

**Part 1 General****1.01 SUBMITTALS**

- .1 Submittals: in accordance with Division 01 – General Requirements.
- .2 Shop drawings to show:
  - .1 Mounting arrangements.
  - .2 Operating and maintenance clearances.
- .3 Shop drawings and product data accompanied by:
  - .1 Detailed drawings of bases, supports, and anchor bolts.
  - .2 Acoustical sound power data, where applicable.
  - .3 Points of operation on performance curves.
  - .4 Manufacturer to certify current model production.
  - .5 Certification of compliance to applicable codes.
- .4 Closeout Submittals:
  - .1 Provide operation and maintenance data for incorporation into manual specified in Division 01 – General Requirements.
  - .2 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
  - .3 Operation data to include:
    - .1 Control schematics for systems including environmental controls.
    - .2 Description of systems and their controls.
    - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
    - .4 Operation instruction for systems and component.
    - .5 Description of actions to be taken in event of equipment failure.
    - .6 Valves schedule and flow diagram.
    - .7 Colour coding chart.
  - .4 Maintenance data to include:
    - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
    - .2 Data to include schedules of tasks, frequency, tools required and task time.
  - .5 Performance data to include:
    - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
    - .2 Equipment performance verification test results.
    - .3 Special performance data as specified.
    - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
  - .6 Approvals:
    - .1 Submit 1 copy of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.

- .2 Make changes as required and re-submit as directed by Departmental Representative.
- .7 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
  - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
  - .2 Transfer information daily to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
  - .3 Submit to Departmental Representative for approval and make corrections as directed.
  - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
  - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

**1.02 QUALITY ASSURANCE**

- .1 Quality Assurance: in accordance with Division 01 – General Requirements.

**1.03 MAINTENANCE**

- .1 Furnish spare parts in accordance with Division 01 – General Requirements as follows:
  - .1 One set of packing for each pump.
  - .2 One casing joint gasket for each size pump.
  - .3 One head gasket set for each heat exchanger.
  - .4 One glass for each gauge glass.
  - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Division 01 – General Requirements.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- .1 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials in accordance with Division 01 – General Requirements.

**Part 2 Products****2.01 MATERIALS**

- .1 Section not used.

**Part 3 Execution****3.01 PAINTING REPAIRS AND RESTORATION**

- .1 Prime and touch up marred finished paintwork to match original.
- .2 Restore to new condition, finishes which have been damaged.

**3.02 CLEANING**

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

**3.03 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Division 01 – General Requirements and submit report as described in PART 1 - SUBMITTALS.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

**3.04 DEMONSTRATION**

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
  - .1 Ventilation Systems:
    - .1 Exhaust Systems
    - .2 Re-zoned areas

- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.

**3.05 PROTECTION**

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

**END OF SECTION 23 05 00**

**Part 1            General**

**1.01            USE OF SYSTEMS**

- .1        Use of new and or existing permanent heating and ventilating systems for supplying temporary heat or ventilation is not permitted.

**Part 2            Products**

**2.01            NOT USED**

- .1        Not Used.

**Part 3            Execution**

**3.01            NOT USED**

- .1        Not Used.

**END OF SECTION 23 05 01**

**Part 1            General****1.01            DELIVERY, STORAGE AND HANDLING**

- .1      Deliver, store and handle in accordance with Division 01 – General Requirements.
- .2      Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

**Part 2            Products****2.01            NOT USED**

- .1      Not used.

**Part 3            Execution****3.01            APPLICATION**

- .1      Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

**3.02            CONNECTIONS TO EQUIPMENT**

- .1      In accordance with manufacturer's instructions unless otherwise indicated.
- .2      Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3      Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- .4      Support full weight of piping from structure – Do not transfer any loads to equipment.

**3.03            CLEARANCES**

- .1      Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
- .2      Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, and components.

**3.04            PIPEWORK INSTALLATION**

- .1      Screwed fittings jointed with Teflon tape.
- .2      Protect openings against entry of foreign material.
- .3      Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .6 Install concealed pipework to minimize furring space, maximize headroom, and conserve space.
- .7 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .8 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .9 Group piping wherever possible and as indicated.
- .10 Ream pipes, remove scale and other foreign material before assembly.
- .11 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .12 Provide for thermal expansion as indicated.
- .13 Valves:
  - .1 Install in accessible locations.
  - .2 Remove interior parts before soldering.
  - .3 Install with stems above horizontal position unless otherwise indicated.
  - .4 Valves accessible for maintenance without removing adjacent piping.
  - .5 Use ball or butterfly valves at branch take-offs for isolating purposes except where otherwise specified.
  - .6 Install butterfly valves between weld neck flanges to ensure full compression of liner.
- .14 Check Valves:
  - .1 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

**3.05 SLEEVES**

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
  - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
  - .2 Other floors: terminate 25 mm above finished floor.

- .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
  - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
  - .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
  - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
  - .4 Ensure no contact between copper pipe or tube and sleeve.

### 3.06 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: one piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.
- .3 Sizes: outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

### 3.07 PREPARATION FOR FIRE STOPPING

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 - Fire Stopping.
- .2 Uninsulated unheated pipes not subject to movement: No special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fire stopping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

### 3.08 FLUSHING OUT OF PIPING SYSTEMS

- .1 Before start-up, clean interior of piping systems in accordance with requirements of Division 01 – General Requirements supplemented as specified in relevant mechanical sections.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

### 3.09 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Piping work: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.



- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .6 Insulate or conceal work only after approval of tests by Departmental Representative.

**3.10 EXISTING SYSTEMS**

- .1 Connect into existing piping systems at times approved by Departmental Representative.
- .2 Be responsible for damage to existing plant by this work.
- .3 Ensure daily clean-up of existing areas.

**3.11 CLEANING**

- .1 Clean in accordance with Division 01 – General Requirements.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION 23 05 05**

**Part 1 General****1.01 REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 90.1 2016, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.02 SUBMITTALS**

- .1 Submittals: in accordance with Division 01 – General Requirements.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Division 01 – General Requirements. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Division 01 – General Requirements.
- .3 Quality Control: in accordance with Division 01 – General Requirements.
  - .1 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals
  - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Division 01 – General Requirements.

**1.03 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Division 01 – General Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

**Part 2 Products****2.01 GENERAL**

- .1 Motors: high efficiency, in accordance with ASHRAE 90.1.

**2.02 MOTORS**

- .1 Provide motors for mechanical equipment as specified.

- .2 Motors under 560 W (3/4 HP) : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 560 w (3/4 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 575 V, unless otherwise indicated.

### 2.03 TEMPORARY MOTORS

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

### 2.04 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW 10 HP: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW 10 HP and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed in accordance with Division 01 – General Requirements.

