be tested and certified in accordance with ASHRAE Standard 52.

Units shall be designed in accordance with site seismic requirements.

All instrumentation and controls shall be commercial quality.

TFA panel shall be selected as per the location & connection required as per the drawing and project requirements.

SELECTION CRITERIA

The equipment shall be of factory fabricated only and shall be selected for the given air flow and static pressure at the lowest operating noise level, High efficiency, Capacity ratings, Low power consumption, with operating points clearly indicated, properly balanced shall be submitted and verified at the time of testing and commissioning of the installation.

The fan outlet velocity shall be within 10m/sec.

The noise level at 1m distance from the equipment shall not exceed 60dba.

The fan speed for the fan dia above 450mm shall not exceed 1000rpm.

The fan speed for the fan dia up to 450mm shall not exceed 1450rpm.

The face velocity across the pre-filter shall not be exceeding 2.5m/s.

SUBMITTALS

General arrangement of the (GA) drawings of the TFA, fan equipments with parts details, static & operating weight.

Fan Performance curve for the required air quantity and the static pressure loss, indicating the speed of the fan (RPM), total and static efficiency of the fan, fan motor absorbed power, Actual motor capacity, Max. fan speed, Max absorbed power, noise level in dbA at different octave band spectrum from 63 Hz to 8 kHz. Etc.,

Fan total static pressure drop calculation indicating the internal pressure drop and external pressure drop in mm of water column or in Pascal's.

Filter type with filtration data, dimensional data, and installation requirements should be provided for the filters.



TFA noise level calculation using the Fan Inlet & outlet noise level in different octave band spectrum from 63hz to 8 kHz and the attenuation by the cabinet etc.,

Fan total static pressure drop calculation indicating the TFAs internal pressure drop and external pressure drop in mm of water column or in Pascal's.

- Seismic design calculations.
- Factory fan vibration balancing reports.
- Factory performance test certificates.

CONSTRUCTION DETAILS

CABINET:-

The cabinet shall be constructed suitable to accommodate the fan section, drive motor, filters etc., as required. Necessary powder coated GI canopy to be provided for the unit located at outdoor.

The cabinet shall be of airtight construction and sufficiently rigid for the entire capacity of the unit. The cabinet shall be constructed with double skin acoustic panels with minimum 0.8mm thick Pre coated Galvanized sheet outer skin and minimum 0.8mm thick plain galvanized sheet inner skin. All the panels shall be of thickness 23+/-2mm as mentioned in the BOQ. The insulation shall be sandwiched between the inner & outer skin with pressure injected with CFC free Polyurethane Foam (PUF) of density not less than 40+/-2kg/m³ and thermal conductivity K value not exceeding 0.020w/m²K at 0°C as per ASTM-C518.

The TFA panels shall be of modular construction. All the panels shall be detachable. EPDM gaskets and stainless steel screws are only to be used for fastening the panels. The AHU panels to be provided with opening for the electrical cable entry. The Entire panel shall be mounted on aluminium alloy channel of minimum 10mm high. The lifting lugs of minimum 4 Nos. to be provided on the base channels. The entire rigid & corner joint frame shall be of high rigid Extruded Aluminium alloy channels.

The TFA shall be provided with double skin quick opening type panel door for the fan and the motor sections. Protective guard shall be provided behind the access door. The door should be provided with powder coated die-cast aluminium hinges and hard nylon handles. The door should be providing with limit switches for safety interlock. The TFA should be provided with LED light for easy visibility at the time of service.

The fan & motor to be mounted on the high grade aluminium extruded slide rail base frame. It should be isolated from the main casing using high quality vibration isolators (spring). The fan outlet shall be connected to the main casing, using high quality fire and moisture resistant flexible connection to avoid vibration transmittance.

DX TYPE COOLING COIL SECTION:-



The Cooling DX Type Coil shall be suitable for refrigerant flow. The number of rows of cooling coil shall be as per BOM or as per the manufacturer selection whichever is greater.

Contractor shall submit the computerised coil selection as per the above VRF conditions for consultant review and approval.

The Air velocity across the coil shall not to be exceeding 2.5m/sec (500 fpm).

The coils shall be mounted over an adequately sized condensate drain pan. Particular, care shall be taken to ensure that condensate is drained totally without leaving any stagnant pools anywhere in the unit. The drain pan shall be of stainless steel construction of thickness not less than 1.2 mm and of grade not less than SS 304 and shall be insulated for thermal protection with of not less than 25mm thick Nitrile rubber or equivalent insulation (refer insulation part for specification) to avoid any surface condensation.

FAN & MOTOR SECTION:-

All fans shall be of factory fabricated only and shall be selected for the lowest operating noise level. High efficiency, Capacity ratings, Low power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

The fan shall be of direct driven plug type with **aerofoil blade**, non-overloading type blades. The efficiency of the fans shall not be less than 70%. The fan casing, impeller and the blades shall be constructed with heavy gauge galvanized sheet and rigidly reinforced and supported with galvanized angles.

The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy-duty ball bearings. Bearings shall be self-aligning; pillow block type selected for an average life of 200,000 hours at design operating conditions and shall be provided with grease line extending to outside of the AHU Casing. The impeller & blades shall be selected / designed for quiet - running. The fan assembly shall be statically & dynamically balanced. Multiple impellers for the entire flow rate specified for the unit is preferred to provide redundancy. Blanking sheets to be provided in front of each fan section to isolate and prevent backflow during maintenance or non-operation times.

The motors should be of TEFC squirrel cage induction class F insulated motor with minimum IP 55 protection and suitable for 3phase, 415volts, 50 Hz power operation. The motor should be of High efficiency (**IE3**) and should have efficiency of not less than 85%. The motor should be suitable for the Variable frequency drive (VFD) operation wherever required. The motor rpm shall not exceed 1450. Motor name plate horsepower shall exceed brake horsepower by a minimum of 15%. Any power transmission loss from motor to the fan, efficiency loss of motor, necessary safety factor of not less than 5%, all to be added at motor rating selection. The starting torque of the motor is also to be taken care while selecting.

FILTER SECTION:-

The filtration are classified as per the standards of ASHRAE 52.2, DIN 24185, ISO 16890, EN1822 based on the efficiency of filtration as a function of specific particle sizes

The TFAs shall be provided with Pre filter (MERV-11) as mentioned in the BOQ and requirements. These filters should be fixed on the modular type mounting frames made of heavy gauge Powder coated GI or anodized aluminium. The filters shall be with Neoprene / felt gasket to be used for airtight fixing of the filters. These filters should be provided with handles for easy removable. The Pre filters shall be provided at the inlet side of the fan section.

ELECTRIC HEATING:

The air handling units shall be with strip heater (Only if asked in the BOQ) upstream to the cooling coil, complete with safety thermostat for manual resetting to cut off the power supply and trigger the alarm in the event of overheating. The heating should have dual purpose;

1. Heating the air in order to reach and maintain the set point.
2. Reheating in the dehumidifying phase so as to restore the air temperature to the set point.

FACTORY TESTS

The Contractor / manufacturer shall describe the tests that will be conducted at their works on the Ceiling Suspended Fresh Air Units. They shall furnish a test certificate /certificates to the effect that such tests have been duly performed on the TFAs.

INSTALLATION

A manufacturer's representative for the fans shall be provided as necessary to assist the Subcontractor during installation, and to provide written certification that the equipment has been installed complete as specified and in accordance with the manufacturer's directions as approved.

All the TFAs to be suspended from the ceiling shall be provided with G.I. base channels, threaded rods, anchor fasteners, adequately sized vibration isolation spring hangers (sized as per operating weight of the TFA), rubber bush to prevent swing of the TFA, hot dipped galvanized bolts, washers (plate & spring) and nuts to eliminate vibration transmittance from TFAs.

All fan equipment shall be verified by field vibration tests that factory balance has been maintained during shipment and erection. Field rebalances if required.

Note: All TFA's to be provided with additional insulated drip tray below the unit with independent drain point.



Control

Computerized PID control shall be used to maintain a correct room temperature. Unit shall be equipped with a self-diagnosis for easy and quick maintenance and service.

The LCD (Liquid Crystal Display) remote controller shall memorize the latest malfunction code for easy maintenance.

☐ It shall be able to control up to 16 indoor units and change fan speed and angle of swing flap individually in the group.

Centralized intelligent Touch Remote Controller / VRF PLANT MANAGER

A multifunctional compact centralized controller shall be provided with the system if specified in BOQ.

The Graphic Controller must act as an advanced air-conditioning management system to give complete control of VRV air-conditioning Equipment, It should have ease of use for the user through its touch screen, icon display and colour LCD display.

It shall be able to control up to 64 groups of indoor units with the following functions:

- a. Starting/stopping of Air conditioners as a zone or group or individual unit.
- b. Temperature settling for each indoor unit or zone.
- c. Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.
- d. Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.
- e. Display of air conditioner operation history.
- f. Daily management automation through yearly schedule function with possibility of various schedules.

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

BMS integration

The VRV system shall have full BMS integration feature in line with open protocol communication. All the outdoor unit parameters will be monitored through BMS by soft link so that all data shall be available in **BMS PC**.

The AC vendor shall co-ordinate with BMS vendor for proper integration of VRV system.

Communication protocol shall be native BacNET/IP.

VENTILATION FANS

FAN SECTIONS

GENERAL

The scope of this section comprises the supply, installation, testing and commissioning of various types of fans like centrifugal, in-line and wall mounted fans and roof mounted units conforming to BOQ specifications and in accordance with the requirement of Drawings and schedule of Quantities.

SCOPE

The scope of the HVAC contractor is not limited to but inclusive of the supply of fan, installation, termination of cables with suitable terminal blocks for motors, providing base frame, vibration isolators, hangers, flexible connection etc. The cost quoted shall be inclusive of all above for the equipment and air distribution system as mentioned in the BOQ.

STANDARDS

The design, materials, construction, manufacture, inspection, testing and performance of fans shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. The fan performance curves shall be AMCA certified. Contractor shall also submit corrected performance curves for the fan considering the as installed condition of the fan at site.

All fans shall be of factory fabricated only and shall be selected for the lowest operating noise level. High efficiency, Capacity ratings, Low power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation. The motor insulation class for smoke or higher temperature application shall be of class 'H' and above for kitchen ventilation system.

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.



The Air moving capacity and static pressure shall be as shown in the schedule of quantities and in the drawings.

There are various type of fan like Centrifugal fan, Tube Axial flow fan, In-line fans, Propeller fans, roof mounted extract fans etc., shall be of as described below.

FAN CONSTRUCTION CLASS:-

Fan construction is classified under four categories based on the maximum total pressure they can safely develop.

Fan up to 3.75" (95mm) wc– Class I

Fan from 3.76" (96mm) to 6.75" (171mm) – Class II

Fan from 6.76" (172mm) to 12.25" (311mm) – Class III

Fan from 12.26" (312mm) and above – Class IV

• CENTRIFUGAL FAN: -

Centrifugal fan shall be DIDW / SISW of required pressure Class of construction. The bearings shall be on both the sides for DIDW fans and both bearings on one side (non air stream side) for SISW fans. The fans shall be complete with access door, squirrel-cage induction motor, V-belt drive belt guard and vibration isolators, direction of discharge / rotation, and motor position shall be as per the Approved-for-Construction shop drawings.

1. Housing shall be constructed of 2 / 1.6 / 1.0mm thick GI sheet steel welded construction as per the standards. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene/ asbestos packing should be provided throughout split joints to make it air-tight. 18-gauge galvanized wire mesh inlet guards of 50mm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout door with handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

2. Fan Wheel shall be backward-curved / Aerofoil non-cover loading type. Fan wheel and housing shall be statically and dynamically balanced. The fan outlet velocity shall not exceed 10m/sec. For fans up to 450mm dia., maximum fan speed shall not exceed 1500 rpm. For fans above 450mm dia. the maximum fan speed shall not exceed 1000 RPM. High static pressure fan speed shall be as per manufacturer.

3. Shaft shall be constructed of steel, turned, ground and polished.

4. Bearings: shall be of the sleeve / ball- bearing type mounted directly on the fan housing / with additional platform. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil / grease pack pillow block type. The bearing shall have a minimum life of 200,000 hours.

5. The fan motor shall be energy efficient and suitable for 415+/-10% volts, 50 cycles, 3phase AC power supply, squirrel-cage, totally enclosed, fan- cooled motor, provided with class-F insulation, and of approved make. Motor name plate horsepower shall exceed brake horsepower by a minimum of 15%. Any power transmission loss from motor to the taken care while selecting. The motor also should be suitable for VFD operation. Motor shall be designed especially for quiet operation and motor speed shall not exceed 1440 RPM. The fan and motor combination selected for the particular required performance shall be of the most efficient, low energy consumption and low noise. All the motors should be of IP-55 protection and above as required.

6. The Belt driven to fan shall be provided with V-Belts, Pulleys, and Belt Guard. Belts shall be of the Oil- resistant type. The number of grooves should be of minimum two (2) numbers and number of belts should be one number more than the fan selection to prevent start up failure and pre mature belt failure.

7. MS base channel shall be provided for both the fan and motor with the provision for finer movement of motor for easy alignment. The base frame shall be mounted on a concrete foundation shall be of at least 150mm above finished floor level. Necessary cushy foot and spring mounts to be provided for reduced vibration.

