

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results – Mechanical.

1.2 USE OF SYSTEMS

- .1 Use of new and or existing permanent heating and or ventilating systems for supplying temporary heat or ventilation is **not permitted**.
- .2 Exhaust systems are not included in approvals for temporary heating ventilation.

2 Products

2.1 NOT USED

- .1 Not Used.

3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

1 General

1.1 SCOPE OF WORK

- .1 Provide all piping to the building as shown on plans and described in the specification.
- .2 Trim pipe lengths left in previous contract as necessary to connect piping and equipment installed in this contract. Provide all flanges, welds, and/or material to make these connections.

1.2 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results – Mechanical
- .2 Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
- .3 Section 23 05 53 – Mechanical Identification
- .4 Section 23 07 15 – Thermal Insulation for Piping
- .5 Section 23 08 02 – Cleaning and Startup of Mechanical Systems

1.3 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Green Seal Environmental Standards (GSES)
 - .2 Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.

2 Products

2.1 MATERIAL

- .1 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: maximum VOC limit to SCAQMD Rule 1168 and to GSES GS-36.
- .2 Sealants: maximum VOC limit to SCAQMD Rule 1168 and to GSES GS-36.
- .3 Adhesives: maximum VOC limit to SCAQMD Rule 1168 and to GSES GS-36.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 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.

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and required by relevant codes.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer and as indicated without interrupting operation of other system, equipment and components.

3.4 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

- .1 Install manual air vents at high points in piping systems.
- .2 Install isolating valve at each automatic air valve.

3.6 DIELECTRIC CONNECTIONS

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Use brass fittings (eg valves, strainers) to join dissimilar metals on closed systems.
- .3 Use dielectric unions to join dissimilar metals on open systems (ie domestic water) 50 mm and smaller.
- .4 Where dielectric connections are concealed, provide access through access doors or removable ceiling tiles.

3.7 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.

- .2 Cover open ends of pipe to 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, etc 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 and remove scale and other foreign material before assembly.
- .11 Use concentric reducers at pipe size changes unless shown differently on contract drawings.
- .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 indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use gate or ball valves at branch take-offs for isolating purposes except where specified.
- .14 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.8 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Pipe sleeves shall be SCH 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.

- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, and 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:
 - .1 Provide space for firestopping.
 - .2 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.

3.9 ESCUTCHEONS

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

3.10 PREPARATION FOR FIRE STOPPING

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with 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 firestopping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush system in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.

- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Departmental Representative 72 hours minimum prior to performance of pressure tests.
- .2 Pressure test pipework according to following table:

Service	Minimum Pressure	Test Length
Hot Water Heating	860 kPa or 150% of maximum system pressure	4 hours

- .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 Conduct tests in presence of Departmental Representative or approved third party.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.
- .8 Record test results and provide copy to Departmental Representative.

3.13 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Departmental Representative.
- .2 Request written approval by Departmental Representative 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results – Mechanical
- .2 Section 23 05 05 – Installation of Pipework.
- .3 Section 23 05 53.01 – Mechanical Identification.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M, Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS-SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 21 05 01 – Common Work Results - Mechanical.

2 Products

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.

- .2 Copper tube systems: solder ends grooved ends to ANSI/ASME B16.18.
- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- .4 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: handwheel or lockshield, as applicable.
 - .3 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: handwheel.
- .5 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125 4140-kPa CWP, 860 kPa steam.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders solder ends to ANSI.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.
- .6 Acceptable Materials: Apollo, Crane, Jenkins, Nibco, Kitz, Victaulic, Milwaukee Valve Company.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage, and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results - Mechanical.
- .2 Section 23 05 05 – Installation of Pipework.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1, Power Piping.
- .2 ASTM International
 - .1 ASTM A125, Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .4 Underwriter's Laboratories of Canada (ULC)

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 21 05 01 – Common Work Results - Mechanical