### 2.05 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
  - .1 Expanded metal screen welded to steel frame.
  - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
  - .3 38 mm dia. holes on both shaft centres for insertion of tachometer.
  - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:

- .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
- .2 Securely fasten in place.
- .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
  - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
  - .2 Net free area of guard: not less than 80% of fan openings.
  - .3 Securely fasten in place.
  - .4 Removable for servicing.

### **Part 3 Execution**

#### **3.01 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

#### **3.02 INSTALLATION**

- .1 Fasten securely in place.
- .2 Make removable for servicing, easily returned into, and positively in position.

#### **3.03 FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
  - .1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .2 Schedule site visits to review Work as required.

#### **3.04 CLEANING**

- .1 Proceed in accordance with Division 01 – General Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION 23 05 13**

**Part 1            General****1.01            SHOP DRAWINGS**

- .1      Submit shop drawings in accordance with Division 01 – General Requirements.
- .2      Provide shop drawings complete with performance and product data.

**1.02            WASTE MANAGEMENT AND DISPOSAL**

- .1      Separate and recycle waste materials in accordance with Division 01 – General Requirements.
- .2      Dispose of corrugated cardboard and plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

**Part 2            Products****2.01            GENERAL**

- .1      Size and shape of bases type and performance of vibration isolation to be as indicated.

**2.02            ELASTOMERIC PADS**

- .1      Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.
- .2      Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.
- .3      Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.
- .4      Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.
- .5      Acceptable material: Vibro-Acoustics, Vibron, VAW.

**2.03            ELASTOMERIC MOUNTS**

- .1      Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.
- .2      Acceptable material: Vibro-Acoustics, Vibron, VAW.

**2.04            SPRINGS**

- .1      Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with levelling devices.

- .2 Ratio of height when loaded to diameter of spring to be between 0.8 and 1.0.
- .3 Cadmium plate for all installations.
- .4 Colour code springs.

## **2.05 SPRING MOUNT**

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- .4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.
- .6 Acceptable material: Vibro-Acoustics, Vibron, VAW.

## **2.06 HANGERS**

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, molded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with molded isolation bushing which passes through hanger box.
- .4 Type H3 - stable spring, elastomeric element, cup with molded isolation bushing which passes through hanger box.
- .5 Type H4 - stable spring, elastomeric element with precompression washer and nut.
- .6 Acceptable material: Vibro-Acoustics, Vibron, VAW.

## **2.07 INERTIA BASE**

- .1 Type B3 - Full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; spring mounted, carried by gusseted height-saving brackets welded to frame; and clear housekeeping pads by 50 mm minimum.
- .2 Pump bases: "T" shaped, where applicable, to provide support for elbows.

**Part 3 Execution****3.01 INSTALLATION**

- .1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
  - .1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.
  - .2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.
- .5 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

**3.02 ISOLATION SCHEDULE**

- .1 Rotating equipment internal to the following equipment shall have isolation provided by the unit manufacturer in accordance with ASHRAE Applications Handbook (2007), Chapter 47, Table 48.

.2

Equipment	Isolator Type	Min. Deflection (mm)
Rooftop Units	Internal by Manufacturer	--
Exhaust Fans	Internal by Manufacturer	--

**END OF SECTION 23 05 48**

**Part 1            General****1.01            REFERENCES**

- .1 Canadian Gas Association (CGA)
  - .1 CSA/CGA B149.1-15, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
  - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.

**1.02            SUBMITTALS**

- .1 Submittals: in accordance with Division 01 – General Requirements.
- .2 Product data to include paint colour chips, other products specified in this section.
- .3 Samples:
  - .1 Submit samples in accordance with Division 01 – General Requirements.
  - .2 Samples to include nameplates, labels, tags, lists of proposed legends.

**1.03            QUALITY ASSURANCE**

- .1 Quality assurance submittals: submit following in accordance with Division 01 – General Requirements.

**Part 2            Products****2.01            MANUFACTURER'S EQUIPMENT NAMEPLATES**

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
  - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
  - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

**2.02            SYSTEM NAMEPLATES**

- .1 Colours:
  - .1 Hazardous: red letters, white background.
  - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
  - .1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.



**.3 Sizes:****.1 Conform to following table:**

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

**.2 Use maximum of 25 letters/numbers per line.****.4 Locations:****.1 Terminal cabinets, control panels: use size # 5.****.2 Equipment in Mechanical Rooms: use size # 9.****2.03 PIPING SYSTEMS GOVERNED BY CODES****.1 Identification:****.1 Natural gas: to CSA/CGA B149.1.****2.04 IDENTIFICATION OF PIPING SYSTEMS****.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.****.2 Legend:****.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.****.3 Arrows showing direction of flow:****.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.****.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.****.3 Use double-headed arrows where flow is reversible.****.4 Extent of background colour marking:****.1 To full circumference of pipe or insulation.****.5 Materials for background colour marking, legend, arrows:****.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.****.2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.**

- .6 Colours and Legends:
- .1 Where not listed, obtain direction from Departmental Representative.
- .2 Colours for legends, arrows: to following table

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

- .3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Sanitary	Green	SAN
Natural gas	to Codes	
Gas regulator vents	to Codes	

## 2.05 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: black, or co-ordinated with base colour to ensure strong contrast.

## 2.06 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

## 2.07 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

## 2.08 LANGUAGE

- .1 Identification in English.

## Part 3 Execution

### 3.01 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

**3.02 TIMING**

- .1 Provide identification only after any painting has been completed.

**3.03 INSTALLATION**

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC or CSA registration plates as required by respective agency.

**3.04 NAMEPLATES**

- .1 Locations:
  - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
  - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection:
  - .1 Do not paint, insulate or cover.

**3.05 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS**

- .1 On long straight runs in open areas in mechanical rooms, equipment rooms, service spaces: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

**3.06 VALVES, CONTROLLERS**

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Number valves in each system consecutively.

**END OF SECTION 23 05 53.01**

**Part 1 General****1.01 INTENT**

- .1 This Section specifies commissioning requirements common to all Division 21, 22, 23, & 25 equipment and systems starting and testing, Component Verifications and Systems Performance Verification Testing.
- .2 The Contractor shall expedite required revisions identified during the testing and verification in a cooperative manner to maintain the construction schedule.

**1.02 WORK INCLUDED**

- .1 General inspection and component verification of all mechanical equipment.
- .2 Specific equipment and system performance testing as specified herein or in other sections of the specifications.
- .3 Co-ordination with other trades and testing agencies including local Authority having Jurisdiction.
- .4 Integrated systems testing.
- .5 Instruction for the Departmental Representative's staff in the cleaning, maintenance and operation of the building systems, equipment and finishes.
- .6 Coordinate closely with work of Section 01 91 13.

