

PART 1 - GENERAL

- 1.1 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Product Data:
    - .1 Submit manufacturer's instructions, printed product literature and data sheets. Include product characteristics, performance criteria, physical size, finish and limitations.
  - .3 Shop Drawings:
    - .1 Indicate on drawings:
      - .1 Mounting arrangements.
      - .2 Operating and maintenance clearances.
    - .2 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.
    - .3 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- 1.2 CLOSEOUT SUBMITTALS
- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
  - .2 Operation and Maintenance Data: submit operation and maintenance data.
    - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
    - .2 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.
- .3 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.
- .4 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.
- .5 Approvals:
  - .1 Submit 2 copies 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.
- .6 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 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 weekly 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.
- .8 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.

.9 Submit copies of as-built drawings for inclusion in final TAB report.

1.3 MAINTENANCE  
MATERIAL SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Furnish spare parts as follows:

.1 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

1.4 DELIVERY,  
STORAGE AND  
HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS .1 Not Used.

PART 3 - EXECUTION

3.1 EXAMINATION .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.  
.1 Visually inspect substrate in presence of Departmental Representative.  
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.  
.3 Proceed with installation only after unacceptable conditions have been remedied [and after receipt of written approval to proceed from Departmental Representative.

3.2 PAINTING REPAIRS AND RESTORATION .1 Do painting in accordance with Section 09 91 23 - Interior Painting.  
.2 Prime and touch up marred finished paintwork to match original.  
.3 Restore to new condition, finishes which have been damaged.

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

3.4 FIELD QUALITY CONTROL .1 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 - ACTION AND INFORMATIONAL 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.

3.5 DEMONSTRATION

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 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.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements 24hrs.
- .5 Departmental Representative will record these demonstrations on video tape for future reference.

3.6 PROTECTION

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

END OF SECTION

PART 1 - GENERAL

- 1.1 USE OF SYSTEMS .1 Use of existing permanent heating and or ventilating systems for supplying temporary heat or ventilation is permitted only under following conditions:
- .1 There is no possibility of damage.
  - .2 Return systems have approved filters over openings, inlets, outlets.
  - .3 Systems will be:
    - .1 Operated as per manufacturer's recommendations and instructions.
    - .2 Operated by Contractor.
    - .3 Monitored continuously by Contractor.
  - .4 Warranties and guarantees are not relaxed.
  - .5 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Departmental Representative.
  - .6 If condition after construction is not as per the original condition, the contractor shall refurbish entire system to reinstate the original condition, and replace filters.
- .2 Filters specified in this Section are over and above those specified in other Sections of this project.

PART 2 - PRODUCTS

- 2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

- 3.1 NOT USED .1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B31.1-2016, Power Piping.
- .2 ASTM International
  - .1 ASTM A 307-2014, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .2 ASTM A 563-15, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP 58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 MSS SP 58-2009, Pipe Hangers and Supports - Selection and Application.
- .4 Underwriter's Laboratories of Canada (ULC)
- .5 National Fire Code of Canada (2015)
- .6 National Plumbing Code of Canada (2015)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit shop drawings for:
    - .1 Bases, hangers and supports.
    - .2 Connections to equipment and structure.
    - .3 Structural assemblies.
- .4 Certificates:
  - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .5 Manufacturers' Instructions:
  - .1 Provide manufacturer's installation instructions.
    - .1 Departmental Representative will make available one copy of systems supplier's installation instructions.

1.3 CLOSEOUT  
SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

PART 2 - PRODUCTS

2.1 SYSTEM  
DESCRIPTION

- .1 Design Requirements:
  - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
  - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP 58.
  - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
  - .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment. Hangers to be seismic type.
  - .5 Provide for vertical adjustments after erection. Amount of adjustment in accordance with MSS SP 58.

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.3 PIPE HANGERS

- .1 Finishes:
  - .1 Pipe hangers and supports: galvanized or painted with zinc-rich paint after manufacture.
  - .2 Use electro-plating galvanizing process or hot dipped galvanizing process.

- .3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - .1 Rod: 9mm UL listed.
    - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP 58 and MSS-SP 69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP 69.
  - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Upper attachment to concrete:
  - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6mm minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP 69.
- .5 Shop and field-fabricated assemblies:
  - .1 Trapeze hanger assemblies
  - .2 Steel brackets
  - .3 Sway braces for seismic restraint systems: to Section 23 05 48.
- .6 Hanger rods: threaded rod material to MSS SP 58:
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
  - .3 Do not use 28mm rod.
- .7 Pipe attachments: material to MSS SP 58:
  - .1 Attachments for steel piping: carbon steel galvanized.
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Use insulation shields for hot pipework.
  - .4 Oversize pipe hangers and supports to accommodate Thermal Insulation.