8. The fan inlet and outlet shall be connected to the sheet metal ducting by mean of 100mm length fire retardant, weather proof flexible connections.

9. The fan noise level shall not exceed 82dba at 1m from the equipment.

- **TUBE AXIAL FAN:-**

Fan shall be of class-1 construction, complete with motor, motor mount, direct driven (or belt driven) and vibration isolators, inspection/access door, suspension arrangement as per approved for construction shop drawings.

1. The fan Casing shall be constructed of heavy gauge Galvanized steel / mild steel sheet. Casing shall have flanged connection on both ends. An inspection door with handle and neoprene gasket shall be provided. Fan Casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting shall be minimum 15mm thick and machined to receive motor flange. All the necessary footing & brackets shall be welded with casing for ceiling suspension / floor mounting of the units. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. The Casing shall be finished galvanized after manufacturing or with 1 coat of primer and 2 coats of enamel paint as required. Necessary arrow marks to be provided to indicate the air flow direction.

2. The Impeller hub & blades should be made out of high grade pressure casted aluminium. The blade should be of aerofoil type, statically and dynamically balanced. The blade should be able to readjust manually at site for obtaining actual flow and pressure as per final site condition.

3. The fan motor shall be energy efficient and suitable for 415+/-10% volts, 50 cycles, 3 phase AC power supply, squirrel-cage, totally enclosed, air over motor cooled (or fan-cooled motor if motor is out of air stream), provided with class-F insulation, and of approved make. Motor name plate horsepower shall exceed brake horsepower by a minimum of 15%. The starting torque of the motor should also be taken care while selecting. The fan and motor combination selected for the particular required performance shall be of the most efficient, low energy consumption and low noise level. All the motors should be IE-3 rated. Motor speed shall not exceed 1500rpm for the impeller up to 450mm dia. and shall not exceed 1000rpm for the impeller above 450mm dia. The sound pressure levels of the fan shall not be exceeding 75 dBA at 1.5M distance. Necessary sound attenuators shall be considered to achieve the above sound pressure levels.

4. The Belt driven fans shall be provided with V-Belts, Pulleys, and Belt Guard. Belts shall be of the Oil-resistant type. The number of groove should be of minimum two (2) numbers and number of belts should be one number more than the fan selection to prevent start up failure and premature belt failure.

5. The fan inlet and outlet shall be connected to the sheet metal ducting by means of 100mm length fire retardant, weather proof flexible connections.

6. Necessary silencer to be provided if specifically called for in the bill of quantities.

7. The fan noise level shall not exceed 75dBA at 1.5m from the equipment of normal application.

8. The fan of normal operation shall be with operating temperature range of -20°C to 55°C and the fan of smoke / fire emergency operation should be rated for +250°C temperature for 2 hours and motor insulation class should be selected as required in accordance with ANSI/AMCA -210 method of testing or as per British standard BS7346 part2: 1990.

- **IN LINE FAN (RECTANGULAR):-**

The Rectangular type Inline fan shall be of class-1 construction, complete with motor, motor mount, direct driven (or belt driven) and vibration isolators, inspection/access door, suspension arrangement as per approved for construction shop drawings.

1. The fan section shall be of single skin cabinet type shall be constructed of heavy gauge Galvanized steel sheet with necessary access door and flanged connection on both inlet & outlet for ducted application. The cabinet shall be provided with necessary footings / bracket to support from ceiling or floor mounted.

2. Fan Wheel shall be forward / backward-curved type. Fan wheel and housing shall be statically and dynamically balanced. The fan outlet velocity shall not exceed 10m/sec. For fans up to 450mm dia., maximum fan speed shall not exceed 1500 rpm. For fans above 450mm dia. the maximum fan speed shall not exceed 1000 RPM. High static pressure fan speed shall be as per manufacturer.

3. The fan motor shall be of 230V +/-10% volts, 50hz, 1phase AC power supply for below 1.0kw motor and shall be suitable for 415+/-10% volts, 50 cycles, 3 phase AC power supply for

1.0kw & above capacity, The motor shall be squirrel-cage, totally enclosed, air over motor (or fan-cooled motor if motor is out of air stream), provided with class-F insulation, and of approved make. Motor name plate horsepower shall exceed brake horsepower by a minimum of 15%. The starting torque of the motor should be taken care of while selecting. The fan and motor combination selected for the particular required performance shall be of the most efficient, low energy consumption and low noise level. All the motors should be of IP-44 / 21 protections and above as required.

4. The single phase fan shall be of direct driven and the 3phase shall be of belt driven type. The Belt driven fan shall be provided with V-Belts, Pulleys, and Belt Guard. Belts shall be of the Oil-resistant type. The number of groove should be of minimum two (2) numbers to prevent start up failure and premature belt failure.

5. The fan inlet and outlet shall be connected to the sheet metal ducting by means of 100mm length fire retardant, weather proof flexible connections.

6. The fan noise level shall not exceed 65dba at 1m from the equipment of normal application.

- **IN LINE FAN (CIRCULAR):-**

The Circular Inline fan shall complete with casing, impeller, motor, back draft damper etc.

The fan casing shall be constructed of pressed heavy gauge Galvanized steel sheet or tough reinforced plastic or equivalent finished with tough epoxy painting. The impeller with motor shall be housed inside the circular casing. The fan motor shall be suitable for 230V +/-10% volts, 50 Hz, 1phase AC power supply with minimum class B insulation & IP 21 / 44 protections. The fan speed shall be of maximum 3000rpm. The fan should be selected for required low pressure class with low noise level. The fan should be provided with necessary supporting brackets.

- **PROPELLER FAN:-**

The Propeller fan complete with mounting plate, fan blades, motor, wire guard on inner side, bird screen on the outer side and fixed / gravity louver etc.,

The fan casing shall be constructed of pressed heavy gauge Galvanized steel sheet or tough reinforced plastic or equivalent complete with polyester paint finish. The fan speed shall be of maximum 1000rpm for small sizes up to 450mm dia. The fan blade shall be of 3 / 4 blade type. The fan motor shall be of standard (easily replaceable) permanent split capacitor or shaded pole type for small sizes and suitable for 230V +/-10% volts, 50hz, 1phase AC power supply with minimum of class B insulation & with minimum IP 21 protection. The motor for fan size above 450mm shall be suitable for 415V +/- 10% volts, 50 Hz, 3phase AC power supply. The motor should be of totally enclosed and pre-lubricated sleeve / ball bearing designed for quiet operation. The fan should be provided with necessary supporting brackets.

DAMPERS

GENERAL

The scope of this section comprises of construction details of dampers involved in the project. The cost shall inclusive of supply, installation, testing, balancing, flanges, GI bolts & nuts etc.

SCOPE

The scope of the damper for the HVAC contractor not limited to but inclusive of supply, installation, testing, balancing of the same. The cost shall inclusive of necessary connecting flanges, bolts, nuts, hangers, vibration pads or suspenders, operating handles, necessary electrical actuators, control panels; step down transformers, labour for installation, testing, balancing & commissioning and any necessary item required for fully completion of works. For the GI damper all the angles, bolts, nuts etc., shall be of galvanized material only.

a) VOLUME CONTROL DAMPER (VCD)

Dampers shall be placed in ducts and at every branch of supply or return air duct connection whether or not indicated on the drawings, but shall be provided for the proper volume control and balancing the system.

- **GI VCD - Standard Type.**

All dampers should of robust construction with multi opposed blade construction of low leakage type. The outer casing shall be made out of 1.6mm thick GI welded frame with flat type 1.6mm. GI sheet blade with galvanized steel spindle, provided with bronze bushes, suitable links, levers and quadrant, handle as required for their proper operation, control or setting to any desired position, flanges to connect to the equipment / duct. Dampers and their operating devices shall be made robust, easily operable. Every damper shall have clear indication showing the damper position at all the times.

- **GI VCD - Aerofoil Type**

All dampers should of robust construction with aerofoil multi opposed blade construction of low leakage type. The outer casing and the blade shall be made out of 1.6mm thick GI welded frame with 0.7mm. GI aerofoil type blade is on 19mm dia steel shaft. The shaft shall running full length of the blade and pivoting on bronze bushes. The damper is to be provided with stainless steel side gasket, to be operated with suitable gear for smooth

operation. The Gear can be operated with handle as required for their proper operation, with control or setting with lock arrangement to keep any desired position. Damper is to be provided with flanges to connect to the equipment / duct. Dampers and their operating devices shall be made robust, easily operable. Every damper shall have clear indication showing the damper position at all the times.

- **Aluminium VCD - Aerofoil Type**

All dampers should of robust construction with aerofoil multi opposed blade construction of low leakage type. The outer casing and the blade shall be made out of High quality extruded aluminium and it should be suitable for flange connection. The blades are to be pivoted on PVC bushes. Dampers are to be operated with suitable gear for smooth operation. The Gear can be operated with handle as required for their proper operation with control or setting with lock arrangement to keep any desired position. Dampers are to be provided with flanges to connect to the equipment / duct. Dampers and their operating devices shall be made robust, easily operable. Every damper shall have clear indication showing the damper position at all the times.

- b) **FIRE DAMPER (FD)**

The scope of the fire damper supply inclusive of Fire damper, Sleeves, Duct connecting GI Flanges, Wall retaining GI flanges, Actuator / Fusible links, Temperature sensor / smoke sensor, control panel, step down transformer, Fire sealant material, supports, bolts & nuts etc., The scope also inclusive of necessary installation, testing and commissioning of the same.

Fire Damper construction

All Fire Damper should be tested for UL-555. All Fire dampers should of robust construction with multi leaf opposed blade construction to prevent passage of fire/smoke. It should be suitable for flange connection. The outer casing shall be made out of 1.6mm.thick GI welded frame with flat V type 1.6mm GI sheet blade with chrome plated steel spindle, provided with self lubricated bronze bushes, with stainless steel side seal gasket, with suitable links, levers and quadrant as required for their proper operation, And the linkage should be fully enclosed inside GI coverage and completely placed outside the air stream

Wherever the fire damper located in the wall, the fire damper should have minimum depth of approximately 450 to 600mm to have the connecting flanges out of fire wall / partition

provided and to get connected to the equipment / duct as per the actual site condition. The damper shall be able to operate by handle or the Actuator located on the extended inner wall side portion of the fire damper casing to enable proper sealing around the damper. The damper shall also be provided with necessary retainer angle flanges to fix in the wall.

The HVAC contractor should ensure the proper closing of the wall opening around the fire damper with fire wall by co-coordinating with necessary other agencies. However the balance short gap around the fire damper should be sealed with fire retardant leak & fire proof sealant by the HVAC contractor. The cost of the fire damper should be inclusive of the same. The installation of fire damper shall be as per SMACNA standards.

The fire damper can be provided with any one of the following options as mentioned in the BOQ / Tender drawing & specifications. If any clarification needed HVAC should get confirmation about the controls & Actuator type before quote for the same.

Fire damper control options

1. With Fusible Link and Spring Mechanism

The damper is held open by a replaceable fusible link rated at 74⁰C (U.L.stamped). In the event of the increase in temperature the fusible link shall melt & the damper shall close shut with spring action.

a. With on/off actuator without spring return, control panel and temp-sensor.

The damper is held open by the 24V Ac/Dc heavy duty actuator. The actuator shall close the damper on receiving a signal from the Temperature sensor (74⁰C U.L.stamped) / smoke detector / fire panel through the control panel which is field mounted or mounted on the casing required. The Actuator selection shall be as per manufactured standard and not be less than 7.5Nm/Sqmt (Sqmt of damper face area) and minimum protection class of IP 54 for indoor application. The same should be suitable for remote control operation & monitoring to the BMS system.

b. With on/off spring return actuator, control panel & temp. Sensor.

The damper is held open by a 24 VAC/DC heavy duty actuator. The actuator shall be of the spring return type. The power to the actuator shall get disconnected / connected as required, based on application, on receiving a signal from the Temperature sensor / smoke detector / fire panel through the control panel which is field mounted or mounted on the

casing required. When the power is not available during smoke/fire condition the spring actuator shall ensure the closure of the damper. When the power is made available the actuator shall open the damper against the spring force. The Actuator selection shall be as per manufactured standard and not be less than 7.5Nm/Sqmt (Sqmt of damper face area) and minimum protection class of IP 54 for indoor application. The same should be suitable for remote control operation & monitoring to the BMS system.

c. Solenoid

The blades are held in open position by solenoid against spring loaded linkage mechanism. On receiving signal the solenoid actuates and releases the blades to shut off.

Control panel for motorized operation.

The Fire / Smoke damper is with motorized operation to be provided with necessary control panel, Temperature sensor/Smoke detector. The control panel power supply input shall be 220V. AC. The control panel should be provided with audio, visual alarm. Independent indicator to indicate incoming power supply, Damper open & close, Fault indication when smoke is sensed by smoke sensor or the temperature inside the duct increases more than fault temperature. The panel also to be provided with reset button. The panel should have provision to receive signal from fire alarm panel. The same should be suitable for remote control operation & monitoring to the BMS system.

2. ALUMINIUM OPPOSED BLADE COLLAR DAMPER.

The collar damper should be of robust construction for positive control of air at the supply air collar position, to be of multiple leaves oppose blade type made of high quality extruded aluminium extruded alloy. It should be provided with necessary linkage for smooth operation. These dampers should be with anodized matt black finish for durability and non visibility.. It shall be installed at the terminal supply air collar / neck of the grille / neck of the diffuser. These dampers are to be provided with key for the operation from the face of the grille or diffuser at the same time it should not projected out of the grille / diffuser.

c) BUTTERFLY DAMPER WITH SINGLE FLAP WITH SLEEVE TYPE.