**1.03 OVERVIEW**

- .1 The commissioning process follows a logical sequence, from Contractor equipment start-up and testing to Component Verifications through to System Performance Verification Testing and finally Integrated System Testing.
- .2 At completion of the commissioning process, all defined system components, each mode of systems operation, and each control sequence will have been started and tested in accordance with the Manufacturer's requirements and verified operational relative to design intent and operational requirements.
- .3 Equipment Starting and Testing:
  - .1 Complete equipment starting and testing procedures as defined in the respective Sections of this specification.
  - .2 All starting, testing, adjusting, balancing and calibration activities are to be documented by the Contractor.
  - .3 All Contractor and Manufacturer start-ups and testing procedures are to be completed and approved prior to conducting the System Performance Verification Testing defined herein.
  - .4 The Contractor will be responsible for identifying in the commissioning schedule, the required equipment starting and testing, including all Manufacturer's start-up and field verifications.
- .4 Component verification sheets shall be developed by this Contractor for each piece of equipment specified and installed. The Contractor shall be responsible for completion of these sheets.

- .5 System Performance Verification Testing:
  - .1 The System Performance Verification Tests provide a functional demonstration of the system performance during the various modes of operation including start-up, operation, shut down and various disturbance situations such as power failure and fire alarm.
  - .2 The System Performance Verification Tests shall be developed by the Contractor.
  - .3 All Contactor and Manufacturer's start-up and proving tests are to be completed and approved prior to conducting the defined System Performance Verification Tests.
  - .4 All Component Verifications and identified testing pre-requisites related to a given system, shall be completed and approved prior to conducting the defined System Performance Verification Testing.
  - .5 The Contractor will be responsible for the scheduling and implementation of the System Performance Verification Testing.
- .6 The commissioning process associated with the component and systems verifications does not negate the need for the normal contractor equipment and system start-up and proving and the associated training requirements.

#### **1.04 RELATED REQUIREMENTS**

- .1 Equipment start-up and testing procedures, including Manufacturer start-ups, specified in this and other Sections.

#### **1.05 EQUIPMENT STARTING AND TESTING**

- .1 Prior to starting and testing, ensure all equipment is cleaned and free of dust.
- .2 After testing, protect equipment from dust.
- .3 Do not conceal or cover components or equipment until inspected, tested and approved by the Commissioning Contractor.
- .4 Assume all liabilities associated with the starting and testing.
- .5 Assume all costs associated with the starting, testing, adjusting and balancing, including the supply of testing equipment.

#### **1.06 WITNESSING OF EQUIPMENT STARTING AND TESTING**

- .1 Prior to starting and testing of equipment and systems, prepare a schedule for the required starting and testing.

#### **1.07 MANUFACTURER'S STARTING RECOMMENDATIONS**

- .1 Prior to starting components or systems, obtain and review manufacturer's installation, operation and starting instructions. Read in conjunction with the procedures specified herein.
- .2 Use manufacturer's and supplier's starting personnel where required to maintain validity of manufacturer's warranty. Confirm with manufacturer that all testing specified in these specifications will not void any warranties.

- .3 Compare installation to manufacturer's published data and record discrepancies. Modify procedures detrimental to components performance prior to starting equipment.

#### **1.08 CO-ORDINATION**

- .1 Co-ordinate all sub-trades, other divisions, manufacturers, suppliers and other specialists as required to ensure all phases of work shall be properly organized prior to commencement of each particular start-up, testing and commissioning procedure.
- .2 Where any components or systems require testing prior to starting, ensure that such work has been completed and approved prior to starting of the components and systems.

#### **Part 2 Products**

- .1 Provide all instruments, meters, and equipment required to conduct tests during and at the conclusion of the project.

#### **Part 3 Execution**

##### **3.01 EQUIPMENT STARTING AND TESTING**

- .1 Schedule and complete the equipment start-up, run-ins and testing as defined in the respective Sections.
- .2 Submit all start-up and test reports, including Manufacturer's reports.
- .3 All start-up and testing is to be done in accordance with approved Manufacturer's procedures.

##### **3.02 COMPONENT VERIFICATIONS**

- .1 Complete Component Verifications in accordance with this Section.
- .2 In addition to the starting and testing requirements identified for each piece of equipment, as defined in the respective Sections, the Component Verifications sheets identified in this Section are to be completed by the Contractor.
- .3 The Component Verification sheets are used to track individual pieces of equipment and provide a submittal verification and a field verification of equipment.

The submittal verification includes verifying and confirming the specified requirements against the shop drawing submittal data and the field verification includes confirming that the installed parameters meet the specified requirements.

- .4 The Component Verification sheets shall be completed as follows:
  - .1 The 'Specified' fields on the sheet shall be completed by the Departmental Representative.
  - .2 The 'Shop Drawing' fields on the sheets shall be completed by the Contractor.

- .3 The 'Installed' fields on the sheets shall be completed by the Contractor.
- .5 A Component Verification sheet is to be completed for each specified piece of equipment.

### 3.03 EQUIPMENT START-UP AND OPERATIONAL TESTING

- .1 Ventilation Systems
  - .1 Air Handling Units
    - .1 Check fit of all doors and casing joints for leakage.
    - .2 Check fit of all filter banks for bypass.
    - .3 Check internal surfaces for debris and general cleanliness.
    - .4 Verify fan rotation direction.
    - .5 Monitor operation of fans for abnormal vibration.
    - .6 Ensure bearings are greased.
  - .2 Exhaust Fans
    - .1 Check for good cleanliness.
    - .2 Verify fan rotation direction.
    - .3 Monitor operation of fans for abnormal vibration.
    - .4 Ensure bearings are greased.
    - .5 Ensure associated dampers operate as intended.
  - .3 Duct Systems
    - .1 Check duct sealing.
    - .2 Check duct identification.
    - .3 Check all manual balance dampers are secured and marked at balance point.
    - .4 Check mounting of all grilles registers and diffusers.

### 3.04 MECHANICAL CX FORMS

- .1 The Contractor shall record information required by this section onto standardized format forms. Record shall be legible and in digital form.
- .2 Sample forms for each type of equipment follow. The contractor shall provide a single form for each individual unit of the equipment. Form shall be passed on sample, but shall be modified to show specific information.
- .3 Refer to sample forms
  - .1 Exhaust fan
  - .2 Water closet – conventional
  - .3 Water closet – combi
  - .4 Basin
  - .5 Shower



**Part 1 General****1.01 GENERAL**

- .1 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

**1.02 QUALIFICATIONS OF TAB PERSONNEL**

- .1 Names of personnel it is proposed to perform TAB to be submitted to and approved by Departmental Representative within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.

**1.03 PURPOSE OF TAB**

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

**1.04 EXCEPTIONS**

- .1 TAB of systems and equipment regulated by codes, standards to be to satisfaction of authority having jurisdiction.

**1.05 CO-ORDINATION**

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

**1.06 PRE-TAB REVIEW**

- .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing all proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

**1.07 START-UP**

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23 or 25.