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 and MSS SP58.
 - .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.
 - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
- .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 painted with zinc-rich paint after manufacture but before installation.
 - .2 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
 - .3 Apply to hangers, supports and equipment fabricated from ferrous metals at least one (1) coat of corrosion resistant paint before shipment to job site. Touch-up damaged finish surfaces to satisfaction of Departmental Representative.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers,[UL listed FM approved to MSS-SP58 and MSS-SP69.
 - .1 Acceptable Materials: Myatt Fig. 514; Grinnell Fig. 131, Hunt.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed FM approved.
 - .1 Acceptable Materials: Myatt Fig. 506; Grinnell Fig. 267, Hunt
- .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 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved to MSS SP69.
- .5 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
- .6 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon black steel
 - .1 Standard of Acceptance: Myatt Fig 12.
- .7 Adjustable clevis: material to MSS SP69 UL listed FM approved, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
- .8 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.

- .1 Finishes for steel pipework: (black) (galvanized).
- .2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated.
- .9 Wall brackets: carbon steel prime coated.
 - .1 Acceptable Materials: Myatt Fig. 321; Grinnell Fig. 195, Anvil, Taylor, Hunt, Cooper B-Line, Hunt; Anvil.
- .12 Acceptable Materials: Anvil, Bibby, Grinnell, Hunt, Myatt

2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, ULC listed.
 - .1 Acceptable Materials: Anvil Fig. 261, Hunt; Myatt; Grinnell
- .2 Copper pipe: carbon steel copper or epoxy plated to MSS SP58, type 42.
 - .1 Acceptable Materials: Anvil Fig. CT-121, Hunt; Myatt, Grinnell
- .3 Cold Water pipe: For pipes with liquids below 20 deg C use pre-insulated riser clamps.
 - .1 Acceptable Materials: Bergen, Pipe Shields Piping Technology and Products, Tolco Fig 6F
- .4 Bolts: to ASTM A307, Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping: 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping: 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 SP69.

2.6 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel for Buildings. Submit calculations with shop drawings.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 All pipes shall be hung securely from structure.
- .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 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.
- .5 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING (HORIZONTAL)

- .1 Cast Iron pipe: At or adjacent to each hub or joint, at 3050 mm. and at 900 mm. if the pipe has mechanical joints and the length of pipe between adjacent fittings is 300 mm or less.
- .2 Provide support within 300 mm of each elbow
- .3 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.

Maximum Pipe Size (mm)	Hanger Rod Dia (mm)	Pipe Hanger Maximum Spacing (mm)	
		Steel	Copper
Up to 12	10	1800	1500
19 to 32	10	2100	1825
38	10	2750	2450
50	10	3050	2750

3.4 HANGER SPACING (VERTICAL)

- .1 Support metallic vertical piping at every other floor or 7600 mm intervals unless noted otherwise below.

3.5 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.

3.6 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.

3.7 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

1 General

1.1 RELATED SECTIONS

- .1 .Section 21 05 01 – Common Work Results – Mechanical

1.2 REFERENCES

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems.
- .2 National Building Code of Canada (NBC) - 2010.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results - Mechanical.

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; 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 Materials: Kinetics, Korfund, Mason, Vibro-Acoustics, Vibron.

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 Acceptable Materials: Kinetics, Korfund, Mason, Vibro-Acoustics, Vibron.

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 100% relative humidity installations.
- .4 Colour code springs.
- .5 Acceptable Materials: Vibron, Vibro-Acoustics, Mason, Korfund, Kinetics.

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 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 Performance: as indicated.
- .7 Acceptable Materials: Kinetics, Korfund, Mason, Vibro-Acoustics, Vibron, VAW.

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.
- .7 Acceptable Materials: Kinetics, Korfund, Masdom VM, Mason, Vibro-Acoustics, Vibron, Vibra-Sil Inc., Vimco.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 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 25 mm minimum static deflection as follows:
 - .1 Up to 100mm: first 3 points of support. NPS5 to NPS8: first 4 points of support.
 - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .5 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.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results – Mechanical.
- .2 Section 25 05 54 – EMCS Identification.

1.2 REFERENCES

- .1 Canadian Gas Association (CGA):
 - .1 CSA/CGA B149.1-10, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B128.1 – Non Potable Water Systems.