Circular Butterfly damper is for controlling air inside the circular duct or for connecting circular flexible connection to air terminals. The damper should be with single / multi flap sleeve type with manual quadrant. The casing and the flap should be made of not less than 0.8mm GI sheet. And to be provided with nitrile rubber / metal stopper to ensure maximum air tight at the time of closure of damper. It should be provided with flange for sheet metal duct connection (or) one side flange for sheet metal duct connection and other end with plain & rib groove to connect to the flexible duct.

GRILLES

GENERAL

Diffusers, registers, grilles and other air terminal fittings shall be of the types, sizes, numbers and positions as shown on the drawings and/or specified hereafter.

The ceiling arrangement, type of suspension system, and type of air terminal fitting shall be checked with the Consultants and Architects prior to ordering of equipment.

Engineering data shall be submitted in a manner to facilitate convenient review of the following factors:

Aspiration ability, including temperature and velocity traverses, throw and drop of each unit, noise criteria ratings for each unit, sizes, free area and quality of construction.

Each air supply outlet shall have the required capacity and shall be guaranteed to give the required draft with draft less diffusion. Where manufacturer's recommendations require duct size differing from those on the drawings, the same shall be provided at no additional cost to the Employer.

Volume control dampers shall be provided for all diffusers, registers and grilles. Single blade stream splitter type volume controls shall be provided as shown on the drawings at the duct branch takeoffs to individual outlets in which case Diffuser Volume Control (DVC) and/or Opposed Blade Damper (OBD) throttling dampers are not required behind the outlet.

Multi blade DVC stream splitter volume controls shall be provided behind registers mounted on the side of ductwork and at spigot takeoffs from duct branches serving more than one outlet.

OBD volume controllers shall be provided behind all return air face exhaust air grilles to give even air flow over the face of the grilles. Diffusers or registers which do not have multi-blade DVC dampers, and which have spigot connections between the duct and the outlet of less length than the larger neck dimension of the diffuser or register, shall be fitted with equalizing deflection grids to ensure even air distribution from the outlet.

All volume controls where mounted behind grilles, registers and diffusers shall be finished in matt black paint.

Where flexible duct connections are provided to ceiling diffusers, they shall be supplied with a plenum box incorporating turning vanes as necessary to give even distribution of air through the neck of the diffuser.

All diffusers, grilles and registers shall have performance data tested in accordance with the Air Diffusion Council (ADC) Code 1062: GRD-84 and ASHRAE Standard 70-72. Diffusers, grilles and registers without ADC and ASHRAE test performance data shall not be accepted. The material used shall be of not less than 16 gauge aluminium anodized. OBD and DVC dampers shall have blades linked together in sections for ganged operation from adjusting screws. Where OBD or DVC dampers are mounted on the back of outlets or grilles the screw shall be accessible through the blades of the outlet. Where the OBD or DVC damper is mounted in the duct spigot back from the outlet, then the screw adjustment shall be accessible through the removable core of the diffuser or by removing the register or grade.

DVC dampers shall give volume control and even air distribution over the full face of the outlet without the introduction of noise.

DVC dampers shall have a sheet metal frame enclosure around the blades to give reasonable robust construction and to ensure all the air diverted by the blades is directed through the outlet.

Grilles

a. Return Air and Exhaust Grilles

Ceiling mounted grilles shall be of anodized aluminium construction with a minimum 50% free area. The grille frame and cores shall be such that no screw heads are visible on the face of the grille after fixing.

b. Toilet Exhaust Grilles and Transfer Grilles

Grilles shall be of the perforated face type, constructed from anodized aluminium.

Grilles shall have a removable perforated core with a minimum 50% free area.

Grilles shall be fitted with a rear mounted, opposed blade volume control

Damper and shall have secure concealed fixing.

UPVC SLEEVE:

1. GENERAL

This section of the specification covers the supply, delivery, installation, testing, commissioning of UPVC pipes for drain pipes and supplying Fresh air.

2. SCOPE

The scope the item for the contractor is not limited to but inclusive of supply, installation, clamps, hangers, suspenders, adhesive, testing, commissioning and any necessary item required for fully completion of works. The cost shall inclusive of all above mentioned item.

3. MATERIAL

All fresh air tapping shall be of UPVC pipes confirming to IS 13592 - 1992 and IS 4985.

4. Handling:

Pipes are lightweight so reasonable care should be taken in handling and storage to prevent damage to the pipes and others. The pipes shall be stored as per manufacturer's specification. The contractor will hold full responsibility in this case. On no account the pipes should be dragged on the ground. Pipes should be given adequate supports at all times.

5. Storing:

The UPVC pipes shall be laid under the floors below slab or on walls either buried or exposed as the case may be, as shown in the drawings. The fittings shall be of injection mould type suitable for solvent cement joint or rubber ring joint. The pipes and fittings shall be capable of withstanding sun's rays. UPVC pipes laid below slab or suspended in ceiling shall be supported by angle brackets/ supports as detailed in the drawings. All external pipes shall be mounted on special sliding brackets of Galvanized MS grouted to the duct wall, with the pipes being held to it using GI "U" clamps. These brackets shall provide for a least 50mm clear working space behind the pipes.

6. Pipe laying:

The UPVC pipes shall be laid under the floors below slab or on walls either buried or exposed as the case may be, as shown in the drawings. The fittings shall be of injection mould type suitable for solvent cement joint or rubber ring joint. The pipes and fittings shall be capable of withstanding sun's rays. UPVC pipes laid below slab or suspended in ceiling shall be supported by angle brackets/ supports as detailed in the drawings. All external pipes shall be mounted on special sliding brackets of Galvanized MS grouted to the duct wall, with the pipes being held to it using GI "U" clamps. These brackets shall provide for a least 50mm clear working space behind the pipes.

7. Joints and fittings for UPVC Pipes:

The jointing of pipes to fittings shall be done as per the manufacturer's instructions / recommendations. The UPVC pipes and fittings shall be joined (pasted joint) with Solvent cement; this method of jointing shall be used for piping below slab or at sunken floor and jointing shall be carried out as follows:

- i. Cut the spigot end of the pipe square.
- ii. All burrs from the internal and external surfaces should be removed.
- iii. The spigot should be marked with a pencil line and a distance equivalent to the socket depth. Clean the surface within the marked area.
- iv. Apply uniform coat of solvent cement on the external surface to the pipe and a lighter coat on the internal surface of the fitting.
- v. Insert the pipe end into the socket of the fitting and push it in up to the mark.
- vi. Remove the excess solvent cement and hold the joint firmly in position as per solvent manufacturer's recommendation.
- vii. Every joint shall be made air-tight and water-tight.

The method of jointing shall be by rubber rings and all the external pipe jointing and in stacks shall be by this method. The material of rubber ring should conform to IS 5382. The ring is housed in groove formed in a plastic housing. The rubber is compressed and makes a seal between the pipe and housing. Lubricating paste should be applied before compressing the rubber. Where natural rubber rings are used, mineral oil or petrol or grease should be used.

All such pipes shall be supported and clamped as per the table below.

Maximum support distance in meters						
Size in mm	40	50	75	90	110	160

Horizontal	0.4	0.5	0.75	0.9	1.1	1.6
Vertical	1.2	1.5	2.0	2.0	2.0	2.0

SECTION-10. AIR SIDE WORKS

SHEET METAL DUCTING

TECHNICAL SPECIFICATIONS FOR SHEET METAL DUCTING WORKS (FABRICATION AS PER SMACNA STANDARDS 2005-THIRD EDITION)

a) General

This section comprises supply fabrication, installation and testing of all sheet metal ducts. All are to be in accordance with these specifications and the general arrangement shown on the Drawings.

b) Scope

The scope of the sheet metal works for the HVAC contractor not limited to but inclusive of supply, installation, testing, balancing of sheet metal works and also inclusive of all fire retardant double layer leak proof flexible connections, necessary internal turning vanes, internal straightening vanes, internal duct splitter damper, flanges, gaskets, bolts & nuts, duct supports, hangers, vibration isolation pads or suspenders, flexible connection, inspection door, sealant, labour for installation, testing, balancing & commissioning and any other accessories required for fully completion of sheet metal ducting works as per approved shop drawing and as per actual site condition. All the above mentioned accessories are the part of the ducting work only. No additional measurement considered for the same.

c) Testing of Duct

All the Factory Duct mate corner piece, Longitudinal seam joint, Transverse joints and where ever required should sealed with quality fire retardant, low VOC Sealant to restrict the leakage not exceeding 3% or as per acceptable leakage as per SMACNA standards whichever is the stringent.

After duct installation, a part of duct section (approximately 5% of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA – ‘HVAC Air Duct Leakage Test manual; (First Edition). The test shall be conducted at the cost of the contractor. No extra shall be paid for the test.

d) Duct Raw Material

All the sheet metal ducting material shall be of Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by Client’s site representative shall be subject to approval and tested for thickness and coating at contractor’s expense.

The raw material in Coil form (Sheet metal in Roll Form/ cut sheet) in order to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.

GSS Ducting:- Galvanized steel sheet shall be of Class VIII – light coating of zinc, nominal 200gm / sqmt as per IS-277.

e) **Fabrication Standards & Equipment**

1. All duct construction, installation, and commissioning shall be in accordance with SMACNA standards 2005 (Third edition).
2. Longitudinal seams at Corners / Folded edges only to obtain the duct rigidity and low leakage characteristics. No longitudinal seams permitted along any side of the duct.
3. All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.
4. Electric lock seamer to join the corners, mallet for fixing the flanges, Electric Drilling machine, C. Jaw clamp to hold flanges, Crimper to crimp the cleats, ratchet spanner for tightening bolts to be used for proper manufacturing and installation of ducts.
5. All edges to be machine treated using lock formers, flanges and rollers for turning up edges.
6. All the transverse duct connectors (Flanges\Cleats) and accessories related hardware such as support system shall be zinc coated (galvanized).

f) **Duct Construction**

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

1. The fabricated duct dimensions should be as per approved shop drawings prepared by the Contractor and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities.
2. Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.
3. All ducts for air conditioning system irrespective of width shall have DUCTMATE joints. The internal ends of joints shall be in the direction of airflow. Ducts and accessories including insulation within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.

4. Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees or angels, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.
5. Self-adhesive Neoprene rubber / UV resistant PVC foam lining 5 mm nominal thickness instead of felt shall be used between duct flanges and between duct supports in all ducting installation.
6. Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7).
7. All the changes in direction shall be made with elbows. The centre line radius of elbows shall not be less than 1.5 times the width of the duct. For shorter radius elbows necessary turning vanes shall be installed as per SMACNA standards.
8. Necessary Air turning vanes or Air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
9. All sheet metal factory fabricated Plenums: - required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS /SS or 14 Gauge aluminium, thoroughly stiffened with not less than 25 mm x 25 mm x 3mm galvanized steel / SS angle braces for low pressure system up to 750Pascal. And for the High pressure system above 750pascal shall be of 16 gauge GSS / SS or 12 Gauge aluminium and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 450mm x 450mm in size. All the plenum should be stiffened for not less than 150% of the rated plenum pressure or 130% of the connected fan total pressure whichever is greater.
10. Access Door: - Access door shall be provided in the duct before and after the equipment installed and all the fire damper locations and any other place of requirements. All access doors shall be fabricated of same material as the sheet metal duct work and shall have minimum two hinges. Hinges shall be Zinc / SS plated and pins shall be of brass / SS. Access door shall be of minimum 450mm x 450mm size. At least two heavy solid brass fasteners and brass handle are required for each door. A continuous self-adhesive neoprene rubbergasket shall be adhered to the opening frame / flange.
11. Flexible connection (connecting duct to the equipment like Supply or Exhaust fan etc.,):- All the flexible connection shall be of fire retardant double layer heavy duty canvas or equivalent material. The length of the canvass connection shall not be less than 100mm and the width & height shall be as suitable to connecting sheet metal duct and the equipment. The material shall be attached to Galvanized angle flanges at the end of the flexible connections. The material shall be secured between the galvanized flat strip and angle frame by riveting at regular intervals of not more than 75mm. The angle flanges & other fixing material shall be of galvanized MS

g) GI Sheet Gauge, Brazing by Size of Ducts

TECHNICAL SPECIFICATION

All ducts shall be fabricated from galvanized steel of the following thickness, and brazing as indicated below. Duct gauges based on G-60 coated galvanized steel of lock forming grade to ASTM standards A653 and A924.