**1.08 OPERATION OF SYSTEMS DURING TAB**

- .1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

**1.09 START OF TAB**

- .1 Notify Departmental Representative 14 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
  - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
  - .2 Application of weatherstripping, sealing, caulking.
  - .3 All pressure, leakage, other tests specified elsewhere Division 21, 23 & 25.
  - .4 All provisions for TAB installed and operational.
- .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
  - .1 Proper thermal overload protection in place for electrical equipment.
  - .2 Air systems:
    - .1 Filters in place, clean.
    - .2 Duct systems clean.
    - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
    - .4 Correct fan rotation.
    - .5 Fire and volume control dampers installed and open.
    - .6 Coil fins combed, clean.
    - .7 Access doors, installed, closed.
    - .8 Outlets installed, volume control dampers open.

**1.10 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
  - .1 HVAC systems: plus 5%, minus 5%.

**1.11 ACCURACY TOLERANCES**

- .1 Measured values to be accurate to within plus or minus 2% of actual values.

**1.12 INSTRUMENTS**

- .1 Prior to TAB, submit to Departmental Representative list of instruments to be used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

### **1.13 SUBMITTALS**

- .1 Submit, prior to commencement of TAB:
  - .1 Proposed methodology and procedures for performing TAB if different from referenced standard.

### **1.14 PRELIMINARY TAB REPORT**

- .1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
  - .1 Details of instruments used.
  - .2 Details of TAB procedures employed.
  - .3 Calculations procedures.
  - .4 Summaries.

### **1.15 TAB REPORT**

- .1 TAB report to show results in SI units and to include:
  - .1 Project record drawings.
  - .2 System schematics.
- .2 Submit 5 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

### **1.16 VERIFICATION**

- .1 Reported results subject to verification by Departmental Representative.
- .2 Provide manpower and instrumentation to verify up to 15% of reported results.
- .3 Number and location of verified results to be at discretion of Departmental Representative.
- .4 Bear costs to repeat TAB as required to satisfaction of Departmental Representative.

### **1.17 SETTINGS**

- .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

### **1.18 COMPLETION OF TAB**

- .1 TAB to be considered complete when final TAB Report received and approved by Departmental Representative.

**1.19 AIR SYSTEMS**

- .1 Standard: TAB to be to most stringent of this section, AABC or NEBB.
- .2 Do TAB of systems, equipment, components, controls specified in Division 23 & 25.
- .3 Qualifications: personnel performing TAB to be qualified to standards of AABC or NEBB.
- .4 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .5 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
  - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
  - .2 At controllers, controlled device.
- .6 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

**Part 2 Products****2.01 NOT USED**

- .1 Not used.

**Part 3 Execution****3.01 NOT USED**

- .1 Not used.

**END OF SECTION 23 05 93**

**Part 1 General****1.01 GENERAL**

- .1 New duct systems over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment to be pressure tested for leaks.

**1.02 TIMING**

- .1 Ducts to be tested before installation of insulation or any other form of concealments.
- .2 Test after seals have cured.
- .3 Test when ambient temperature will not affect effectiveness of seals, gaskets, etc.

**1.03 EXCLUSIONS**

- .1 Flexible connections to air terminal control boxes.
- .2 Existing duct systems being re-connected to new rooftop equipment.

**1.04 REFERENCES**

- .1 SMACNA HVAC Air Duct Leakage Test Manual.

**1.05 TEST PROCEDURES**

- .1 Maximum lengths of ducts to be tested to be consistent with capacity of test equipment.
- .2 Section of duct to be tested to include:
  - .1 Fittings, branch ducts, tap-ins.
- .3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.
- .4 Base partial system leakage calculations on Reference Standard.
- .5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

**1.06 TESTING AGENCY**

- .1 Installing Contractor.

**1.07 VERIFICATION**

- .1 Departmental Representative to witness tests and to verify reported results.
- .2 Provide testing schedule to Departmental Representative 3 days in advance of test. Departmental Representative may authorize un-witnessed testing.

**1.08 TEST INSTRUMENTS**

- .1 Contractor to provide instruments for tests.

- .2 Test apparatus to include:
  - .1 Fan capable of producing required static pressure.
  - .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
  - .3 Flow measuring instrument compatible with the orifice plate.
  - .4 Certified calibration curves for orifice plates used.
  - .5 Flexible duct for connecting to ductwork under test.
  - .6 Smoke bombs for visual inspections.
- .3 Test apparatus to be accurate to within +/- 2 % of flow rate and pressure.
- .4 Submit details of test instruments to be used to Departmental Representative at least one month before anticipated start date.
- .5 Test instruments to be calibrated and certificate of calibration deposited with Departmental Representative no more than 7 days before start of tests.
- .6 Instruments to be re-calibrated every six months thereafter.

#### **1.09 SYSTEM LEAKAGE TOLERANCES**

- .1 System leakage tolerances specified herein are stated as a percentage of total flow rate handled by the system. Therefore, when testing sections of ductwork this acceptable leakage shall be pro-rated to entire system. Leakage for sections of duct systems shall not exceed the total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates.
  - .1 Small duct systems up to 250 Pa: Leakage 2%.
  - .2 Large low pressure duct systems up to 500 Pa: Leakage 2 %.
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

#### **1.10 REPORT FORMS**

- .1 Submit proposed report form and test report format to Departmental Representative for approval at least one month before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.

#### **1.11 PRESSURE TEST REPORTS**

- .1 Prepare report of results and submit to Departmental Representative within 48 hours of completion of tests. Include:
  - .1 Schematic of entire system.
  - .2 Schematic of section under test showing test site.
  - .3 Required and achieved static pressures.
  - .4 Orifice differential pressure at test sites.
  - .5 Permissible and actual leakage flow rate (L/s) for test sites.
  - .6 Witnessed certification of results.
- .2 Include test reports in final TAB report.

**Part 2            Products**

**2.01            NOT USED**

.1            Not Used.

**Part 3            Execution**

**3.01            NOT USED**

.1            Not Used.

**END OF SECTION 23 05 94**

**Part 1 General****1.01 DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as defined herein.
  - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

**1.02 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Division 01 – General Requirements.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

**1.03 SAMPLES**

- .1 Submit samples in accordance with Division 01 – General Requirements.
- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.

**1.04 MANUFACTURER'S INSTRUCTIONS**

- .1 Submit manufacturer's installation instructions in accordance with Division 01 – General Requirements.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

**1.05 QUALIFICATIONS**

- .1 Installer to be specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project.

**1.06 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather and construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions required by manufacturer.

**1.07 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01 – General Requirements.



- .2 Place packaging materials in designated containers.
- .3 Place excess or unused insulation and insulation accessory materials in designated containers.