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures and Section 21 05 01 Common Work Results – Mechanical.
- .2 Provide list of abbreviations for pipe and duct labeling in shop drawing submittal.
- .3 Provide pipe banding colour in shop drawing submittal.
- .4 Submit valve tag list for review prior to installing tags.

2 Products

2.1 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Before starting work, submit identification system for review.

2.2 NAMEPLATE CONSTRUCTION

- .1 Lamicoid
 - .1 3 mm thick laminated plastic matte finish, with square corners, letters accurately aligned and machine engraved into core.
 - .2 Use maximum of 25 letters/numbers per line.
- .2 Brass Tags
 - .1 Brass tags to be made of 18 ga brass.
 - .2 Tags to be round or rectangular with rounded corners.

- .3 Attach to valves / equipment with chain.

2.3 PIPING SYSTEMS

- .1 Identify contents by background colour marking, stencils, and/or pictogram (as necessary) showing name and service including temperature and pressure and direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Where background colour marking does not cover full circumference of pipe provide full circumference banding at both ends of identifier.
- .3 Background colour to be full length of pipe identifier.
- .4 Identification of pipe to include Pictograms where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.
- .5 Use block capital letters 50 mm high for pipes of 75 mm nominal and larger o.d. including insulation and not less than 19 mm high for smaller diameters..
- .6 Arrows showing direction of flow:
- .1 OD of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 OD 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 Pre-manufactured banding incorporating arrows is acceptable.
- .7 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.
 - .3 Waterproof and Heat Resistant Pressure Sensitive Plastic Marker Tags: for pipes and tubing 19 mm nominal and smaller.
 - .4 Acceptable Materials: SMS Coilmark, W.H. Brady Inc., Seton Name Plate Corp.,
- .8 Colours and Legends:
- .1 All pipes to be identified. Where not listed, obtain direction from Departmental Representative.
 - .2 Colours for legends, arrows: to following table:

Background Colour	Text and Arrows
White	Black

.3 Background colour marking and legends for piping systems:

Contents	Banding	Background colour marking	Legend
Plumbing			
Domestic hot water	Black	White	DOMESTIC HOT WATER
Domestic cold water	Black	White	DOMESTIC COLD WATER

.9 Exposed Ceilings Painted Black

- .1 Pipe identification to be consist of a grey band at each end of the identification, grey directional arrows, and the service written in grey.

2.4 VALVES

- .1 Brass tags with 12 mm stamped identification data filled with black paint or coordinated with base colour to ensure strong contrast.
- .2 Valves to be identified using the same system as exists.
- .3 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.
- .4 Where new valves replace valves being removed the same identifier can be used.

2.5 CONTROLS COMPONENTS IDENTIFICATION

- .1 In addition to other identification specified in this section the following requirements apply.
- .1 Identify all control valves with plastic encased cards attached with a chain. Lettering on card to be a minimum of 4 mm high and to include the EMCS point name, point address and failsafe position (if applicable).
- .2 EMCS cabinet associated with these devices to include a list of all device point name and point address for each device.
- .3 Room temperature sensors to have identification specified above attached with adhesive.
- .2 Wiring
- .1 Provide numbered tape markings on wiring at panels, junction boxes, and devices.
- .2 Use colour coded wiring throughout.
- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.
- .4 Control system wiring conduit to be identified by painting couplings White.
- .5 Pull and Junction Boxes
- .1 Coloured inside and out white.
- .2 Ensure a clearly defined diagonal line from corner to corner of box cover plate separated the two (2) colors.
- .3 Apply coloring prior to installation.