Minimum Reinforcement class & GI Sheet gauge required for Positive or Negative pressure class as per SMACNA 2005 - Third edition

Minimum Reinforcement class & GI Sheet gauge required for Positive or Negative pressure class as per SMACNA 2005 - Third edition												
Duct	GI Sheet Gauge for 1200mm Joints.											
Dimension	250 pa. static			500 pa. static			750 pa. static			1000 pa. static		
(mm)	Gauge	Joint Reinf	Alt. Joint Reinf	Gauge	Joint Reinf	Alt. Joint Reinf	Gauge	Joint Reinf	Alt. Joint Reinf	Gauge	Joint Reinf	Alt. Joint Reinf
250 & below	26	N/R	N/A	26	N/R	N/A	26	N/R	N/A	26	N/R	N/A
251-300	26	N/R	N/A	26	N/R	N/A	26	N/R	N/A	26	N/R	N/A
301-350	26	N/R	N/A	26	N/R	N/A	26	N/R	N/A	26	N/R	N/A
351-400	26	N/R	N/A	26	N/R	N/A	26	N/R	N/A	26	N/R	N/A
401-450	26	N/R	N/A	26	N/R	N/A	26	N/R	N/A	26	N/R	N/A
451-500	26	N/R	N/A	26	N/R	N/A	24	N/R	N/A	24	N/R	N/A
501-550	26	N/R	N/A	26	N/R	N/A	24	N/R	N/A	24	N/R	N/A
551-600	26	N/R	N/A	26	N/R	N/A	24	N/R	N/A	24	N/R	N/A
601-650	26	N/R	N/A	26	N/R	N/A	24	N/R	N/A	22	N/R	N/A
651-700	26	N/R	N/A	26	N/R	N/A	24	N/R	N/A	22	N/R	N/A
701-750	26	N/R	N/A	24	N/R	N/A	24	N/R	N/A	22	N/R	N/A
751-900	26	N/R	N/A	24	N/R	N/A	22	N/R	N/A	20	N/R	N/A
901-1000	24	N/R	N/A	22	N/R	N/A	20	N/R	N/A	18	N/R	N/A
1001-1200	24	N/R	N/A	22	JTR	N/A	20	JTR	(2)E	18	JTR	(2)H
1201-1300	22	N/R	N/A	20	JTR	(2)E	18	JTR	(2)H	18	JTR	(2)H
1301-1500	22	N/R	N/A	20	JTR	(2)E	18	JTR	(2)H	18	JTR	(2)H
1501-1800	22	JTR	(2)E	20	JTR	(2)H	18	JTR	(2)I	18	JTR	(2)I
1801-2100	20	JTR	(2)H	20	JTR	(2)H	16	JTR	(2)I	--	--	--
2101-2400	18	JTR	(2)H	18	JTR	(2)H	16	JTR	(2)L	--	--	--
2401-2700	18	JTR	(2)H	16	JTR	(2)H	--	--	--	--	--	--
2701-3000	16	JTR	(2)H	--	JTR	(2)I	--	--	--	--	--	--
Legend:-												
NR= Not Required; N/A=Not Applicable; JTR=Joint Tie Rod;												
(2)(x)=indicate 2external reinforcement of class (X) to be used in lieu of Joint tie Rod.												
Alt. Joint reinforcement shall be as indicated in the SMACNA standard table.												

NOTES:

SMACNA NOTES:

*1 – SMACNA – Sheet Metal and Air conditioning Contractors National Association Inc – “HVAC Duct Construction Standards – Metal and Flexible” – 1995, U.S.A.

*2 – Under SMACNA, alternative configurations of the duct gauge and flange system to be used to obtain an equivalent structural rigidity and class of construction of the duct system as shown here as per the supplier recommendation with previous approval.

*3 – For non-critical comfort cooling applications (250 pa. wg pressure class), optional Slip-and-Drive (C and S) cleats joints can be used.

*4 - A higher-class flange can always be substituted for a lower class (e.g. class “J” for class “H”, class “H” for Class “F”)

*5 – The additional GI metal clip for the different class of duct mate flanges should be spaced so that the cleat end is within 150mm of each companion flange end and the maximum pitch between cleats is 300mm. and the minimum length of the cleat should be 150mm.

*6 – The duct manufacturer should confirm for the ability of fabrication for the respective pressure class of sheet metal ducting with respective gauge of the sheet and the respective reinforcement distance & details as mentioned in the above chart and as per SMACNA standard 2005 (Third edition).

h) Installation Practice

All ducts shall be installed generally as per tender drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor.

1. The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Client's site representative in all its parts and details.

2. The Contractor shall make all necessary allowances and provisions for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed or divided or curved to one side (the required equivalent air flow area being maintained) all as per the site requirements with the approval of Client's site representative.

3. If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of Client's site representative.

4. All ductwork shall be independently supported from building construction. All Horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle / channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.4 meter. Structural members on each floor slab shall support all vertical ductwork. Duct supports may be through galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger

formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners. Self-adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness shall be used between duct and duct supports in all ducting installation.

5. Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Client's site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All sheet metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor's work in the building.

6. Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick Phenotherm insulation around the duct and totally covered with fire barrier mortar for complete sealing. The cost of the Phenotherm shall be part of ducting & shall not be covered separately in BOM. It can also be executed with a layer of neoprene around the ducting.

7. All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection; located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 100mm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connections. The flexible connection shall be suitable for pressure at the point of installation.

8. All the Anchor fasteners, Grouting bolts, supporting rods used / selected shall be capable of handling minimum twice the actual Duct weight and pressure irrespective of size mentioned in the tender specification and drawing.

i) Factory Duct mate System components shall be as follows:

Slip on Flanges

Roll-formed GI section with embedded sealant.

Sections to provide a range of rigidity and strength characteristics.

Corners

To be inserted into the hollow web of the slip-on flange. 4 corner pieces. Are required for each rectangular frame, 8 corner pieces, per joint.

Sealant

Sealant to be applied as a thin bead at the interface of duct and Factory Duct mate corner piece, Longitudinal seam joint, Transverse joints and where ever required to maintain the leakage not exceeding 3%.

Cleats

GI Metal Cleat 150 mm in length can be snap-fitted or slid over the mating flanges.

Gasket –Neoprene / EPDM

UV resistant, Non toxic, self-adhesive, Polyethylene / Neoprene / EPDM

10 mm wide and 4.5 mm thick for Duct mate flange of class E,F& I

15 mm wide and 6.0 mm thick for Duct mate flange of class 'J' and for all the flanges with 750pasacal wg pressure static and above.

Bolts, Nuts and Washer

Electro-galvanized, square-necked carriage bolts, nuts and washers. Each joint to have 4 sets.

Flange Selection

(Recommended Configurations as per SMACNA – 1995)

Factory Duct mate Flanges shall be available in different sizes and identified by its Rigidity / Reinforcement 'Class' as per SMACNA. The proper selection of the right flange depends on the independent parameters: a) duct static pressure b) duct size c) spacing between joint and or reinforcement.

ALTERNATIVE REINFORCEMENT CLASSES USING ANGLE IRON FLANGES FOR TRANSVERSE JOINTS INSTEAD OF DUCTMATE FOUR (4) BOLT SYSTEM.

(PRIOR APPROVAL SHALL BE OBTAINED BEFORE USING THE ANGLE FLANGES)

Under SMACNA – 2005, the approximate Transverse joint reinforcement classes for duct assemblies with companion Angle Iron Flanges are:

Reinforcement Class	Nearest Galvanized / SS Angle Iron nominal size in	Nearest Aluminum alloy Angle for aluminum ducting in mm.
A,B,C	25 x 25 x 3	32 x 32 x 3
D	25 x 25 x 3	40 x 40 x 3
E	25 x 25 x 3	50 x 50 x 3
F	32 x 32 x 3	65 x 65 x 3
G	32 x 32 x 3	50 x 50 x 6
H	40 x 40 x 3	65 x 65 x 5
I	40 x 40 x 6	65 x 65 x 8
J	40 x 40 x 6	65 x 65 x 8
K	50 x 50 x 6	75 x 75 x 10
L	50 x 50 x 6	75 x 75 x 10

The angle, rivets, bolts shall be of galvanized material. The Angle shall be riveted to the duct sheet as the starting rivet point shall be 40mm away from the corner of the duct, and the in-between spacing of rivets shall not be more than 100mm.

Two ducts can be joined with angle iron flange with necessary bolts and nuts of minimum 6mm diameter with c/c of the bolt not exceeding 200mm.

Support for Horizontal Duct – Rectangular:

A completely galvanized system consisting of fully threaded rods and bottom brackets, nuts, washers and anchor bolts conformed to SMACNA standards or as mentioned below whichever are greater.

MINIMUM SUPPORTING REQUIREMENTS.				
Sl. No.	Larger side of the Duct in mm.	Duct gauges	Supporting Angle in mm.	Minimum Pair of vertical Hanger Rod Diameter
1	1 - 750	24	40x40x6	8 mm
2	751 - 1500	22	50x50x6	10 mm
3	1501 - 2000	20	65x65x6	12 mm
4	2000 and above	18	ISMC-75x6	15 mm

SUPPORTING DISTANCE			
Sl. No.	Cross sectional area of duct in Sq.m	Diameter in meter	Maximum space between supports
1	Less than 0.4	Less than 0.12	2.4 m
2	0.4 – 1.0	0.12 to 1.0	1.8 m
3	1.0 and more	1.0 and more	1.2 m

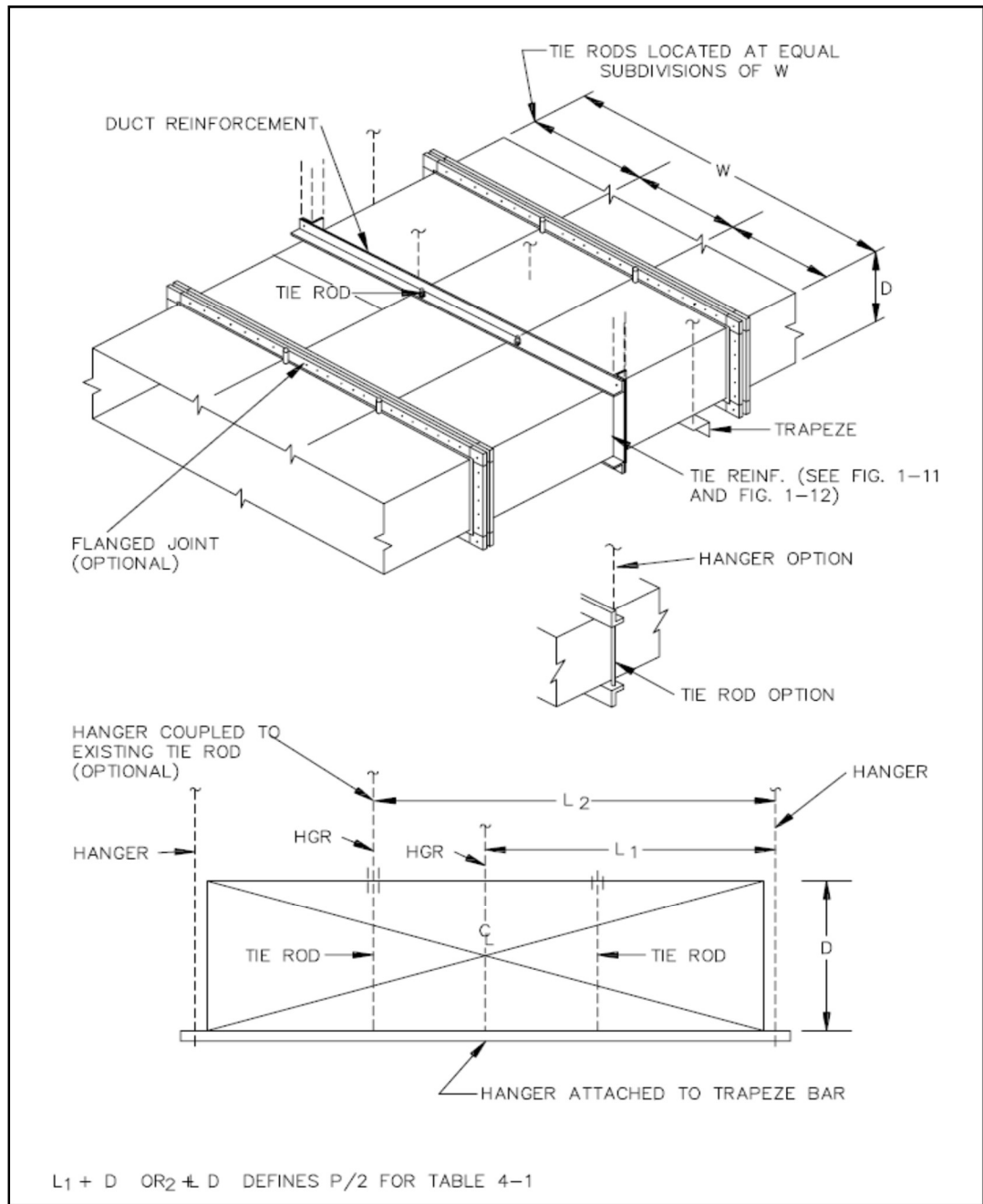
j) **General:-**

The Adhesive & Sealant selected should be non-combustible, fire retardant, not stinking, eco-friendly, fungus proof, non-injurious to health, chemically inert, non-corrosive to steel and aluminium, and should have good bonding capacity etc.

The Adhesives & Sealant required shall be of Low Volatile Organic Compound (VOC). The Adhesive VOC contents shall not be more than 850gm/Litre. The Duct Sealant VOC contents shall not be more than 420gm/ Litre. The supplier has to submit the certificate confirming the same and necessary technical data sheets of the adhesive & sealant to be provided for the approval before the supply.

All the factory fabricated ducts opening shall need to be covered during transportation to the site. Any duct opening and joints needs to be covered during installation till commissioning. The covering of opening shall be done with 500g/m² polythene sheet or any other suitable method to ensure dust shall enter the duct.