**Part 2 Products****2.01 FIRE AND SMOKE RATING**

- .1 In accordance with CAN/ULC-S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

**2.02 INSULATION**

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C 335.
- .3 TIAC Code C-1: Rigid mineral fibre board to CAN/CGSB51.10, with factory applied vapour retarder jacket to CGSB 51-GP-52M (as scheduled in PART 3 of this Section).
  - .1 Maximum 'k' value at 38°C mean temperature of 0.035 (SI)
  - .2 Density of 48 kg/m<sup>3</sup> (3.0PCF)
  - .3 FSK facing
- .4 TIAC Code C-2: Mineral fibre blanket to CAN/CGSB-51.11 faced with factory applied vapour retarder jacket to CGSB 51-GP-52M (as scheduled in PART 3 of this section).
  - .1 Maximum 'k' value at 38°C mean temperature of 0.037 (SI)
  - .2 Density of 24 kg/m<sup>3</sup> (1.5 PCF)
  - .3 FSK facing
- .5 Acceptable Material: Knauf, Owens Corning, Johns Manville, Certain Teed.

**2.03 JACKETS**

- .1 Canvas:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
- .2 Lagging adhesive: Compatible with insulation.
- .3 Aluminum:
  - .1 To ASTM B 209 as scheduled in PART 3 of this section.
  - .2 Thickness: 0.50 mm sheet.
  - .3 Finish: Stucco embossed.
  - .4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

- .5 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

## 2.04 ACCESSORIES

- .1 Vapour retarder lap adhesive:
  - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C 449.
- .4 ULC Listed Canvas Jacket:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
- .5 Outdoor Vapour Retarder Mastic:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
  - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m<sup>2</sup>.
- .6 Tape: self-adhesive, aluminum, reinforced, 50mm wide minimum.
- .7 Contact adhesive: quick-setting
- .8 Canvas adhesive: washable.
- .9 Tie wire: 1.5 mm stainless steel.
- .10 Banding: 19 mm wide, 0.5 mm thick stainless steel.

## Part 3 Execution

### 3.01 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure testing of ductwork systems to be complete, witnessed and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

### 3.02 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and this specification.
- .3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers:

- .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: At 300 mm o/c in horizontal and vertical directions, minimum two rows each side.
- .7 Flexible blanket insulations shall be installed so that the installed thickness is no less than 75% of the listed thickness.

### 3.03 DUCTWORK INSULATION SCHEDULE

- .1 Insulation types and thicknesses: Conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Supply, return and exhaust ducts exposed in space being served			none
Exhaust duct between dampers and louvres	C-1	yes	50
Rectangular supply ducts (air conditioned)	C-1	yes	25
Round supply ducts (air conditioned)	C-2	yes	38
Rectangular supply ducts (non-air conditioned)	C-1	no	25
Round & oval supply ducts (non-air conditioned)	C-2	yes	38

**END OF SECTION 23 07 13**

**Part 1 General****1.01 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Division 01 – General Requirements.
- .2 Indicate following:
  - .1 Sealants.
  - .2 Tape.
  - .3 Proprietary Joints.

**1.02 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**1.03 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01 – General Requirements.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan

**Part 2 Products****2.01 DUCT SYSTEM PRESSURE CLASS**

- .1 Fabricate duct and duct system components to SMACNA 250 Pa pressure class.

**2.02 SEAL CLASSIFICATION**

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	B
- .2 Seal classification:
  - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
  - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant, tape or combination thereof.
  - .3 Class C: transverse joints and connections made air tight with gaskets, sealant or combination thereof. Longitudinal seams unsealed.

**2.03 SEALANT**

- .1 Sealant: water based, polymer type flame resistant duct sealant. Temperature range of minus 30 deg C to plus 93 deg C.
  - .1 Acceptable material: Foster 32-19, United, DuroDyne.

**2.04 DUCT LEAKAGE**

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.

**2.05 FITTINGS**

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
  - .1 Rectangular: Centreline radius of 1.5 times duct dimension in plane of rotation except where duct velocities are less than 4 m/s where radius may be reduced to 1 times.
  - .2 Round: Centreline radius of 1.5 times duct diameter except where duct velocities are less than 4 m/s where radius may be reduced to 1 times.
  - .3 Oval: Centreline radius of 1.5 times duct dimension in plane of rotation except where duct velocities are less than 4 m/s where radius may be reduced to 1 times.
- .3 Mitred elbows, rectangular (to be used only where shown or with permission of Departmental Representative):
  - .1 To 400 mm: with single thickness turning vanes.
  - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 deg. entry on branch.
  - .2 Round main and branch: enter main duct at 45 deg. with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
- .5 Transitions:
  - .1 Diverging: 20 deg. maximum included angle.
  - .2 Converging: 30 deg. maximum included angle.
- .6 Offsets:
  - .1 Full short radiused elbows.

**2.06 FIRESTOPPING**

- .1 Retaining angles around duct, on both sides of fire separation.
- .2 Firestopping material and installation must not distort duct.

**2.07 GALVANIZED STEEL**

- .1 Lock forming quality: to ASTM A653, G90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class B seal.
  - .1 Acceptable material: Ductmate.

**2.08 HANGERS AND SUPPORTS**

- .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct. Maximum size duct supported by strap hanger: 500 mm.
- .2 Hanger configuration: to SMACNA.
- .3 Hangers: black or galvanized steel angle with galvanized steel rods to SMACNA or following table (whichever is heavier construction).

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25x25x3	6
751 to 1050	40x40x3	6
1051 to 1500	40x40x3	10
1501 to 2100	50x50x3	10
2101 to 2400	50x50x5	10
- .4 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
  - .2 For steel joist: manufactured joist clamp.
  - .3 For steel beams: manufactured beam clamps:

**Part 3 Execution****3.01 GENERAL**

- .1 Do work in accordance with SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods on duct transporting cold air. Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

**3.02 HANGERS**

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with SMACNA or following table (whichever is closer spacing).

Duct Size (mm)	Spacing (mm)
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to 1500	3000
1501 and over	2500

**3.03 WATERTIGHT DUCT**

- .1 Provide watertight duct for:
  - .1 Minimum 3000 mm from duct mounted humidifier in all directions.
  - .2 Minimum 3000 mm from each air intake.
  - .3 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams. Solder joints of bottom and side sheets. Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards lowpoint. Slope header ducts down toward risers.

**3.04 SEALING AND TAPING**

- .1 Apply sealant to outside of joint to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

**3.05 LEAKAGE TESTS**

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Do leakage tests in sections.
- .4 Make trial leakage tests as instructed to demonstrate workmanship.
- .5 Install no additional ductwork until trial test has been passed.
- .6 Test section minimum of 10 m long with not less than two branch takeoffs and two elbows.
- .7 Complete test before insulation or concealment.