2.6 CEILING MOUNTED EQUIPMENT

- .1 Where valves and control devices are installed above accessible ceilings, identification in accordance with the tables below. Underceiling identification shall be installed on the ceiling T-Bar spline or Access door frame directly below the access to the equipment. Vinyl adhesive discs shall be 19 mm diameter, white or black center disc (if necessary) to be 6 mm diameter. Letters on underceiling lamicoids to be 6 mm high unless noted otherwise. Letters on equipment lamicoids to be 12 mm high unless noted otherwise. In no case shall a valve or box be installed in a ceiling space that is not considered accessible unless a proper access hatch is provided by the appropriate Trade Contractor.
- .2 Where multiple similar devices are accessed through the same tile or access door only one (1) adhesive disc of each color is needed. If the device is identified with a lamicoid but no unique number only one (1) lamicoid is required stating the device and the quantity (ie 3 Fire Dampers)
- .3 Provide framed legend of colour coding used and mount in the main Mechanical Room. Include a copy of legend in each of the Operation and Maintenance Manuals.
- .4 Use white lamicoid plates with black letters to identify VAV boxes.
- .5 Lamicoid plates to be attached to splines, access door frames, and equipment with two (2) rivets each.

2.7 EQUIPMENT IN CABINETS and CONCEALED BEHIND WALLS

- .1 All EMCS panels to be identified on door.
- .2 Lamicoids to be mechanically fastened to access doors / panels. Tags to be attached to valves equipment with chains or rivits.
- .3 Access door / panel identification letters to be 6 mm high unless noted otherwise.
- .4 Equipment label letters to be 12 mm high unless noted otherwise.
- .5 Where multiple devices such as fire dampers or valves that do not require unique identification are behind an access door / panel a single identifier may be used on the access point. Each device, however, must be labeled.
- .6 Access door / Panel Identification

Service	Identification
EMCS Panels	White lamicoid, Black letters, 6 mm high

2.8 LANGUAGE

1. Identification to be in English.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

- .1 Provide identification only after painting specified in Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and/or CSA registration plates as required by the respective agency.
- .3 Identify all equipment and piping.

3.4 EXISTING PANELS and IDENTIFICATION

- .1 Correct existing nameplates and legends to reflect changes made during Work.

3.5 NAMEPLATES

- .1 Install in conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Do not paint, insulate or cover.

3.6 LOCATION OF IDENTIFICATION ON PIPING

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: 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.
- .10 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.
- .11 Maximum distance between non potable pipe identification to be 1500 mm.

3.7 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 where directed by the Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results, Mechanical.

1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of TAB sub contractor to Departmental Representative within thirty (30) days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB Contractor shall submit list of projects completed within the last five (5) years.
- .4 TAB: performed in accordance with the requirements of industry standards, such as:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB), TABB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.
 - .4 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) – HVAC Applications: Testing, Adjusting and Balancing.
- .5 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .6 Quality assurance: Perform TAB under direction of supervisor qualified by AABC or NEBB
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 Acceptable Contractors: Scan Air, Scotia Air Balance 1996 Ltd., Griffin Air Balance, Systems Balance 2006 Ltd., Barrington Air Balance, Source Management Ltd..

1.3 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.

1.4 EXCEPTIONS

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

1.5 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, where interlocked with other systems, in unison with those systems.

1.6 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 proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 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.

1.8 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.

1.9 START OF TAB

- .1 Notify Owner's Representative 7 days prior to start of TAB.
- .2 Start TAB when system is essentially completed including:
 - .1 Pressure, leakage, other tests specified elsewhere Division 23.
 - .2 Provisions for TAB installed and operational.
 - .3 Start-up, verification for proper, normal / safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

- .1 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values plus or minus 5%.

1.11 ACCURACY TOLERANCES

- .1 Measured values 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 make, model and serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within three (3) months of TAB. Provide certificate of calibration to Departmental Representative.

1.13 SUBMITTALS

- .1 Submit to Departmental Representative, 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 Format in accordance with AABC and/or NEBB.
- .2 TAB report to show results in SI units and include:
 - .1 Project record drawings.
 - .2 System schematics.

- .3 Submit three (3) copies of TAB Report to Departmental Representative for verification and approval, in *.pdf format, in English, and be indexed.

1.16 VERIFICATION

- .1 Reported results subject to verification by Departmental Representative.
- .2 Provide manpower and instrumentation to verify up to 10 % of reported results.
- .3 Number and location of verified results to be at discretion of the 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. Do not eradicate or cover markings.