LARGE DUCT SUPPORT



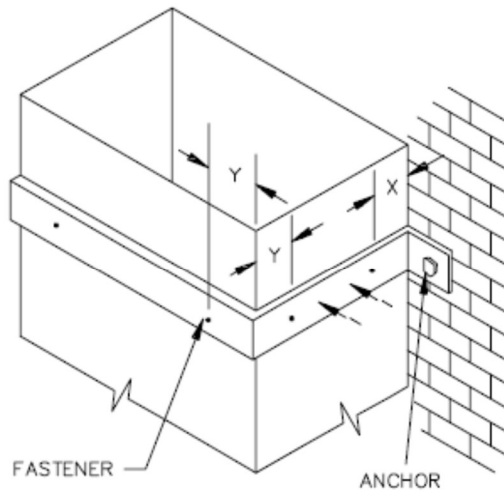


FIG. A

--- SHOWS SUPPLEMENTAL FASTENER LOCATIONS

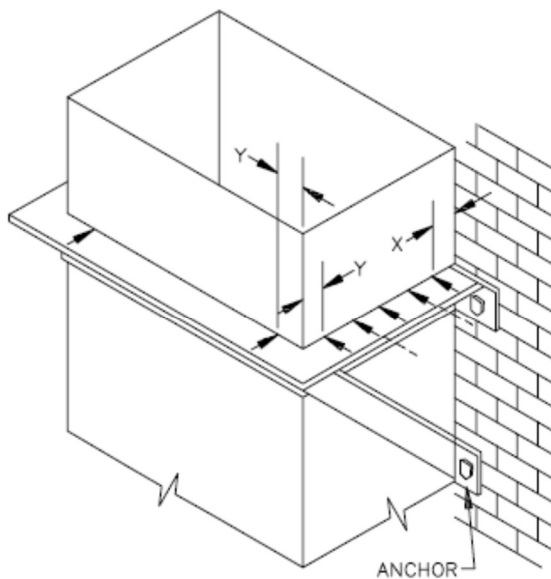


FIG. B

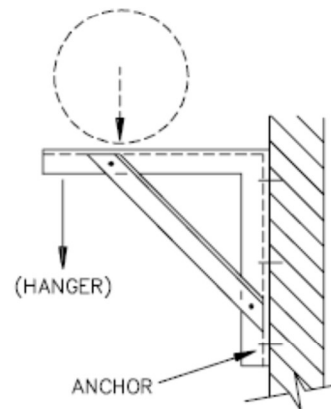
FIG. A - SUGGESTED SIZING

DUCT SIZE	ANGLE
18"x12"	1 1/2"x16 GA.
24"x20"	1"x1/8"

TABLE 4-4

DUCT GAGE	ALLOWABLE LOAD PER FASTENER *
28, 26	25 lb
24, 22, 20	35 lb
18, 16	50 lb

* WELD, BOLT OR NO. 8 SCREW (MIN.) DEVIATION PERMITTED BY OTHER ANALYSIS. X=1", Y=2"; ADD OTHERS TO ACCOMMODATE LOAD. MINIMUM OF 3 ON 24" WIDTH AND UP. ADD ALONG SIDES NEAREST ANCHORS.



SEE KNEE BRACKET TABLES IN THE ROUND INDUSTRIAL STDS.

FIG. B - SUGGESTED SIZING

DUCT SIZE	ANGLE
30" x 12"	1" x 1" x 1/8"
36" x 18"	1" x 1" x 1/8"
42" x 24"	1 1/4" x 1 1/4" x 1/8"
48" x 30"	1 1/4" x 1 1/4" x 1/8"

- NOTES:
- BRACKETS ARE SIZED FOR 12 FEET OF DUCT, MAXIMUM.
 - LOCATE DUCTS AGAINST WALL OR MAXIMUM OF 2" AWAY FROM WALL.
 - EACH WALL ANCHOR SHALL SATISFY THE FOLLOWING CRITERIA UNLESS OTHER ANALYSIS IS MADE:
 - TENSILE LOAD = $3/8 \times$ DUCT WEIGHT; SAFETY FACTOR 4.
 - SHEAR LOAD $\times 1/2 \times$ DUCT WEIGHT; SAFETY FACTOR 4.

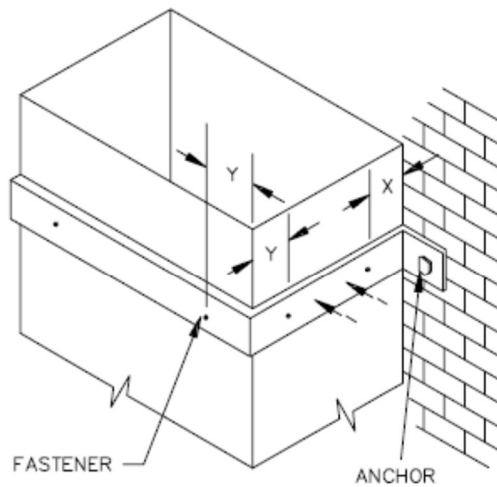


FIG. A

--- SHOWS SUPPLEMENTAL FASTENER LOCATIONS

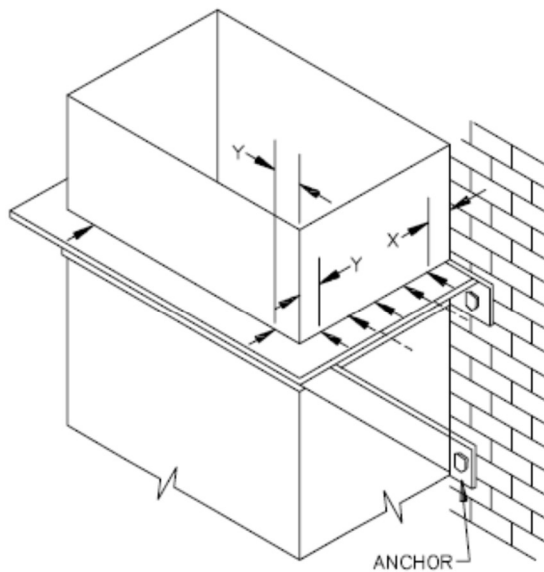


FIG. B

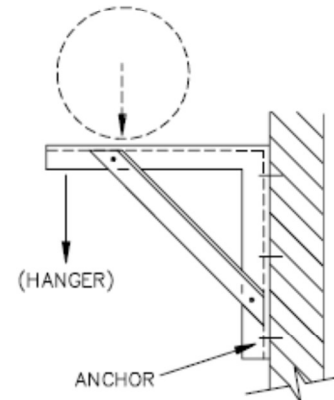
FIG. A – SUGGESTED SIZING

DUCT SIZE	ANGLE
457 x 300 mm	38.1 x 1.61 mm
610 x 508 mm	25 x 3.2 mm

TABLE 4-4

DUCT GAGE	ALLOWABLE LOAD PER FASTENER*
0.48, 0.58 mm	11.3 KG
0.70, 1.00 mm	16 KG
1.31, 1.61 mm	23 KG

*WELD, BOLT OR NO. 8 SCREW (MIN.)
DEVIATION PERMITTED BY OTHER ANALYSIS. X = 25 mm, Y = 51 mm; ADD OTHERS TO ACCOMMODATE LOAD. MINIMUM OF 3 ON 610 mm WIDTH AND UP. ADD ALONG SIDES NEAREST ANCHORS.



SEE KNEE BRACKET TABLES IN THE ROUND INDUSTRIAL STDs.

FIG. B – SUGGESTED SIZING

DUCT SIZE	ANGLE
762 x 305 mm	25 x 25 x 3.2 mm
914 x 457 mm	25 x 25 x 3.2 mm
1067 x 610 mm	31.8 x 31.8 x 3.2 mm
1219 x 914 mm	31.8 x 31.8 x 3.2 mm

- NOTES:
1. BRACKETS ARE SIZED FOR 3.7 M OF DUCT, MAXIMUM.
 2. LOCATE DUCTS AGAINST WALL OR MAXIMUM OF 51 mm AWAY FROM WALL.
 3. EACH WALL ANCHOR SHALL SATISFY THE FOLLOWING CRITERIA UNLESS OTHER ANALYSIS IS MADE:
 - A. TENSILE LOAD = $3/8 \times$ DUCT WEIGHT; SAFETY FACTOR 4.
 - B. SHEAR LOAD $\times 1/2 \times$ DUCT WEIGHT; SAFETY FACTOR 4.