**END OF SECTION 23 31 00**

**Part 1            General****1.01            PRODUCT DATA**

- .1      Submit product data in accordance with Division 01 – General Requirements.
- .2      Indicate the following:
  - .1          Flexible connections.
  - .2          Duct access doors.
  - .3          Turning vanes.
  - .4          Instrument test ports.

**1.02            CERTIFICATION OF RATINGS**

- .1      Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**1.03            WASTE MANAGEMENT AND DISPOSAL**

- .1      Separate and recycle waste materials in accordance with Division 01 – General Requirements.
- .2      Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan

**Part 2            Products****2.01            GENERAL**

- .1      Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

**2.02            FLEXIBLE CONNECTIONS**

- .1      Frame: galvanized sheet metal frame 24 gauge thick with fabric clenched by means of double locked seams.
- .2      Material:
  - .1          Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40deg C to plus 90deg C, density of 1.0 kg/m<sup>2</sup>.

**2.03            ACCESS DOORS IN DUCTS**

- .1      Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2      Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3      Gaskets: neoprene.



- .4 Hardware:
  - .1 Up to 300 x 300 mm: two sash locks.
  - .2 301 to 450 mm: four sash locks.
  - .3 451 to 1000 mm: piano hinge and minimum two sash locks.

#### **2.04 TURNING VANES**

- .1 Factory or shop fabricated single thickness or double thickness, to recommendations of SMACNA and as indicated.

#### **2.05 INSTRUMENT TEST**

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.
- .5 Acceptable material: DuroDyne IP-2, Cain.

### **Part 3 Execution**

#### **3.01 INSTALLATION**

- .1 Flexible connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of flexible connection: 75 mm.
  - .3 Minimum distance between metal parts when system in operation: 50 mm.
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:
    - .1 Ducting on sides of flexible connection to be in alignment.
    - .2 Ensure slack material in flexible connection.
    - .3 Do not install flexible connection direct to fan inlet. Provide minimum 1 fan diameter straight duct at inlet.
- .2 Access doors and viewing panels:
  - .1 Size:
    - .1 600 x 400 mm for servicing entry.
    - .2 450 x 250 mm for viewing.
    - .3 300 x 150 mm minimum size.
  - .2 Locations:
    - .1 Fire dampers.
    - .2 Control dampers.
    - .3 Devices requiring maintenance.

- .4 Required by code.
  - .5 Duct coils.
  - .6 Elsewhere as indicated.
- .3 Instrument test ports.
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
  - .2 Locate to permit easy manipulation of instruments.
  - .3 Install insulation port extensions as required.
  - .4 Locations.
    - .1 For traverse readings:
      - .1 Ducted inlets to roof and wall exhausters.
      - .2 Inlets and outlets of other fan systems.
      - .3 Main and sub-main ducts.
      - .4 And as indicated.
    - .2 For temperature readings:
      - .1 At outside air intakes.
      - .2 In mixed air applications in locations as approved by Departmental Representative.
      - .3 At inlet and outlet of coils.
      - .4 Downstream of junctions of two converging air streams of different temperatures.
      - .5 And as indicated.
- .4 Turning vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

**END OF SECTION 23 33 00**

**Part 1            General****1.01            PRODUCT DATA**

- .1      Submit product data in accordance with Division 01 – General Requirements.
- .2      Indicate the following: Hardware, blade and frame construction.

**1.02            WASTE MANAGEMENT AND DISPOSAL**

- .1      Separate and recycle waste materials in accordance with Division 01 – General Requirements, and with the Waste Reduction Workplan.

**Part 2            Products****2.01            GENERAL**

- .1      Manufacture to SMACNA standards.

**2.02            SINGLE BLADE DAMPERS**

- .1      Of same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2      Size and configuration to recommendations of SMACNA, except maximum height 150 mm.
- .3      Locking quadrant with shaft extension to accommodate insulation thickness.
- .4      Inside and outside nylon end bearings.
- .5      Channel frame of same material as adjacent duct, complete with angle stop.

**2.03            MULTI-BLADED DAMPERS**

- .1      Factory manufactured of material compatible with duct.
- .2      Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3      Maximum blade height: 100 mm.
- .4      Bearings: self-lubricating nylon.
- .5      Linkage: shaft extension with locking quadrant.
- .6      Channel frame of same material as adjacent duct, complete with angle stop.

**Part 3            Execution****3.01            INSTALLATION**

- .1      Install where indicated.

- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 For supply, return and exhaust systems, locate balancing dampers in each branch duct.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 All dampers to be vibration free.
- .6 Ensure damper operators are observable and accessible.

**END OF SECTION 23 33 14**

**Part 1        General****1.01        PRODUCT DATA**

- .1        Submit product data in accordance with Division 01 – General Requirements.
- .2        Indicate the following:
  - .1        Performance data (air pressure drop at flow and air leakage in closed position).
  - .2        Construction details.

**1.02        CLOSEOUT SUBMITTALS**

- .1        Provide maintenance data for incorporation into manual specified in Division 01 – General Requirements.

**1.03        CERTIFICATION OF RATINGS**

- .1        Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency.

**1.04        WASTE MANAGEMENT AND DISPOSAL**

- .1        Separate and recycle waste materials in accordance with Division 01 – General Requirements, and with the Waste Reduction Workplan.

**Part 2        Products****2.01        MULTI-LEAF DAMPERS**

- .1        Opposed or Parallel blade type as indicated.
- .2        Structurally formed steel, interlocking blades, complete with PVC seals, spring stainless steel side seals, structurally formed and welded galvanized steel frame.
- .3        Pressure fit self-lubricated synthetic bearings.
- .4        Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5        Performance:
  - .1        Leakage: in closed position to be less than 1% of rated air flow at 500 Pa differential across damper.
  - .2        Pressure drop: at full open position to be less than 11 Pa differential across damper at 3 m/s.
- .6        Insulated aluminum dampers:
  - .1        Frames: insulated with extruded polystyrene foam with R factor of 2.0.
  - .2        Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, R factor of 2.3.
  - .3        Dampers shall be designed for service temperature range from minus 40°C to 100°C.

**2.02 BACK DRAFT DAMPERS**

- .1 Automatic gravity operated, multi leaf, extruded (1.8 mm thick) aluminum construction with synthetic bearings, set in 3.2 mm aluminum frame.

**Part 3 Execution**

**3.01 INSTALLATION**

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00 HVAC - Duct Accessories.
- .5 Ensure dampers are observable and accessible.
- .6 Dampers on ducts or openings connected directly to outside (o/a intake, exhaust, relief, etc.) shall be insulated aluminum style.

**END OF SECTION 23 33 15**

**Part 1 General****1.01 PRODUCT DATA**

- .1 Submit product data in accordance with Division 01 – General Requirements.
- .2 Indicate the following:
  - .1 Fire dampers.
  - .2 Fire stop flaps.
  - .3 Fusible links.
  - .4 Design details of break-away joints.