- .8 Adjustable clevis: material to MSS SP 69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 69.
- .10 U-bolts: carbon steel to MSS SP 69 with 2 nuts at each end to ASTM A 563.
  - .1 Finishes for steel pipework: galvanized.
  - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with formed portion plastic coated or epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 69.

2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP 58, type 42, UL listed.
- .2 Copper pipe: carbon steel copper plated to MSS SP 58, type 42.
- .3 Bolts: to ASTM A 307.
- .4 Nuts: to ASTM A 563.

2.5 INSULATION  
PROTECTION SHIELDS

- .1 Insulated cold piping:
  - .1 64 kg/m3 density insulation plus insulation protection shield to: MSS SP 69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
  - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP 69.

2.6 EQUIPMENT  
SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel.

2.7 EQUIPMENT ANCHOR BOLTS AND TEMPLATES .1 Provide templates to ensure accurate location of anchor bolts.

PART 3 - EXECUTION

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

3.2 INSTALLATION .1 Install in accordance with:  
.1 Manufacturer's instructions and recommendations.  
.2 Clamps on riser piping:  
.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.  
.2 Bolt-tightening torques to industry standards.  
.3 Steel pipes: install below coupling or shear lugs welded to pipe.  
.4 Cast iron pipes: install below joint.  
.3 Clevis plates:  
.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.  
.4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.  
.5 Use approved constant support type hangers where:  
.1 Vertical movement of pipework is 13 mm or more,  
.2 Transfer of load to adjacent hangers or connected equipment is not permitted.

3.3 HANGER SPACING .1 Plumbing piping: to Canadian Plumbing Code.  
.2 Fire protection: to the National Fire Code.  
.3 Copper piping: up to NPS 1/2: every 1.5m.

- .4 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .5 Within 300mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

- .6 Pipework greater than NPS 12: to MSS SP 69.

3.4 HANGER  
INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL  
MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL  
ADJUSTMENT

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.
- .2 Adjustable clevis:
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

END OF SECTION

PART 1 - GENERAL

- 1.1 SUMMARY
- .1 Related Requirements
    - .1 Section 22 11 16 - Domestic Water Piping.
    - .2 Section 22 13 17 - Drainage Waste and Vent Piping-Cast Iron and Copper.
    - .3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- 1.2 REFERENCES
- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
    - .1 Material Safety Data Sheets (MSDS).
  - .2 National Fire Protection Association (NFPA)
    - .1 NFPA 13-2013, Standard for the Installation of Sprinkler Systems.
  - .3 National Building Code of Canada (NBC) - 2015
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
    - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. 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 Section 01 33 00 - Submittal Procedures.
  - .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
    - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered and licensed in the Province of Ontario, Canada.
    - .2 Provide separate shop drawings for each isolated system complete with performance and product data.
    - .3 Provide detailed drawings of seismic control measures for equipment and piping.
  - .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
    - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .2 Instructions: submit manufacturer's installation instructions.
  - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

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

2.2 ELASTOMERIC PADS

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

2.3 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.

## 2.4 SPRINGS

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
- .3 Cadmium plate for outdoor or 100% relative humidity installations.
- .4 Colour code springs.

## 2.5 SPRING MOUNT

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 - stable open spring: support on bonded 6mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 - stable open spring: 6mm 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 6mm 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 Performance: as indicated.

## 2.6 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

- .4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.
- .6 Performance: as indicated.

### 2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

- .1 Acoustic barriers: between pipe and support, consisting of 25mm minimum thick heavy duty duck and neoprene isolation material.

### 2.8 HORIZONTAL THRUST RESTRAINT

- .1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9mm.
- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

### 2.9 SEISMIC CONTROL MEASURES

- .1 General:
  - .1 Seismic control systems to work in every direction.
  - .2 Fasteners and attachment points to resist same maximum load as seismic restraint.
  - .3 Drilled or power driven anchors and fasteners not permitted.
  - .4 No equipment, equipment supports or mounts to fail before failure of structure.
  - .5 Supports of cast iron or threaded pipe not permitted.
  - .6 Seismic control measures not to interfere with integrity of firestopping.
- .2 Static equipment:
  - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
  - .2 Suspended equipment:
    - .1 Install tight to structure.
    - .2 Cross brace in every direction.
    - .3 Brace back to structure.
    - .4 Cable restraint system.