1.18 COMPLETION OF TAB

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

1.19 AIR SYSTEMS

- .1 Standard: TAB to most stringent of this section or TAB standards of AABC, NEBB, SMACNA, and ASHRAE.
- .2 Qualifications: personnel performing TAB current member in good standing of AABC or NEBB.
- .3 Quality assurance: perform TAB under direction of supervisor qualified by to standards of AABC or NEBB.
- .4 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures, duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .5 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .6 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 POST-OCCUPANCY TAB

- .1 Participate in systems checks twice during Warranty Period - #1 approximately three (3) months after acceptance and #2 within one (1) month of termination of Warranty Period.

2 Products

2.1 NOT USED

3 Execution

3.1 NOT USED

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 21 05 01 Common Work Results – Mechanical.

1.2 REFERENCES

- .1 Reference Standards:
 - .1 ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .5 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - .6 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .7 GSES Standard GS-36, Commercial Adhesives.
 - .8 TIAC: National Insulation Standards.
 - .9 CAN/ULC-S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results - Mechanical.

1.4 DEFINITIONS

- .1 For purposes of this section:
 - .2 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - .3 "EXPOSED" - will mean "not concealed" as specified.
- .2 TIAC codes:
 - .1 CRF: Code Rectangular Finish.

1.5 ACCEPTABLE PIPE INSULATION SUBCONTRACTORS

- .1 Guilfords (2000) Inc., Insul-Energy, Scotia Insulations Ltd, Twin City Insulation, Zink's Mechanical Insulation Ltd., Pro-Insul Ltd.; Insul-Energy Ltd.

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.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-2: Mineral fibre blanket to ASTM C553 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 C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.
- .4 Acceptable Materials: Certainteed, Roxul, Owens Corning, Manson, Knauf, Johns Manville.

2.3 ACCESSORIES

- .1 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Acceptable Materials: Benjamin Foster 82-07 or Flintkote 230-04.
- .2 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PRE-INSTALLATION REQUIREMENTS

- .1 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 manufacturer's instructions and as indicated.

- .3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .4 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.
- .5 Insulation to run continuously when duct pass through non fire/smoke rated partitions

3.4 CLEANING

- .1 Insulation sub-contractor to remove all garbage relating to the installation of their product from site including, but not limited to insulation scraps, tape backing, scraps of jackets, material containers, etc.
- .2 The final cleanup described in this section shall constitute no less than 10% of the progress billing for this sub-contractor.

3.5 DUCTWORK INSULATION SCHEDULE

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

	TIAC Code	Vapour Retarder	Thickness
S/A duct (rectangular)	C-1	Yes	38 mm
S/A duct (round)	C-2	Yes	38 mm
Acoustically lined ducts	None		

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results – Mechanical.
- .2 Section 23 05 05 – Installation of Pipework.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547, Mineral Fiber Pipe Insulation.
 - .7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Thermal Insulation Association of Canada (TIAC) National Insulation Standards.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results – Mechanical.

1.4 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.
 - .3 RUN-OUT(s) – piping, not exceeding 4000 mm long, to individual equipment
- .2 TIAC codes:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish..

1.5 ACCEPTABLE PIPE INSULATION CONTRACTORS

- .1 Guilfords (2000) Inc., Insul-Energy, Scotia Insulations Ltd, Twin City Insulation, Zink's Mechanical Insulation, Pro-Insul Ltd.; Insul-Energy Ltd.

2 Products

2.1 FIRE AND SMOKE RATING

- .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 C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .8 Acceptable Materials: Certainteed, Johns Manville, Knauf, Manson, Owens Corning, Roxul.

2.3 INSULATION SECUREMENT

- .1 Tape: self-adhesive, aluminum, 50 mm wide minimum.

- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting or air drying on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

- .1 Water based, fire retardant type, compatible with insulation.

2.6 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 JACKETS

- .1 Canvas:
 - .1 220 and 120 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.