**1.02 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in Division 01 – General Requirements.

**1.03 EXTRA MATERIALS**

- .1 Provide maintenance materials in accordance with Division 01 – General Requirements.
- .2 Provide following:
  - .1 5 fusible links of each type.

**1.04 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

**1.05 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01 – General Requirements, and with the Waste Reduction Workplan.

**Part 2 Products****2.01 FIRE DAMPERS**

- .1 Fire dampers: arrangement Type A, B or C, listed and bear label of ULC/UL, meet requirements of Fire Commissioner of Canada (FCC) and ANSI/NFPA 90A. Fire damper assemblies to be fire tested in accordance with CAN4-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .3 Top hinged: multi-blade hinged sized to maintain full duct cross section.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.

- .5 Retaining angle iron frame as per damper assembly listing, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 For ducts up to and including 300mm in height use Type B with blades completely out of air stream when in open position. Revise if noted on drawings.
- .7 For ducts over 300mm in height use Type A with blades in air stream when in open position. Revise if noted on drawing.
- .8 For round and oval ducts use Type C fire dampers.
- .9 Acceptable material: Controlled Air, Ruskin, Price, Nailor.

## **2.02 FIRE STOP FLAPS**

- .1 To be ULC listed and labelled and fire tested in accordance with CAN4-S112.2.
- .2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.
- .3 Flaps to be held open with fusible link conforming to ULC-S505.

## **Part 3 Execution**

### **3.01 INSTALLATION**

- .1 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Duct Accessories.
- .5 Coordinate with installer of firestopping.
- .6 Fire Damper
  - .1 Installation of all fire dampers shall be performed according to Manufacturers listed installation instructions. Installation instructions to be submitted to Departmental Representative with approval drawings.
  - .2 All fire damper installations shall adhere to all requirements including but not limited to:
    - Sleeve including proper gauge thickness
    - Retention angles and securement
    - Damper to sleeve securement
    - Duct to sleeve breakaway connection
    - Clearance between opening and sleeve
    - Duct access door



- .3 After installation is completed, remove fusible link, operate curtain, replace fusible link after curtain is returned to open position. Curtain shall operate freely to closed position without assistance or other intervention.
- .4 Installer shall certify each installation on completion of installation and curtain operation test. Certification shall be recorded in format of form appended to this section. Certification shall be turned over to Departmental Representative prior to inspection of installation.
- .7 Install break-away joints of approved design on each side of fire separation.
- .8 Coordinate with work of Section 23 05 93. Repair or replace installations where required for completion of TAB contract.

**END OF SECTION 23 33 16**

**Part 1            General****1.01            PRODUCT DATA**

- .1      Submit product data in accordance with Division 01 – General Requirements.
- .2      Indicate the following:
  - .1          Thermal properties.
  - .2          Friction loss.
  - .3          Acoustical loss.
  - .4          Leakage.
  - .5          Fire rating.

**1.02            CERTIFICATION OF RATINGS**

- .1      Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**1.03            SAMPLES**

- .1      Submit samples with product data of different types of flexible duct being used in accordance with Division 01 – General Requirements.

**1.04            WASTE MANAGEMENT AND DISPOSAL**

- .1      Separate and recycle waste materials in accordance with Division 01 – General Requirements.
- .2      Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

**Part 2           Products****2.01            GENERAL**

- .1      Factory fabricated to CAN/ULC S110.
- .2      Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3      Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50 for any portion of flexible duct including jacket.

**2.02            METALLIC - UNINSULATED**

- .1      Type 1: spiral wound flexible aluminum.
- .2      Performance:
  - .1          Factory tested to 3.0 kPa without leakage.
- .3      Acceptable material: Flexmaster T/L, Thermaflex, UniFlex.

**2.03 METALLIC - INSULATED**

- .1 Type 2: spiral wound flexible aluminum with factory applied, 25 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl jacket.
- .2 Performance:
  - .1 Factory tested to 3.0 kPa without leakage.
- .3 Acceptable material: Flexmaster TL-VT, ThermaFlex, UniFlex.

**Part 3 Execution**

**3.01 DUCT INSTALLATION**

- .1 Install in accordance with: SMACNA.
- .2 Do not allow turns tighter than 1.5 diameter radius.
- .3 Do not allow accumulated turns greater than 90°. Install duct elbows where greater turn angle is required.

**END OF SECTION 23 33 46**

**Part 1 General****1.01 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Division 01 – General Requirements.
- .2 Provide:
  - .1 Fan performance curves showing point of operation, BHP and efficiency.
  - .2 Sound rating data at point of operation.
- .3 Indicate:
  - .1 Motors, sheaves, bearings, shaft details, electrical data and all other pertinent information.
  - .2 Minimum performance achievable with variable speed controllers.

**1.02 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance data for incorporation into manual specified in Division 01 – General Requirements.

**1.03 EXTRA MATERIALS**

- .1 Provide maintenance materials in accordance with Division 01 – General Requirements.
  - .1 Spare parts to include:
    - .1 Matched sets of belts (one set for each set installed).
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

**1.04 MANUFACTURED ITEMS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.

**Part 2 Products****2.01 FANS GENERAL**

- .1 Capacity: flow rate, static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
- .2 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
- .3 Sound ratings: comply with AMCA 301, tested to AMCA 300. Unit shall bear AMCA certified sound rating seal.

- .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51. Unit shall bear AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.
- .5 Motors:
  - .1 In accordance with Section 23 05 13 – Common Motor Requirements for HVAC Equipment, supplemented as specified herein.
  - .2 For use with variable speed controllers where noted.
  - .3 Sizes as indicated.
  - .4 Two speed with two windings and speeds as indicated.
- .6 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet safety screens as indicated and as specified in Section 23 05 13 Common Motor Requirements for HVAC Equipment.
- .7 Factory primed before assembly in colour standard to manufacturer.
- .8 Scroll casing drains: as indicated.
- .9 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .10 Vibration isolation: to Section 23 05 48 Mechanical - Vibration Isolation.
- .11 Flexible connections: to Section 23 33 00 Mechanical - Duct Accessories.

## **2.02 CENTRIFUGAL FANS**

- .1 Fan wheels:
  - .1 Welded steel construction.
  - .2 Maximum operating speed of centrifugal fans not more than 50% of first critical speed.
  - .3 Air foil, forward curved or backward inclined blades, as indicated.
- .2 Bearings: heavy duty split pillow-block grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 h.
- .3 Housings:
  - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, steel or aluminum, for smaller wheels, braced, and with welded supports.
  - .2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.
  - .3 Provide bolted airtight access doors with handles.

## **2.03 CABINET FANS - GENERAL PURPOSE**

- .1 Fan characteristics and construction: as centrifugal fans.