- .3 Seismic restraints:
  - .1 Cushioning action gentle and steady.
  - .2 Never reach metal-like stiffness.
- .3 Vibration isolated equipment:
  - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
  - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
  - .3 As indicated.
- .4 Piping systems:
  - .1 Fire protection systems: to NFPA 13.
  - .2 Piping systems: hangers longer than 300mm; brace at each hanger.
  - .3 Compatible with requirements for anchoring and guiding of piping systems.
- .5 Bracing methods:
  - .1 Shall be reviewed as a shop drawing by the Departmental Representative.
  - .2 Structural angles or channels.
  - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

### PART 3 - EXECUTION

#### 3.1 MANUFACTURER'S INSTRUCTIONS

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

#### 3.2 INSTALLATION

- .1 Seismic control measures to meet requirements of NBC.
- .2 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- .3 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.

- .4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25mm 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: static deflection of twice deflection of isolated equipment, but not more than 50mm.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.
- .6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
  - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
  - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
    - .1 After delivery and storage of Products.
    - .2 After preparatory work is complete but before installation commences.
    - .3 Twice during the installation, at 25% and 60% completion stages.
    - .4 Upon completion of installation.
  - .3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.
  - .4 Make adjustments and corrections in accordance with written report.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA 13-2016, Standard for the Installation of Sprinkler Systems.
  - .2 NFPA 14-2016, Standard for the Installation of Standpipe and Hose Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
- .2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Product data to include paint colour chips, other products specified in this section.
- .4 Samples:
  - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Samples to include nameplates, labels, tags, lists of proposed legends.
- .5 Contractor to complete and submit BGIS CMMS (Computerized Maintenance Management System) forms for new, removed and modified equipment. Include completed BGIS CMMS inventory sheets in the O&M manual.

1.3 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

PART 2 - PRODUCTS

2.1 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.

2.2 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 3mm 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 Identification for BGIS Computerized Maintenance Management System (CMMS):
  - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
  - .2 Equipment in Mechanical Room:
    - .1 Main identifier: size #9.
    - .2 Source and Destination identifiers: size #6.
    - .3 Terminal cabinets, control panels: size #5.
  - .3 Equipment elsewhere: sizes as appropriate.

- 2.3 EXISTING IDENTIFICATION SYSTEMS
- .1 Apply existing identification system to new work.
  - .2 Where existing identification system does not cover for new work, use identification system specified this section.
  - .3 Before starting work, submit samples of identification system for review by the Departmental Representative. The submission shall be in the form of a formal shop drawings submission.
- 2.4 PIPING SYSTEMS GOVERNED BY CODES
- .1 Identification:
    - .1 Sprinklers: to NFPA 13.
    - .2 Standpipe and hose systems: to NFPA 14.
- 2.5 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 Pictograms:
    - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
  - .3 Legend:
    - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
  - .4 Arrows showing direction of flow:
    - .1 Outside diameter of pipe or insulation less than 75mm: 100mm long x 50mm high.
    - .2 Outside diameter of pipe or insulation 75mm and greater: 150mm long x 50mm high.
    - .3 Use double-headed arrows where flow is reversible.
  - .5 Extent of background colour marking:
    - .1 To full circumference of pipe or insulation.
    - .2 Length to accommodate pictogram, full length of legend and arrows.
  - .6 Materials for background colour marking, legend, arrows:
    - .1 Pipes and tubing 20mm 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.

- .7 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
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Fire protection water	Red	FIRE PROT. WTR

2.6 IDENTIFICATION  
 DUCTWORK SYSTEMS

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

2.7 VALVES,  
 CONTROLLERS

- .1 Brass tags with 12mm 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.

2.8 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.

2.9 LANGUAGE

- .1 Identification in English and French.
- .2 Use one nameplate and label for both languages.

PART 3 - EXECUTION

- 3.1 MANUFACTURER'S INSTRUCTIONS
- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 INSTALLATION
- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
  - .2 Provide ULC and CSA registration plates as required by respective agency.
  - .3 Identify systems, equipment to conform to BGIS CMMS.
- 3.3 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.
- 3.4 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS
- .1 On long straight runs in open areas: 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.

3.5 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 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass in a service room of close proximity. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

- .1 TAB means to test, adjust and balance.
- .2 TAB: performed in accordance with the requirements of:
  - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
  - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-2005.
  - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .3 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .4 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

1.2 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 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.

1.3 EXCEPTIONS

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

1.4 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule 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.

1.5 PRE-TAB REVIEW

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

1.6 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

1.7 OPERATION OF SYSTEMS DURING TAB

- .1 Operate systems for length of time required for TAB for verification of TAB reports.

1.8 START OF TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Provisions for TAB installed and operational.
- .6 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, smoke, volume control dampers installed and open.
- .6 Access doors, installed, closed.
- .7 Outlets installed, volume control dampers open.