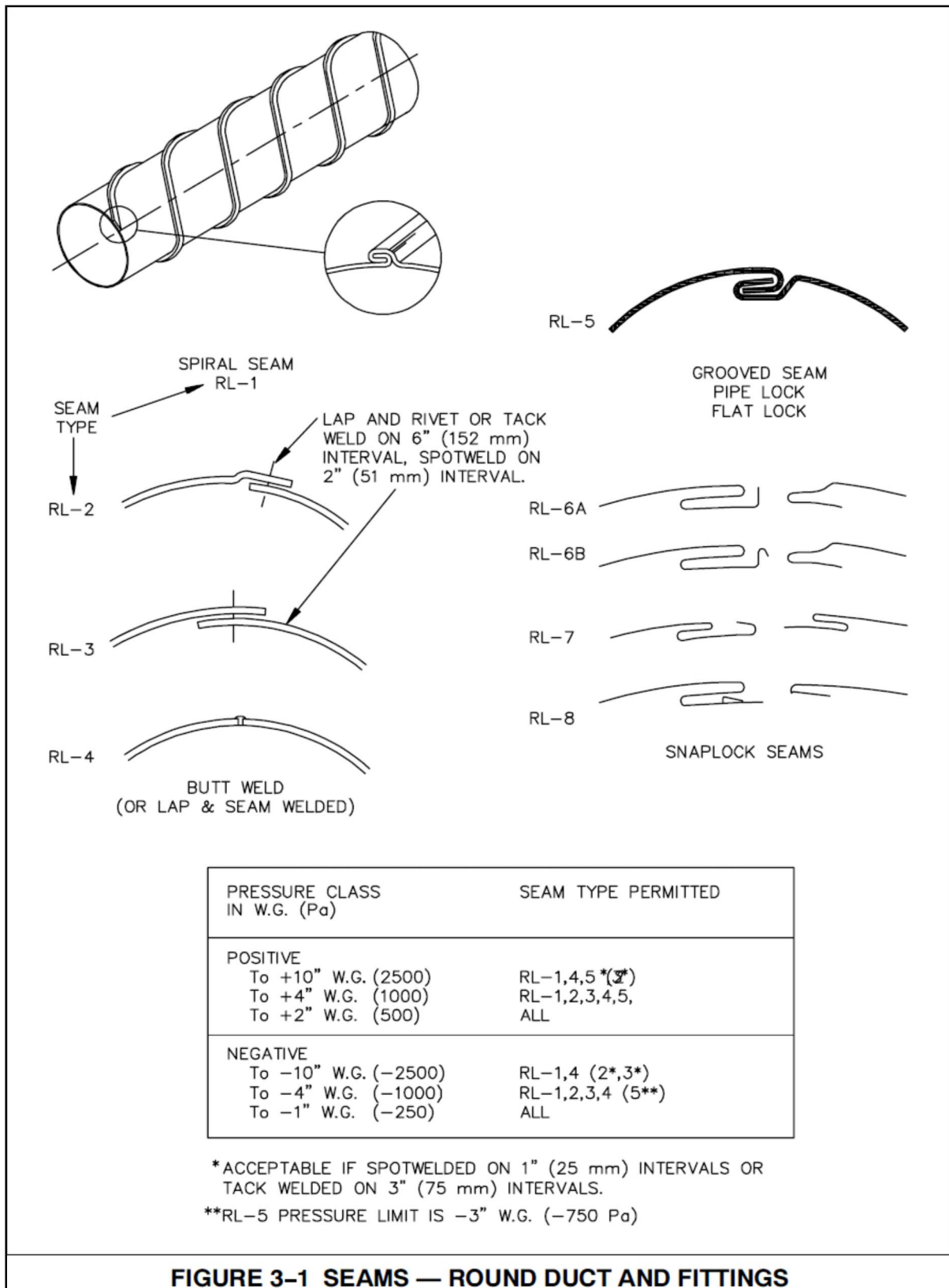
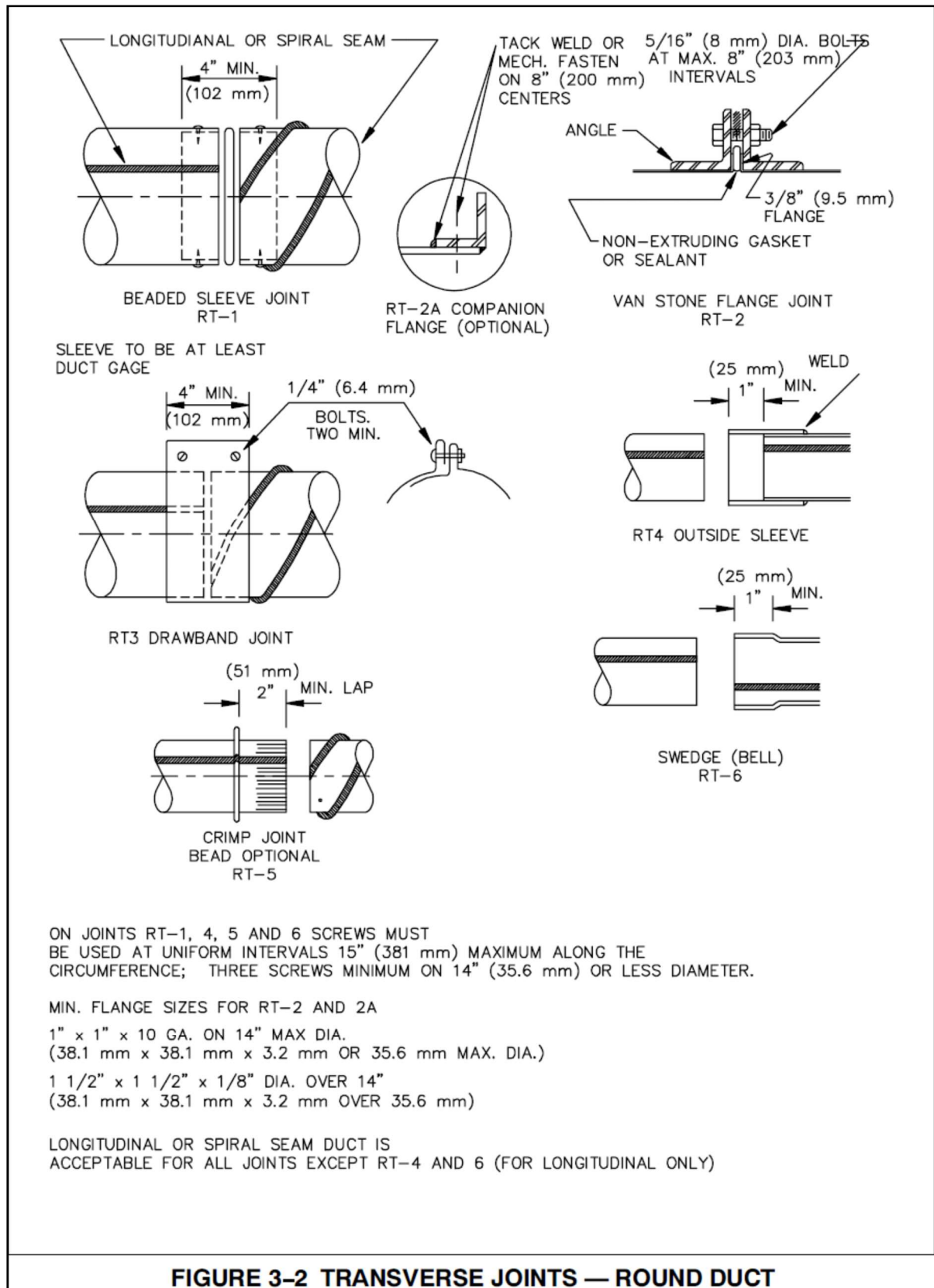
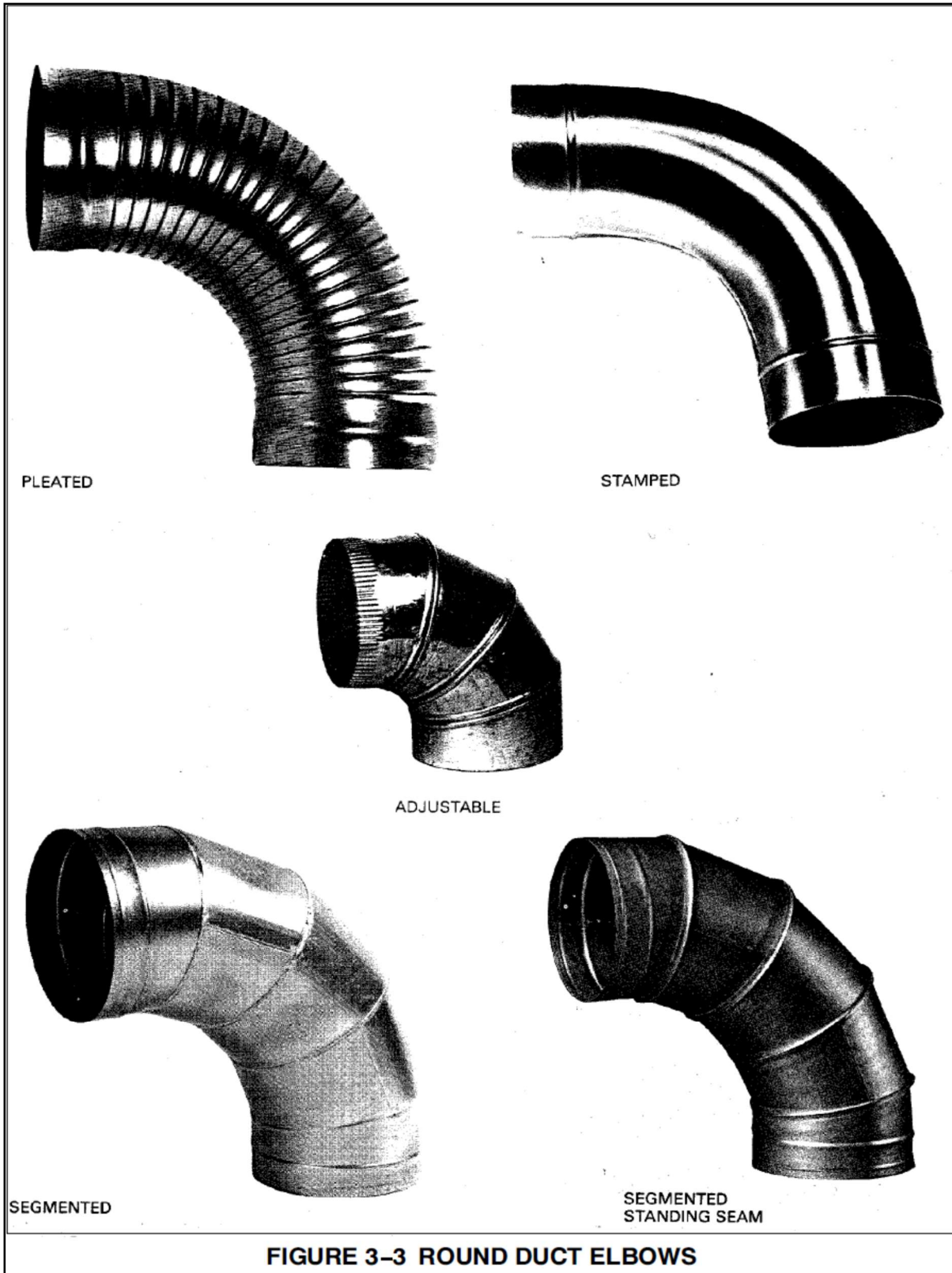


FIGURE 3-1 SEAMS — ROUND DUCT AND FITTINGS



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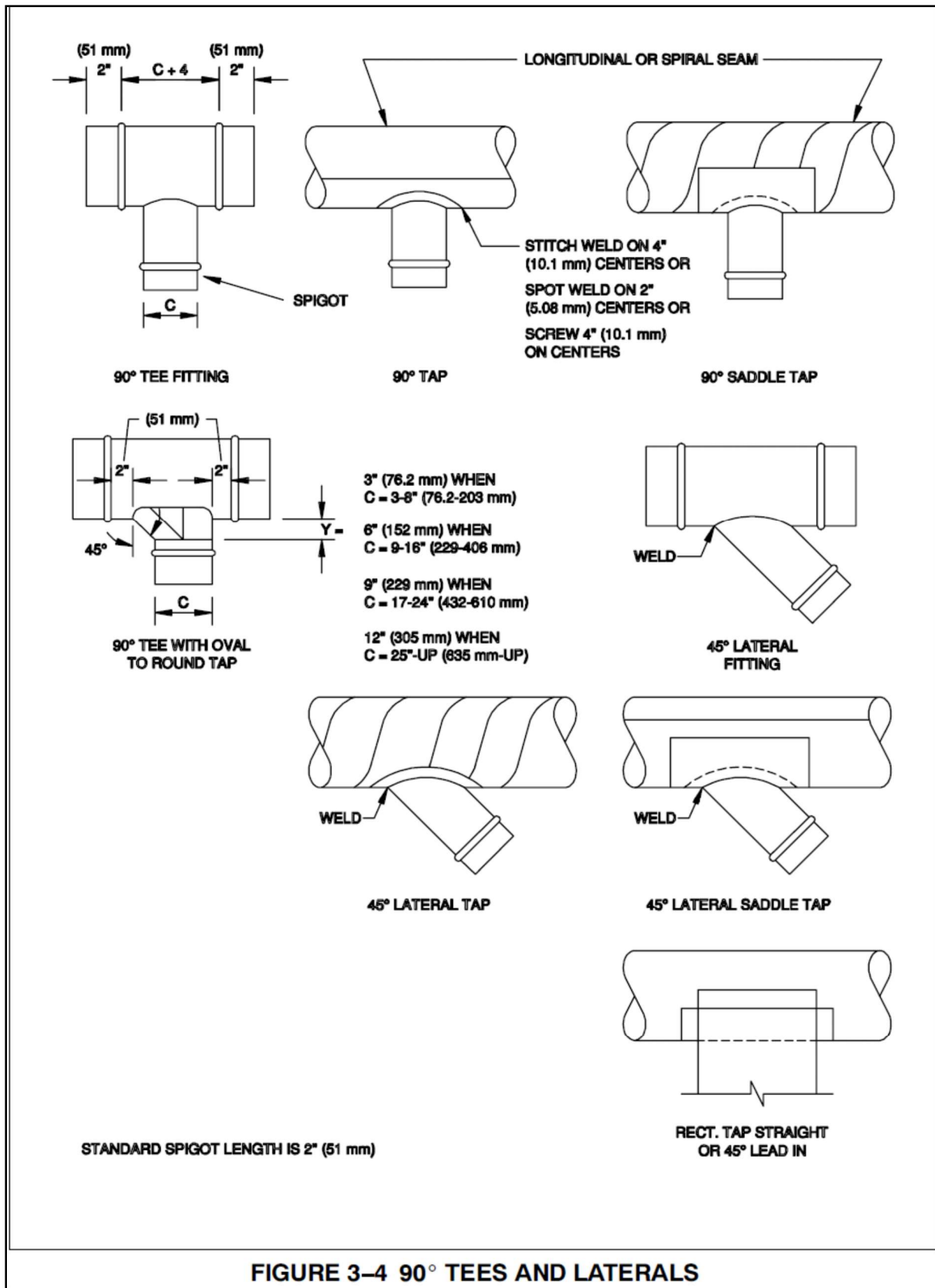