- .2 Cabinet hung single or multiple wheel with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, inside or outside casing as noted.
- .3 Fabricate casing of zinc coated or phosphate treated steel reinforced and braced for rigidity. Provide removable panels for access to interior. Uncoated, steel parts shall be painted over with corrosion resistant paint to CGSB 1-GP-181M. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with 25 mm thick rigid acoustic insulation, pinned and cemented.

#### **2.04 UTILITY SETS**

- .1 Characteristics and construction: for centrifugal fans.
- .2 Preassemble single width centrifugal fan with removable weatherproof protective hood with vents.
- .3 Provide belt driven sets with adjustable motor bed plate.

#### **2.05 IN-LINE CENTRIFUGAL FANS**

- .1 Characteristics and construction: as for centrifugal fan wheels, with axial flow construction and direct or belt drive as indicated.
- .2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

### **Part 3 Execution**

#### **3.01 FAN INSTALLATION**

- .1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration Isolation and Seismic Control, flexible electrical leads and flexible connections in accordance with Section 23 33 00 Mechanical - Duct Accessories.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

**END OF SECTION 23 34 00**

**Part 1 General****1.01 PRODUCT DATA**

- .1 Submit product data in accordance with Division 01 – General Requirements.
- .2 Indicate the following:
  - .1 Capacity.
  - .2 Throw and terminal velocity.
  - .3 Noise criteria.
  - .4 Pressure drop.
  - .5 Neck velocity.
  - .6 Construction and finish.
  - .7 Mounting details.

**1.02 SAMPLES**

- .1 Submit samples in accordance with Division 01 – General Requirements.
- .2 Samples are required for following:
  - .1 Secure area grilles.

**1.03 CERTIFICATIONS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

**1.04 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01 – General Requirements.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Dispose of corrugated cardboard plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

**Part 2 Products****2.01 GRILLES, REGISTERS, AND DIFFUSERS**

- .1 Provide standard product to meet capacity, throw, noise level, throat and outlet velocity.
- .2 Where grilles, registers and diffusers penetrate fire walls and fire partitions, provide approved steel sleeve secured to structure in accordance with NFPA 90A-2015.
- .3 Frames:
  - .1 Steel: prime coated with exposed welded joints and mitred corners.

- .2 Aluminum: extruded with welded joints and mitred corners.
- .3 Provide full perimeter gaskets.
- .4 Provide plaster frames as plaster stops where set into plaster or gypsum board at all locations.
- .5 Provide concealed fasteners and operators as specified.
- .4 Sizes and capacities: as indicated in Schedule on drawings.
- .5 Standard of Acceptance: E.H. Price, Titus, Krueger, Nailor.

**Part 3 Execution**

**3.01 INSTALLATION**

- .1 Install in accordance with manufacturers instructions.
- .2 Install with flat head colour matched screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place.
- .4 All diffusers, grilles and registers shall fit level, square and plumb to building lines with frame tight to adjacent surface. Where mounted in acoustic tile ceiling, centre in tile as shown on Departmental Representative's reflected ceiling plan.

**END OF SECTION 23 37 13**



**Part 1        General****1.01        PRODUCT DATA**

- .1       Submit product data in accordance with Division 01 – General Requirements.
- .2       Indicate the following:
  - .1       Pressure drop.
  - .2       Face area.
  - .3       Free area.
  - .4       Materials of construction, construction methods and dimensions.

**1.02        TEST REPORTS**

- .1       Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

**1.03        CERTIFICATION OF RATINGS**

- .1       Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

**1.04        WASTE MANAGEMENT AND DISPOSAL**

- .1       Separate and recycle waste materials in accordance with Division 01 – General Requirements.
- .2       Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3       Dispose of corrugated cardboard, plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

**Part 2        Products**

- .1       Not used.

**Part 3        Execution****3.01        INSTALLATION**

- .1       In accordance with manufacturer's and SMACNA recommendations.
- .2       Reinforce and brace as indicated.
- .3       Anchor securely into opening. Seal with caulking around to ensure weather tightness.
- .4       All hood to curb fasteners shall be installed from inside throat of intake hood so as not to be accessible from roof areas.

**Part 1 General****1.01 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawing and product data in accordance with Division 01 – General Requirements.

**1.02 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in Division 01 – General Requirements.

**1.03 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Division 01 – General Requirements, and with the Waste Reduction Workplan.

**1.04 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with Division 01 – General Requirements.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.

**1.05 EXTRA MATERIALS**

- .1 Spare filters: in addition to filters to be installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank in accordance with Division 01 – General Requirements.

**Part 2 Products****2.01 GENERAL**

- .1 Media: suitable for air at 100% RH and air temperatures between -40°C and 50°C.
- .2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated.
- .3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.

**2.02 ACCESSORIES**

- .1 Holding frames: channel section construction of galvanized steel, 1.6 mm thick, except where specified otherwise.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.

- .4 Access and servicing: through doors/panels on each side and/or from upstream face of filter bank where indicated.

### **2.03 RIGID, SUPPORTED PLEAT TYPE FILTERS, 25-30% EFFICIENCY**

- .1 Media: disposable preformed cotton/polyester blend cartridge.
- .2 Holding frame: high wet strength cardboard.
- .3 Media support: welded wire grid.
- .4 Performance:
  - .1 Average atmospheric dust spot efficiency 25-30% to ASHRAE 52.1.
  - .2 MERV 8 to ASHRAE 52.2.
- .5 Fire rated: to ULC -S111.
- .6 Acceptable material: Camfil 30/30, AAF, Air Guard.

### **2.04 CARTRIDGE TYPE FILTERS, 80-85 % EFFICIENCY**

- .1 Media: deep pleated, disposable, high efficiency, to CAN/CGSB-115.14.
- .2 Holding frame: galvanized steel with bracing.
- .3 Media support: welded wire grid.
- .4 Performance:
  - .1 Average atmospheric dust spot efficiency 80-85 % to ASHRAE 52.1.
  - .2 MERV 13 to ASHRAE 52.2.
- .5 Fire rated: to ULC -S111.
- .6 Acceptable material: Camfil riga-flo, AAF, Air Guard.

### **2.05 FILTER GAUGES - DIAL TYPE**

- .1 Diaphragm actuated, direct reading. Compatible with air from -6°C to 48°C. Scale calibrated to read full range of filter from clean installation through fully loaded at 50% pressure beyond changeout limit.
- .2 Two phototransistor actuated DPDT relays included for low/high limit sensing. Electrically rated for 10A@28 VDC, 10A@120 VAC.
- .3 Acceptable material: Dwyer Photohelic A3000.

## **Part 3 Execution**

### **3.01 INSTALLATION GENERAL**

- .1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

**3.02            REPLACEMENT MEDIA**

- .1        Replace all media with new upon acceptance.

**3.03            FILTER GAUGES**

- .1        Install type as indicated across each filter bank (pre-filter and final filter) in approved and easy readable location.
- .2        Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

**END OF SECTION 23 44 00**