1.9 APPLICATION TOLERANCES

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

1.10 ACCURACY TOLERANCES

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

1.11 INSTRUMENTS

- .1 Prior to TAB, submit to Departmental Representative list of instruments 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.

1.12 ACTION AND INFORMATIONAL SUBMITTALS

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

1.13 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.

- 1.14 TAB REPORT
- .1 Format in accordance with referenced standard.
  - .2 TAB report to show results in SI units and to include:
    - .1 Project record drawings.
    - .2 System schematics.
  - .3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in both official languages in D-ring binders, complete with index tabs.
- 1.15 VERIFICATION
- .1 Reported results subject to verification by Departmental Representative.
  - .2 Provide personnel and instrumentation to verify up to 30% of reported results.
  - .3 Number and location of verified results as directed by Departmental Representative.
  - .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.
- 1.16 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. Do not eradicate or cover markings.
- 1.17 COMPLETION OF TAB
- .1 TAB considered complete when final TAB Report received and approved by Departmental Representative.
- 1.18 AIR SYSTEMS
- .1 Standard: TAB to most stringent of this section or TAB standards of AABC, NEBB, SMACNA, ASHRAE.
  - .2 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC or NEBB.

- .3 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .4 Locations of equipment measurements: to include as appropriate:
  - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
  - .2 At controllers, controlled device.
- .5 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.19 POST-OCCUPANCY  
TAB

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, NC levels, in occupied zone.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not used.

END OF SECTION

PART 1 - GENERAL

- 1.1 REFERENCES
- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
    - .1 Material Safety Data Sheets (MSDS).
  - .2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
    - .1 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:
    - .1 Submit proposed report form and test report format to Departmental Representative for approval at least two weeks before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.
    - .2 Prepare report of results and submit to Departmental Representative within 24 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.
    - .3 Include test reports in final TAB report.
    - .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
    - .5 Instructions: submit manufacturer's installation instructions.
    - .6 Manufacturer's field reports specified.

1.3 QUALITY  
ASSURANCE

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

PART 2 - PRODUCTS

2.1 TEST  
INSTRUMENTS

- .1 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 Calibration curves for orifice plates used.
  - .5 Flexible duct for connecting to ductwork under test.
  - .6 Smoke bombs for visual inspections.
- .2 Test apparatus: accurate to within +/- 3% of flow rate and pressure.
- .3 Submit details of test instruments to be used to Departmental Representative at least two weeks before anticipated start date.
- .4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 14 days before start of tests.

2.2 EQUIPMENT  
LEAKAGE TOLERANCES

- .1 Equipment and system components such as VAV boxes, duct heating leakage: 2% at operating pressure.

PART 3 - EXECUTION3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TEST PROCEDURES

- .1 Maximum lengths of ducts to be tested 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 SMACNA HVAC Air Duct Leakage Test Manual.
- .5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 SITE TOLERANCES

- .1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed 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 VAV box and duct on downstream side of VAV box: leakage 2%.
  - .3 Large low pressure duct systems up to 500 Pa: leakage 2%.
  - .4 HP duct systems up to 1000 Pa pressure classification, including upstream side of VAV boxes: leakage 1.
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

- .1 Test ducts before installation of insulation or other forms of concealment.
- .2 Test after seals have cured.
- .3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.
- .4 Flexible connections to VAV boxes.

3.5 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services.
  - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its product[s] and submit written reports, in acceptable format, to verify compliance of Work with Contract.
  - .2 Manufacturer's Field Services: 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, at stages listed:
    - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
    - .2 Twice during progress of Work at 25% and 60% complete.
    - .3 Upon completion of the Work, after cleaning is carried out.
  - .4 Obtain reports, within 3 days of review, and submit, immediately, to Departmental Representative.
- .2 Performance Verification:
  - .1 Departmental Representative to witness tests and to verify reported results.
  - .2 To be certified by same TAB agency to undertake TAB on this project.

END OF SECTION

PART 1 - GENERAL1.1 REFERENCES

- .1 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" - means "not concealed" as previously defined.
    - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
  - .2 TIAC Codes:
    - .1 CRD: Code Round Ductwork,
    - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
  - .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
    - .1 ANSI/ASHRAE/IESNA 90.1-2016, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - .2 ASTM International Inc.
    - .1 ASTM B 209M-2014, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
    - .2 ASTM C 335-2017, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
    - .3 ASTM C 449/C 449M-2013, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
    - .4 ASTM C 553-2013, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
    - .5 ASTM C 612-2014, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
    - .6 ASTM C 921-2015, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
  - .3 Canadian General Standards Board (CGSB)
    - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards 2005.
  - .5 Underwriters Laboratories of Canada (ULC)
    - .1 CAN/ULC-S102-2010, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND  
INFORMATIONAL  
SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
    - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
    - .2 Details of operation, servicing and maintenance.
    - .3 Recommended spare parts list.
- .3 Samples:
  - .1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
  - .2 Mount sample on 12mm plywood board.
  - .3 Affix typewritten label beneath sample indicating service.
- .4 Manufacturers' Instructions:
  - .1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence and cleaning procedures.