FIGURE 3-4 90° TEES AND LATERALS

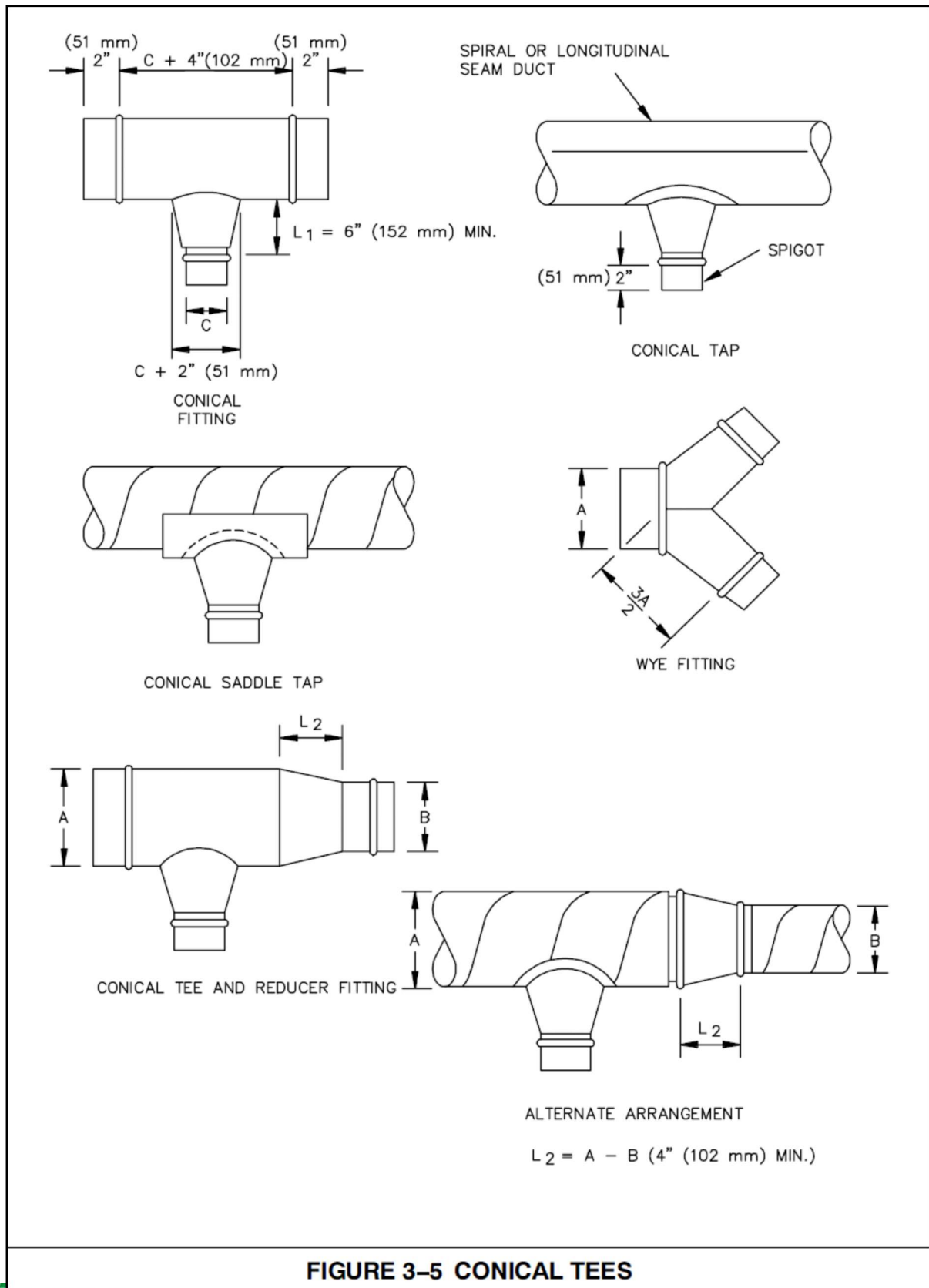
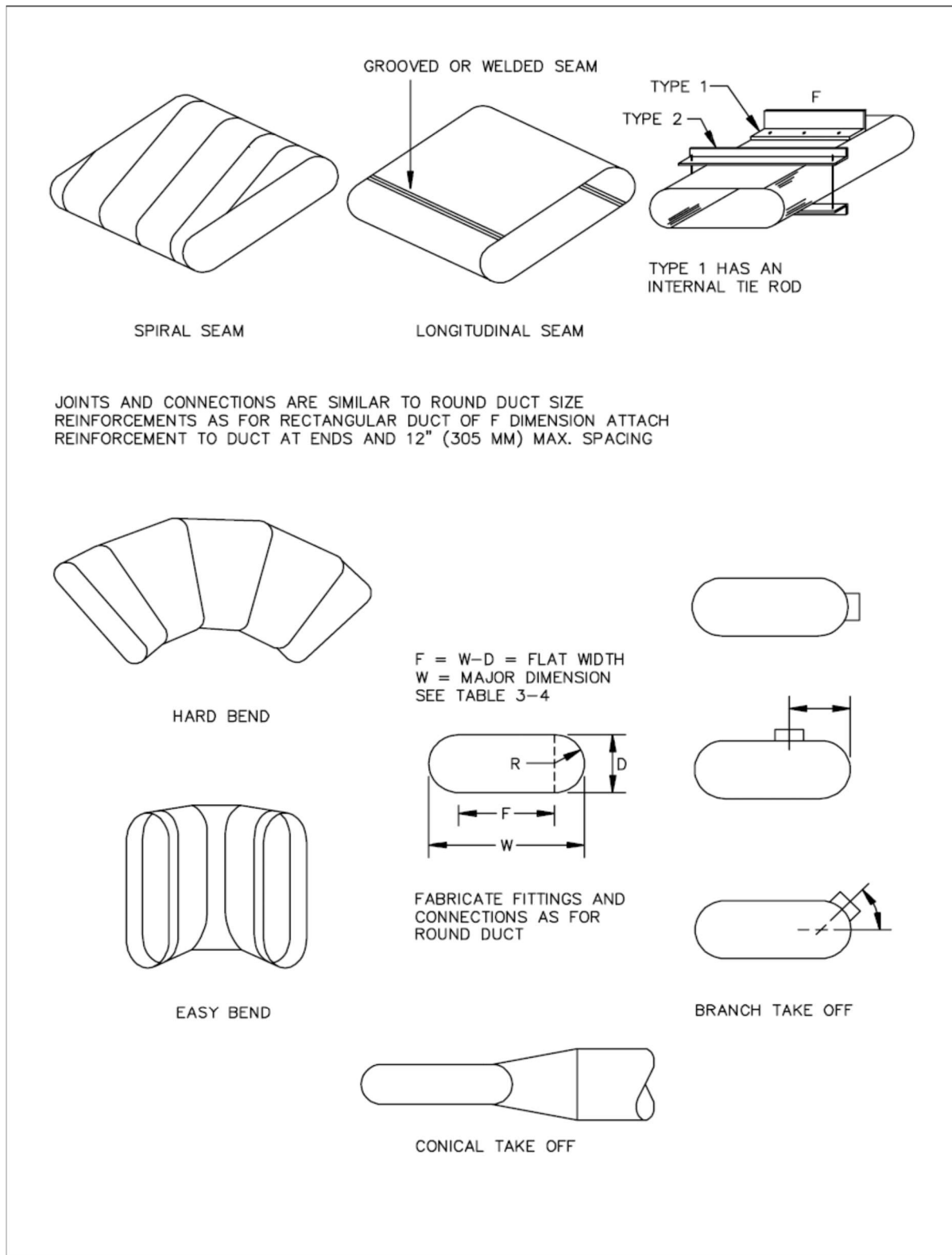


FIGURE 3-5 CONICAL TEES



SECTION-11. HVAC RELATED ELECTRICAL WORKS

MCCB - Moulded Case Circuit Breaker

General:

The Moulded Case Circuit Breaker shall be incorporated in the switchboard wherever specified and shall be of the current limiting type upto 630 A. Ratings of 800 and above shall be Cat B with Icw 0.5 Sec of 20 KA. MCCB shall conform to IS 13947-1 & 2 / IEC 60947 (part I and II / section 1). It shall be suitable for Horizontal and Vertical mounting and line load reversibility without any de-rating. MCCB shall be suitable for 3 Phase 415V. The MCCB shall be available in 4 pole versions with 100% neutral. It shall have tropicalisation as a standard feature.

The MCCB cover and case shall be made of high strength heat-resistant and flame-retardant thermosetting insulating material. The operating handle shall be quick make, quick break, trip - free type. The operating handle shall have suitable 'ON' 'OFF TRIPPED' indicators and in order to ensure suitability for isolation complying as per annexure 7.1.2 IS 13947-2/IEC 60947-2, the operating mechanism shall be designed such that the toggle or the handle can only be in 'OFF' position: if the main contacts are actually separated.

Protections.

Over Load: - Adjustable from 40 – 100% of nominal current (I_n) with time delay.

Short circuit: - Adjustable from 2-10 times of set current (I_r) with time delay.

Earth Fault: - Adjustable - 0.1 – 1(I_n) with time delay

(Wherever specified in SLD or Bill of Quantities)

Earth Leakage: - Adjustable upto 25 A with time delay

(Wherever specified in SLD or Bill of Quantities)

Note: If earth leakage wherever asked for – earth fault shall not be provided in the Breaker. Non integral relay shall be provided wherever ACB s or MCCBs are not built in with ELR.

Accessories

MCCB shall be designed to have following accessories and it shall be fittable at site.

- a. Under voltage trip with time delay wherever specified.
- b. Shunt trip wherever specified.

- c. Alarm switch and Aux switches wherever specified.
- d. Remote operation using motor mechanism with facility of using the same in auto / manual mode wherever specified.

Interlocking

MCCB shall be provided with following interlocking devices for interlocking the door of a switchboard.

- a. Handle interlock to prevent unnecessary manipulations of the breaker.
- b. Door interlock to prevent door being opened when breaker is in ON position.

In addition to the above, and other features indicated elsewhere shall also be provided.

Breaking Capacity

Short time with standing capacities different ratings of MCCB's shall be as follows:

Ratings [Amps] Ics [kA] & Icw [kA]

As Specified in SLD or Short circuit current calculation chart.

Other Equipment

Contactors

Contactors shall comply with IS 13947-1 for general rules and IS 13947 - 4.1 for Standards pertaining to Contactor and Motor Starter.

The Contactors shall be capable of withstanding breaking and making capacities per following:

	AC3 Category	AC4 category
Making Current	10 x Rated Current	12 x Rated Current
Breaking Current	08 x Rated Current	10 x Rated Current

Contactors shall be capable of withstanding an impulse voltage of 8kV and have an insulation voltage of 1000V.

Contactors shall be suitable for copper termination with a maximum permissible temperature rise of 75°C at the terminals with an ambient temperature of 40° C.

The coils shall have three terminals and the insulation shall be of class H type.

The auxiliary contact block shall have a switching capacity of 240V at 2A.

Contactors shall have one auxiliary in built and it shall be possible to have additional normally opened, normally closed contacts in steps of two

Miniature Circuit Breakers [MCB]

MCB shall be in 1, 2, 3 or 4, pole versions. MCB casing shall be made of self-extinguishing, tropicalized material. MCB shall comply with IS 8828-1996/IEC 898-1995. It shall be suitable for use in frequency range 40Hz to 60Hz and shall accommodate AC/DC supply according to requirements. It shall have a trip-free mechanism and toggle shall give a positive contact indication. It shall be suitable for mounting on 35mm DIN rail/surface mounting.

Line supply may be connected to either top or bottom terminals i.e. there shall be no line-load restriction. Degree of protection, when the MCB is flush mounted, shall be IP40. MCB shall be supplied with clamping terminals fully open. Contact closing shall be independent of the speed of the operator. The breaking capacity of the MCB shall be 10kA. The MCB shall be capable of being used as Incomer Circuit Breaker and shall be suitable for use as an isolator. In case of multiple MCBs in a single location (DB), it shall be possible to remove any MCB without having to disturb other MCB's in the vicinity.

Current Transformers

Current transformers shall comply with the requirements of IS 2705. They shall have ratios, outputs and accuracy as specified/required. All CT's shall be of resin cast type unless otherwise specifically called for.

All CT's shall be of bar type primary or suitable for the cable given type and size.

For all the CT's suitable type and size clamps are to be supplied for mounting in the switchboards.

All CT's shall be of 1 or better accuracy class.

Polarities and terminal markings of primary and secondary shall be clearly marked on all CT's.

Specifications for CT's (Cast Resin Type)

a) Current Ratios:

1. Primary: As per feeder ratings
2. Secondary: 5A (Specification in SLD is final)

b) Type: Resin Cast



c) Class: PS-Differential, REF Protection

5P10-O/C, E/F, RPR

Class 1 or better for metering

d) System Voltage

LT: 415V, 3Ph, 50Hz

Potential Transformers (Cast Resin Type)

All the Potential Transformers shall comply with the requirements of IS 3156 latest edition. All PT's shall be resin cast type and shall have Voltage ratios, output and accuracy class as Specified in Data Sheer.

All PT's shall be single phase, dry type suitable for mounting inside the panel or cubicles. Clamps, brackets and supports required for the mounting shall be supplied along with PT.

Polarities and Terminal markings shall be clearly marked in all PT's. Name plate indicating, voltage ratio, burden, accuracy class, type, serial number, make and model plus other related data, shall be provided.

A common earth terminal for earthing of core, bolts, clamps (non-current carrying metal parts) etc., shall be provided.

Specification of the PT's shall be as follows:

a) Voltage ratio: $(415/\sqrt{3})/(110/\sqrt{3})$

b) Type: Resin cast

c) Burden: As per SLD

d) Class (Metering/Protection): 1/3P

Instruments and Meters

All instruments and meters shall be enclosed in dust proof, moisture resistant black finished cases and shall be suitable for tropical use. They shall be calibrated to read directly the primary quantities. They shall be accurately adjusted and calibrated at Works and shall have means of calibration, check and adjustment at site.

Indicating Instruments

Indicating instruments shall be flush mounted with digital displays. The indicating instruments shall conform to IS: 1248 and shall have on an accuracy class of 1.5 or better.

The Ammeter and Wattmeter current coils shall withstand 200% of rated current continuously and 10 times the rated current for 0.5 seconds without loss of accuracy. Voltmeter and Wattmeter potential coils

shall withstand 120% of rated voltage continuously and twice the rated voltage for 0.5 sec. without loss of accuracy.

Voltmeter

Voltmeter shall be suitable for operating directly on LT supply voltage 415V, 50Hz or with a PT on HT circuits as per the requirements.

All the Voltmeters used for HT circuits shall be rated for operating Voltage of 110V, 50Hz, AC. with a scale indicating directly HT Voltages whereas for LT metering. 0-500V Voltmeter shall be used.

All Voltmeters are 96mm x 96mm, suitable for mounting on the panel. Type, Serial Number, accuracy class and borders of the Voltmeter shall be indicated on the dial.

Ammeter

All the ammeters shall be CT operated (5A) with a dial marked for line currents.

Type, Serial Number, Accuracy class, Operating Current, Burden etc., shall be indicated on the dial.

All Ammeter shall be digital, panel mounting type and shall be provided with zero adjustment.

All ammeters shall be 96mm x 96mm, suitable for mounting on the panel.

Energy Meters

WATT HOUR and VAR HOUR METERS shall be of the three phase two element type suitable for measurement of unbalanced loads in three phase four wire circuits. They shall be of draw out type and suitable for flush mounting with back connecting terminals. All meters shall be with RS485 port to record energy consumption through BMS. The meter shall have glass covers removable from the front of the panel, without dismantling the meter from the panel. All permanent magnets shall be of the non-ageing type. The meter shall be fitted with a separate test block for testing of the reverse direction. They shall be provided with a separate test block for testing of the meters without disturbing the CT and PT secondary connections. They shall have cyclometer type of register. At least two sealing studs for sealing purposes shall be provided.

The Energy Meter shall be connected to the secondaries of potential transformers and current transformers rated for 110/ $\sqrt{3}$ V and 5 Amp. Respectively. These meters shall conform to IS: 13010 and have an accuracy of class 0.5 or better for KWH meter and 3.0 or better for LVARH meters.