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE  
RATING

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

2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C 335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C 612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).

- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C 553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to ASTM C 553.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to ASTM C 553.

### 2.3 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 Tape: self-adhesive, aluminum, reinforced, 75mm wide minimum.
- .6 Contact adhesive: quick-setting
- .7 Canvas adhesive: washable.
- .8 Tie wire: 1.5mm stainless steel.
- .9 Banding: 19mm wide, 0.5mm thick stainless steel.
- .10 Facing: 25mm stainless steel hexagonal wire mesh stitched on both faces of insulation.
- .11 Fasteners: 4mm diameter pins with 35mm diameter clips, length to suit thickness of insulation.

### 2.4 ACOUSTIC LINING

- .1 Acoustic quality, 25mm thick glass fibre, free of shot and odour; bacteria and fungus resistant; free of corrosion causing or accelerating agents; 100% duct coverage, minimum 10% compression during assembly; and meet NBC fire requirements or requirements of authority having jurisdiction for duct lining.

- .2 Duct sizes indicated on drawings indicate the free area. Increase the size of the duct to account for the internal acoustic lining.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300mm on center in horizontal and vertical directions, minimum 2 rows each side.
- .7 Contractor to install thermal duct insulation on all supply duct work up to VAV boxes, as well as from the VAV box discharge to the ceiling diffusers.

3.4 DUCTWORK  
INSULATION SCHEDULE

.1 Insulation types and thicknesses: conform to following table based on ASHRAE 90.1:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold temperature supply air ducts	C-1	yes	50
Round cold temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	yes	25
Round warm air ducts	C-1	yes	25
Supply, none return and exhaust ducts exposed in space being served			
Outside air ducts to mixing plenum	C-1	yes	50
Mixing plenums	C-1	yes	25
Acoustically none lined ducts			

.2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.1 Finishes: conform to following table:

	TIAC Code	
	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3

END OF SECTION

PART 1 - GENERAL

- 1.1 REFERENCES
- .1 American Society for Testing and Materials International (ASTM)
    - .1 ASTM C 335-17, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
    - .2 ASTM C 547-2017, Mineral Fibre Pipe Insulation.
  - .2 Canadian General Standards Board (CGSB)
    - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .3 Underwriters' Laboratories of Canada (ULC)
    - .1 CAN/ULC-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.
    - .2 CAN/ULC-S702-2016, Thermal Insulation, Mineral Fibre, for Buildings
    - .3 CAN/ULC-S702.2-15, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.
- 1.2 DEFINITIONS
- .1 For purposes of this section:
    - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
    - .2 "EXPOSED" - will mean "not concealed" as specified.
  - .2 TIAC ss:
    - .1 CRF: Code Rectangular Finish.
    - .2 CPF: Code Piping Finish.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Submittals: in accordance with Section 01 00 10 - General Instructions.
  - .2 Product Data:
    - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 00 10 - General Instructions. 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 Section 01 00 10 - General Instructions.
  - .3 Shop Drawings:
    - .1 Submit shop drawings in accordance with Section 01 00 10 - General Instructions.

- .4 Quality assurance submittals: submit following in accordance with Section 01 00 10 - General Instructions.
    - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
    - .2 Instructions: submit manufacturer's installation instructions.
      - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- 
- 1.4 QUALITY ASSURANCE
    - .1 Health and Safety:
      - .1 Do construction occupational health and safety in accordance with Section 01 35 29.0 - Health and Safety Requirements.
- 
- 1.5 DELIVERY, STORAGE AND HANDLING
    - .1 Deliver, store and handle in accordance with manufacturer's written instructions.
- 
- ## PART 2 - PRODUCTS
- 
- 2.1 FIRE AND SMOKE RATING
    - .1 In accordance with CAN/ULC-S102.
      - .1 Maximum flame spread rating: 25.
      - .2 Maximum smoke developed rating: 50.
- 
- 2.2 INSULATION
    - .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
    - .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C 335.
    - .3 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as per in PART 3 of this section).
      - .1 Mineral fibre: to CAN/ULC-S702 and ASTM C 547.
      - .2 Jacket: to CGSB 51-GP-52Ma.
      - .3 Maximum "k" factor: to CAN/ULC-S702 and ASTM C 547.

- 2.3 INSULATION SECUREMENT
- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
  - .2 Contact adhesive: quick setting.
  - .3 Tie wire: 1.5 mm diameter stainless steel.
  - .4 Bands: stainless steel, 19mm wide, 0.5 mm thick.
- 2.4 INDOOR VAPOUR RETARDER FINISH
- .1 Vinyl emulsion type acrylic, compatible with insulation.
- PART 3 - EXECUTION
- 3.1 MANUFACTURER'S INSTRUCTIONS
- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 PRE-INSTALLATION REQUIREMENT
- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
  - .2 Surfaces clean, dry, free from foreign material.
- 3.3 INSTALLATION
- .1 Install in accordance with TIAC National Standards.
  - .2 Apply materials in accordance with manufacturers instructions and this specification.
  - .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
  - .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
    - .1 Install hangers, supports outside vapour retarder jacket.
  - .5 Supports, Hangers:
    - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE,  
PRE-FABRICATED,  
INSULATION AND  
ENCLOSURES

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- .1 Application: at expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
  - .1 Insulation, fastenings and finishes: same as system.
  - .2 Jacket: PVC.

3.5 PIPING  
INSULATION  
SCHEDULES

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- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: C-2 with vapour retarder jacket.
  - .1 Seals: lap seal adhesive, lagging adhesive.
  - .2 Installation: TIAC Code: 1501-C.
- .3 Thickness of all domestic cold water piping shall be 13mm thick and domestic hot water piping insulation shall be 25 mm, TIAC C-2 with vapour barrier.
- .4 Finishes:
  - .1 Exposed indoors: PVC jacket.
  - .2 Concealed, indoors: canvas on valves, fittings. No further finish.
  - .3 Finish attachments: SS screws bands, at 150 mm on centre. Seals: wing closed.
  - .4 Installation: to appropriate TIAC code CRF/1 through CPF/5.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
  - .1 ASTM A 653/A 653M-2015, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-18, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2 NFPA 90B-2018, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
  - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
  - .3 SMACNA IAQ Guideline for Occupied Buildings Under Construction 2007.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Test and Evaluation Reports:
  - .1 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.
    - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings Under Construction.

PART 2 - PRODUCTS

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
125	Unsealed

.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.

.3 Class C: transverse joints and connections made air tight with gaskets sealant. Longitudinal seams unsealed.

.4 Unsealed seams and joints.

2.2 SEALANT

.1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50mm wide.

2.4 DUCT LEAKAGE

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

2.5 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows:

.1 Rectangular: standard radius centreline radius: 1.5 times width of duct .

.2 Round: smooth radius five piece, centreline radius: 1.5 times diameter.

- .3 Mitred elbows, rectangular:
    - .1 To 400mm: with single thickness turning vanes.
    - .2 Over 400mm: with double thickness turning vanes.
  - .4 Branches:
    - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 degrees entry on branch.
    - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
    - .3 Provide volume control damper in branch duct near connection to main duct.
    - .4 Main duct branches: with splitter damper.
  - .5 Transitions:
    - .1 Diverging: 20 degrees maximum included angle.
    - .2 Converging: 30 degrees maximum included angle.
  - .6 Offsets:
    - .1 Full or Short radiused elbows as indicated.
  - .7 Obstruction deflectors: maintain full cross-sectional area.
    - .1 Maximum included angles: as for transitions.
- 2.6 FIRE STOPPING
- .1 Retaining angles around duct, on both sides of fire separation.
  - .2 Fire stopping material and installation must not distort duct.
- 2.7 GALVANIZED STEEL
- .1 Lock forming quality: to ASTM A 653/A 653M, Z90 zinc coating.
  - .2 Thickness, fabrication and reinforcement: to SMACNA.
  - .3 Joints: to SMACNA.
- 2.8 HANGERS AND SUPPORTS
- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
    - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
      - .1 Maximum size duct supported by strap hanger: 500.
    - .2 Hanger configuration: to SMACNA.

.3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA and following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	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

#### 3.1 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE SMACNA and as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
  - .1 Insulate strap hangers 100mm beyond insulated duct Ensure diffuser is fully seated.
- .3 Support risers ASHRAE SMACNA as indicated.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

#### 3.2 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 and as follows:

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

3.3 SEALING AND  
TAPING

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

3.4 LEAKAGE TESTS

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections. Make trial leakage tests as instructed to demonstrate workmanship.
- .3 Do not install additional ductwork until trial test has been passed.
- .4 Complete test before performance insulation or concealment Work.