Meters shall be compensated for temperature errors and factory calibrated to directly read the primary quantities without the use of additional multiplying factor. Multiplying factor, if unavoidable shall be a multiple of 10. Number of digits provided shall be adequate to cover at least 1000hrs, of operations.

The current coil of the meters shall have a continuous overload capacity of 200% for both accuracy and thermal limits. Also the current coils shall withstand at least 10 times the rated current for 0.5 seconds without loss of accuracy.

Push Buttons

Push buttons shall be of momentary contact type with rear terminal connection. These shall be suitably shrouded to prevent inadvertent operation. Integral inscription plates engraved with their functions shall be provided. All push buttons shall have two Normally Closed and two Normally Open contacts comprising rivets of pure silver. The contacts shall be able to make and carry 5A and break up one amp inductive loads at 250V DC.

Cable Terminations

Cable entries and terminals shall be provided in the switchboard to suit the number, type and size of copper conductor power cables and copper conductor control cable specified in the detailed specifications. Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit. Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults. Cable sockets shall be of tinned copper and of the crimping type.

Control Wiring

All control wiring shall be carried out with 660/1100V grade single core PVC cable having stranded copper conductors with minimum cross section of 1.5 Sqmm for potential circuits and 2.5 Sqmm for current transformer circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance.

Wires shall be identified by numbered ferrules at each end. The ferrules shall be of ring type and of non-deteriorating material. They shall be firmly located on each termination so as to prevent free movement.

All control circuit fuses shall be mounted for easy accessibility.

Terminal Blocks

Terminal blocks shall be of 500 Volts grade and of stud/screw less type.

Terminal blocks shall have a minimum current rating of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.



Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities. There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable @ land plate. Also, the clearance between two rows of terminal blocks shall be a minimum of 150mm.

Relays

All Relays shall conform to the requirement of IS: 3231/IS 8686 or other applicable approved standards. Relays shall be suitable for flush and Semi- flush mounting on front at with connections from the rear. All Protective Relays shall be of draw out or plug in type. They shall have modular cases with proper built in test facilities. Test blocks and switches shall be located immediately below each relay for testing. The auxiliary relays shall be self-reset type.

All AC relays shall be suitable for operation at 50Hz. AC Voltage operated relays shall be suitable for 110/ $\sqrt{3}$ Volts PT secondaries and Current operated relays for 5Amp CT secondaries, as specified in this specification. Voltage operated relays shall have adequate thermal capacity for continuous operation. Auxiliary Relays and timers, shall have pairs of contacts as required to complete the scheme. Contacts shall be silver faced with spring action.

All Protective Relays, Auxiliary Relays and Timers except the lockout relays and interlocking relays specified, shall be provided with self-reset type contacts. All Trip relays and Timers shall be provided with externally hand reset positive action provided with inscription subject to consultant / OWNER approval. Timers shall be of the electromagnetic or solid state type.

Wherever solid state relays are used the following requirement shall be met:

- a. All Relays shall be designed for operating under an ambient temperature 40°C and 100% relative humidity.
- b. All accessories required for correct operation of each relay shall be supported by the Contractor without any extra cost.
- c. The solid state relays shall be stable and suitably protected against transient or induced over voltages. The Bidder shall state clearly in his list special requirements, if any, for DC input arrangement or cabling considered necessary for satisfactory operation of solid-state relays quoted by him.

SECTION-12. METHOD OF MEASUREMENTS

All the material of supply & installation applicable to this project shall be measured as per the details and calculation as mentioned below. If required the HVAC contractor should get clarify the same before quoting for any item. All the actual final measurement should be jointly taken along with authorized agent of the client and should obtain written approval of the same. All the actual final measured quantities and details should be incorporated in the as built drawing submitted by the HVAC contractor.

All the below measurement is inclusive of Supply, Lifting, Installation, Testing, Balancing, Commissioning and any other accessories required for fully completion of works as per BOQ and tender specification. No additional measurements shall be considered for the same.

Individual Items (BOQ units in Nos.)

All the individual work like DX split units, etc., shall be counted as numbers (Nos.) only as mentioned in the BOQ. This is inclusive of all the accessories, labour for installation, testing, balancing & commissioning as mentioned in the BOQ and specifications.

Air Control Damper

All the Air control damper like, Volume control damper, Motorized damper, Fire damper, Back draft damper, Collar damper etc., shall be measured based on the internal face area of air flowing excluding the outer flanges. This includes necessary flanges, bolts, nuts, hangers, vibration pads or suspenders, operating handles, necessary electrical actuators, control panels; step down transformers, labour for installation, testing, balancing & commissioning and any necessary item required for fully completion of works. No additional measurements shall be considered for the same.

Grilles, Louvers etc.,

Grilles, Louvers etc., shall be measured based on the internal face neck size area of air flowing excluding the outer flanges. It includes necessary flanges, supporting frames, screws, gaskets,



labour for installation, testing, balancing & commissioning and any other items required for fully completion of works etc. No additional measurements shall be considered for the same.

Any other items required but not captured in the BOQ

Any other items required for the projected other than the items mentioned in the BOQ should be obtain prior approval for the material and method of measurements from the PMC/Consultant/Client. The final measurement for the same shall be considered as per the written approval of the PMC/consultant/Client's authorized representative only.

SECTION-13. TECHNICAL DATA SHEETS

ACOUSTIC INSULATION MATERIAL		
Sl.No:	DESCRIPTION	TECHNICAL DATA
1	Material of Insulation	
2	Insulation Make	
3	Country of Origin	
4	Density of Material	
5	Thermal Conductivity at 0°C in w/m°C	
6	Thermal Conductivity at 10°C in w/m°C	
7	Thermal Conductivity at 20°C in w/m°C	
8	Density of Material	
9	Type of Cell Structure	
10	Type of Bonding	
11	Moisture absorption rating	
12	Class of Fire rating.	
13	Not Allow microbial growth (Yes/No)	
14	Should not cause or accelerate Corrosion and Odor Emissions (Yes/No)	
15	Covering material details	
16	finishing material details	
17	Attach catalogue.	

THERMAL INSULATION OF SHEET METAL WORKS		
Sl.No:	DESCRIPTION	TECHNICAL DATA
1	Material of Insulation	
2	Insulation Make	
3	Country of Origin	
4	Density of Material	
5	Thermal Conductivity at 0°C in w/m°C	
6	Thermal Conductivity at 10°C in w/m°C	
7	Thermal Conductivity at 20°C in w/m°C	
8	Density of Material	
9	Type of Cell Structure	
10	Type of Bonding	
11	Moisture absorption rating	
12	Water Vapor Permeability - kg / Pa.m.s	
13	Moisture Resistance factor - μ	
14	Class of Fire rating.	
15	Not Allow microbial growth (Yes/No)	
16	Should not cause or accelerate Corrosion and Odor Emissions (Yes/No)	
17	Type & Detail of finish for Indoor application.	
18	Type & Detail of finish for Outdoor application.	
19	Attach catalogue.	
VOLUME CONTROL DAMPER		
Sl.No:	DESCRIPTION	TECHNICAL DATA
1	VCD Make	
2	VCD Type	
3	Country of Origin	
4	Outer Casing Material & Thickness in MM.	
5	Blade Leaf Material & Thickness in MM.	
6	Blade shape	
7	Shaft material & size.	
8	Bush material	

TECHNICAL SPECIFICATION

9	Operation through Gear / Linkages	
10	Open & Close indication provided (Yes /No)	
11	Type of Finish.	
12	Attach Manufacturer catalogue.	

COLLAR DAMPER FOR GRILLES & DIFFUSER

Sl.No:	DESCRIPTION	TECHNICAL DATA
1	Make	
2	Type	
3	Country of Origin	
4	Outer Casing Material & Thickness in MM	
5	Blade Leaf Material & Thickness in MM.	
6	Blade Linkage material	
7	Blade operation type	
8	Attach Manufacturer catalogue & Fixing arrangement Drawings.	

BUTTERFLY DAMPER

Sl.No:	DESCRIPTION	TECHNICAL DATA
1	Make	
2	Country of Origin	
3	Outer Casing Material & Thickness in MM.	
4	Single flap / Multiflap type	
5	Blade Leaf Material & Thickness in MM.	
6	Blade Linkage material	
7	Blade operation type	
8	Damper operation handle material	
9	Open & Close indication provided (Yes /No)	
10	Necessary flanges on one side to fix the same to the sheet metal duct (Yes / No.)	
11	Necessary Groove on one side to fix the Flexible duct (Yes / No.)	
12	Necessary stopper provided (Yes / No.)	
13	Type of Finish.	



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14	Attach Manufacturer catalogue & Fixing arrangement Drawings.	
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BACK DRAFT (Non Return) DAMPER		
Sl.No:	DESCRIPTION	TECHNICAL DATA
1	Make	
2	Type	
3	Country of Origin	
4	Outer Casing Material & Thickness in MM.	
5	Blade Leaf Material & Thickness in MM.	
6	Blade shaft Material & dia in MM.	
7	Bush material	
8	Open & Close indication provided (Yes /No)	
9	Type of Finish.	
10	Attach Manufacturer catalogue.	
AIR GRILLES, DIFFUSER, LOUVERS		
Sl.No:	DESCRIPTION	TECHNICAL DATA
	Fixed Blade - GRILLES	
1	Grilles Make	
2	Type	
3	Country of Origin	
4	Flange Material & construction	
5	Blade Material & construction	
6	Blade pitch	
7	Blade Deflection angle - °	
8	Type of Finish.	
9	Attach Manufacturer catalogue.	
	DIFFUSER	
1	Diffuser Make	
2	Type	
3	Country of Origin	
4	Material & construction	
5	Neck size - mm.	

TECHNICAL SPECIFICATION

6	Outer Overall size - mm.	
7	Type of Finish.	
8	Attach Manufacturer catalogue.	
	SLOT DIFFUSER	
1	Slot Diffuser Make	
2	Type	
3	Country of Origin	
4	Material & construction	
5	Nos. of slot	
6	Neck size - mm.	
7	Height - mm.	
8	Outer Overall size - mm.	
9	Type of Finish.	
10	Attach Manufacturer catalogue.	
	CIRCULAR DIFFUSER	
1	Circular Diffuser Make	
2	Type	
3	Country of Origin	
4	Material & construction	
5	Neck size - mm.	
6	Outer Overall size - mm.	
7	Type of Finish.	
8	Attach Manufacturer catalogue.	
	EXHAUST VALVE (circular)	
1	Exhaust valve Make	
2	Type	
3	Country of Origin	
4	Material & construction.	
5	Exhaust air control by -	
6	Neck size - mm.	
7	Outer Overall size - mm.	
8	Type of Finish.	
9	Attach Manufacturer catalogue.	

VRF – OUTDOOR UNIT		
Sl.No.	ITEM DESCRIPTION	
	Outdoor Unit Capacity as per BOQ	
1	Make of VRF System	
2	Origin of Out Door unit	
3	R410a refrigerant.	
4	Model of the Outdoor unit	
5	No. of Units per Machine	
6	Nominal capacity - TR (HP)	
7	Noise level of all the outdoor units at 100% Load.	
8	Total Number of Compressor per unit	
9	Number of Inverter Compressors per unit	
10	Type of Compressor	
11	Make of Compressor	
12	Over all Dimension of Outdoor unit (mm)(H*W*D)	
13	Overall weight - Kg	
14	Power required to each Out door unit	
15	Input Kw IKW	
16	COP	
17	Is the Outdoor Fan is inverter driven	
18	Maximum Indoor units connectable per unit	
19	Maximum Equivalent Length	
20	Maximum Actual Length	

VRF INDOOR UNITS		
S.No	Description	
1	Type of Unit	
2	Model- Indoor Unit	
3	Dimensions (H x W x D) - mm	
4	Air Quantity-CFM	
5	Sound Pressure Level-dB(A)	
6	Weight of the unit-Kg	
7	External Static Pressure(Pa)	
8	Origin of the units	
9	Power Required	
10	Type of controller	
11	No of Speed	
12	Temp Control	
13	Refrigerant Control	

SPECIFICATIONS FOR EXHAUST FANS

Description	Unit	Specifications	Technical Data
SPECIFICATIONS FOR EXTRACT FANS Duty Volume	CFM		
Static Pressure	mm wg		
Selected Model		As per manufacturer	
Blower Type	Axial	Axial	
Impeller Diameter	mm		
No of Blades	Nos	As per manufacturer	
Fan Casing	Long	Long	
Absorbed Shaft Power	KW	As per manufacturer	
Shaft RPM	RPM		
Motor Kw	Kw		
Recommended High Temperature Motor Single speed	KW	Single speed	
Sound Level @ 3 Metres	DbA		

SPECIFICATIONS FOR FRESH AIR FANS

Description	Units	Specifications	As per supplier
Qty.	Nos		
Duty Volume	CFM		
Static Pressure	mm wg		
Selected Model		As per manufacturer	
Blower Type	Axial	Axial	
Impeller Diameter	mm		
No of Blades	Nos	As per manufacturer	
Fan Casing	Long	Long	
Absorbed Shaft Power	KW	As per manufacturer	
Shaft RPM	RPM		
Motor Kw	Kw		
Recommended High Temperature Motor Single speed	KW	Single speed	
Sound Level @ 3 Metres	DbA		
Sound Level @ 3 Metres after 1 No. silencer	DbA		

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