END OF SECTION

PART 1 - GENERAL

- 1.1 REFERENCES .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)  
.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.  
.2 Product Data:  
.1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.  
.2 Indicate:  
.1 Flexible connections.  
.2 Duct access doors.  
.3 Turning vanes.  
.4 Instrument test ports.

PART 2 - PRODUCTS

- 2.1 GENERAL .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.
- 2.2 FLEXIBLE CONNECTIONS .1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.  
.2 Material:  
.1 Fire resistant, self-extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m2.
- 2.3 ACCESS DOORS IN DUCTS .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6mm thick complete with sheet metal angle frame.

- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6mm thick complete with sheet metal angle frame and 25mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
  - .1 Up to 300 x 300mm: two sash locks complete with safety chain.
  - .2 301 to 450mm: four sash locks complete with safety chain.
  - .3 451 to 1000mm: piano hinge and minimum two sash locks.
  - .4 Doors over 1000mm: piano hinge and two handles operable from both sides.
  - .5 Hold open devices.
  - .6 300 x 300mm glass viewing panels.

#### 2.4 TURNING VANES

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

#### 2.5 INSTRUMENT TEST

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

#### 2.6 SPIN-IN COLLARS

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

#### 2.7 VAV boxes

- .1 Furnish and install single duct pressure independent variable air volume terminals of the sizes and capacities shown in the plans. Terminals shall be certified under the ARI Standard 880 Certification program and carry the ARI Seal. Non-certified terminals

are not acceptable. Each unit shall be tagged to identify the reference number and design setting

- .2 The terminal casing shall be minimum twenty-two (22) gauge galvanized steel, internally lined with 3/4" dual density glass fiber insulation which complies with UL 181 and NFPA 90A. All exposed insulation edges shall be coated with NFPA 90A approved sealant to prevent entrainment of fibres in the airstream. The discharge connection shall be slip and drive construction for attachment to metal ductwork.
- .3 The damper shall be heavy gauge steel with peripheral gasket rotating in self-lubricating bearings. Air leakage across the fully closed damper shall not exceed 2% of the nominal catalogue rating at three (3)" inlet pressure.
- .4 The units shall be selected to achieve a room sound level not exceeding NC35 at two (2)" inlet pressure with a room effect of 10 db. Supply laboratory test results showing discharge and radiated NC levels. Provide thirty-six (36)" factor fabricated discharge attenuator with liner.
- .5 Primary air flow sensor shall be differential pressure, averaging multi point type designed to amplify the sensed airflow signal. Provide balancing taps and airflow calibration charts for field airflow measurements.
- .6 The VAV box shall be supplied with DDC controller and actuator to match base building standard, suitable for the existing EMCS.

## PART 3 - EXECUTION

### 3.1 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 connection: 100mm.
  - .3 Minimum distance between metal parts when system in operation: 75mm.
  - .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.
- .2 Access Doors and Viewing Panels:
  - .1 Size:
    - .1 600 x 600mm for person size entry.
    - .2 1200 x 1200mm for servicing entry.
    - .3 300 x 300mm for viewing.
    - .4 As indicated.
  - .2 Locations:
    - .1 Fire and smoke dampers.
    - .2 Control dampers.
    - .3 Devices requiring maintenance.
    - .4 Required by code.
    - .5 Reheat 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

PART 1 - GENERAL

- 1.1 REFERENCES .1 Sheet Metal and Air Conditioning National Association (SMACNA)  
.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-2005.  
.2 SMACNA IAQ Guideline for Occupied Buildings Under Construction, 2007.
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.  
.2 Product Data:  
.1 Submit manufacturer's instructions, printed product literature and data sheets for dampers and include product characteristics, performance criteria, physical size, finish and limitations.  
.2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings Under Construction.
- 1.3 CLOSEOUT SUBMITTALS .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.  
.2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

PART 2 - PRODUCTS

- 2.1 GENERAL .1 Manufacture to SMACNA standards.
- 2.2 SINGLE BLADE DAMPERS .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.  
.2 Size and configuration to recommendations of SMACNA, except maximum height 100mm.  
.3 Locking quadrant with shaft extension to accommodate insulation thickness.

- .4 Inside and outside nylon or bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.3 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: 100mm.
- .4 Bearings: pin in bronze bushings or self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage : 5% at 2500 Pa.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.
- .7 Corrections and adjustments conducted by Departmental Representative.

END OF SECTION

PART 1 - GENERAL1.1 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-18, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2 NFPA 90B-18, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
  - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 2007.
- .4 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S110-2013, Standard Methods of Tests for Air Ducts.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for flexible ducts and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate:
    - .1 Thermal properties.
    - .2 Friction loss.
    - .3 Acoustical loss.
    - .4 Leakage.
    - .5 Fire rating.
- .3 Test and Evaluation Reports:
  - .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.
  - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings Under Construction.

PART 2 - PRODUCTS

2.1 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.

2.2 METALLIC -  
INSULATED

- .1 Type 2: spiral wound flexible aluminum with factory applied, 37mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl jacket, as indicated.
- .2 Performance:
  - .1 Factory tested to 2.5 kPa without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.

2.3 METALLIC  
ACOUSTIC INSULATED  
- MEDIUM PRESSURE

- .1 Type 5: spiral wound, flexible perforated aluminum with factory applied 37mm thick flexible mineral fibre thermal insulation and sleeved by aluminum foil/mylar laminate Type M vapour barrier, as indicated.
- .2 Performance:
  - .1 Factory tested to 2.5 kPa without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.
  - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Duct Diam:	Frequency (Hz)				
	125	250	500	1000	2000
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

PART 3 - EXECUTION

3.1 DUCT  
INSTALLATION

- .1 Install in accordance with: CAN/ULC-S110, UL 181, NFPA 90A, NFPA 90B, SMACNA and ASHRAE.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
  - .1 ANSI/AMCA Standard 99-2016, Standards Handbook.
  - .2 ANSI/AMCA Standard 210-2016/( ANSI/ASHRAE 51-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - .3 ANSI/AMCA Standard 300-2008, Reverberant Room Method for Sound Testing of Fans.
  - .4 ANSI/AMCA Standard 301-2014, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 The Master Painters Institute (MPI)
  - .1 Architectural Painting Specification Manual - current edition.
    - .1 MPI #18, Primer, Zinc Rich, Organic.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC fans and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Provide:
    - .1 Fan performance curves showing point of operation, bhp kW and efficiency.
    - .2 Sound rating data at point of operation.
  - .2 Indicate:
    - .1 Motors, sheaves, bearings, shaft details.
    - .2 Minimum performance achievable with variable speed controllers.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- .1 Performance Requirements:
  - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

.2 Capacity: flow rate, total static pressure, bhp W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.

.3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA Standard 99.

.4 Sound ratings: comply with ANSI/AMCA Standard 301, tested to ANSI/AMCA Standard 300. Supply unit with ANSI/AMCA certified sound rating seal.

.5 Performance ratings: based on tests performed in accordance with ANSI/AMCA Standard 210. Supply unit with ANSI/AMCA certified rating seal, except for propeller fans smaller than 300mm diameter.

2.2 FANS GENERAL

- .1 Motors:
  - .1 For use with variable speed controllers.
  - .2 Sizes as indicated or specified.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable motor bases, belt guards, coupling guards fan as specified in Section.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .5 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.3 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, direct drive.
- .3 Fabricate casing of zinc coated or phosphate treated steel of 1.5mm thickness reinforced and braced for rigidity. Provide removable panels for access to interior. Paint uncoated, steel parts with corrosion resistant paint to MPI #18. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with 50mm thick rigid acoustic insulation, pinned and cemented complete with metal nosings on exposed edges. Include solid state speed controller factory mounted on cabinet and wired to fan.

PART 3 - EXECUTION

3.1 FAN  
INSTALLATION

- .1 Install fans as indicated complete with resilient mountings, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air 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.

3.2 ANCHOR BOLTS  
AND TEMPLATES

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified.

END OF SECTION

PART 1 - GENERAL

1.1 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

1.2 MAINTENANCE MATERIAL SUBMITTALS .1 Extra Materials:  
.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.  
.2 Include:  
.1 Keys for volume control adjustment.  
.2 Keys for air flow pattern adjustment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION .1 Performance Requirements:  
.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 GENERAL .1 To meet capacity as indicated. Pressure drop, terminal velocity, throw, noise level, neck velocity should be in accordance with ASHRAE guidelines.  
.2 Frames:  
.1 Full perimeter gaskets.  
.2 Plaster frames where set into plaster or gypsum board and as specified.  
.3 Concealed fasteners.  
.3 Concealed manual volume control damper operators.  
.4 Colour: standard as directed by Departmental Representative.

2.3 MANUFACTURED UNITS .1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.4 SUPPLY GRILLES  
AND REGISTERS

- .1 General: steel construction. Refer to drawing schedule.

2.5 RETURN AND  
EXHAUST GRILLES AND  
REGISTERS

- .1 General: aluminum construction. Refer to drawing schedule.

2.6 DIFFUSERS

- .1 General: steel construction volume control dampers with flow straightening devices and gaskets. Diffuser shall be square, multi-blade design, with circular collar. Refer to drawing schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with flat head stainless steel or cadmium plated screws in countersunk holes where fastenings are visible.

END OF SECTION