2.8 MINERAL FIBRE INSULATION

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Pipe insulation will be preformed fibre with a nominal density of 5.5 lb/cu ft.

2.9 ACCEPTABLE MATERIALS

- .1 Fiberglass Insulation supported by the following manufacturers are acceptable:
 - .1 Bakor; Owens Corning Canada LP; Johns Manville; Knauf Insulation

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- .2 Install in accordance with TIAC National Standards.

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 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: at expansion joints, valves, primary flow measuring elements, strainers, 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: high temperature fabric.
- .4 Finishes:
 - .1 Exposed indoors: PVC jacket.
 - .2 Exposed in mechanical rooms: PVC jacket where the temperature is less than 65°C.
 - .3 Concealed, indoors: insulation jacketed with PVC or removable blanket on valves, fittings. No further finish.
 - .4 Finish attachments: SS bands, at 150 mm.
 - .5 Installation: To appropriate TIAC code CRF/1 through CPF

3.4 CLEANING

- .1 Insulation sub-contractor to remove all garbage relating to the installation of their product from site including, but not limited to insulation scraps, tape backing, scraps of jackets, material containers, etc.
- .2 Insulation sub-contractor to coordinate with the appropriate trade contractor to have splatter of lagging cleaned from other surfaces including but not limited to. equipment , pipe, duct, walls, structure, and floor.
- .3 Insulation sub-contractor to coordinate with the appropriate trade contractor to repair or replace equipment damaged by splatter of lagging or the cleaning of the splatter.
- .4 The final cleanup described in this section shall constitute no less than 10% of the progress billing for this sub-contractor.

3.5 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

- .2 TIAC Code: A-3.
 - .1 Securements: Tape at 305mm oc.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code 1501-C.

- .3 Thickness of insulation as listed in following table. Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp deg C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)				
			To 25	32-50	63-100	125-150	200 & over
Domestic HW	38-60	A-3	25	35	38	38	38
Domestic CW	4-15	A-3	25	25	25	25	38

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results – Mechanical.
- .2 Section 23 05 05 – Installation of Pipework.
- .3 Section 23 05 53.01 – Mechanical Identification.
- .4 Section 23 08 02 – Cleaning and Start Up of Mechanical Piping Systems.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI/AWS A5.8/A5.8M, Specification Filler Metals for Brazing and Bronze Welding.
- .2 American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B16.4, Gray-Iron Threaded Fittings.
 - .2 ANSI/ASME B16.15, Cast Bronze Threaded Fittings.
 - .3 ANSI B16.18, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.22, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B32, Standard Specification for Solder Metal.
 - .2 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
 - .3 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B88M, Standard Specification for Seamless Copper Water Tube Metric.
- .4 Manufacturers Standardization Society (MSS)
 - .1 MSS SP70, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS SP71, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .3 MSS SP80, Bronze Gate, Globe, Angle and Check Valves.
 - .4 MSS SP85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results - Mechanical.

2 Products

2.1 PIPING

- .1 Type “L” hard drawn copper tubing: to ASTM B88M.

- .2 Acceptable Materials: Victaulic, Gruvlock

2.2 FITTINGS

- .1 Cast bronze threaded fittings: to ANSI/ASME B16.15.
- .2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.
- .3 Cast iron threaded fittings: to ANSI/ASME B16.4.
- .4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18.

2.3 FLANGES

- .1 Brass or bronze: threaded.
- .2 Cast iron: threaded.
- .3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.4 JOINTS

- .1 Solder, tin-antimony, 95:5: to ASTM B32.
- .2 Silver solder BCUP: to ANSI/AWS A5.8.
- .3 Brazing: as indicated.

2.5 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: solder.
- .2 Globe valves: application: throttling, flow control, emergency bypass :
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PFTE disc, Bronze.
 - .2 Elsewhere: globe, with composition disc, Bronze.
 - .3 Acceptable Materials: Crane 5, Jenkins 106BP, Nibco S-211-Y, Toyo, Kitz, Milwaukee Valve Company, Hattersley A50M; Parker Kaefer Inc.
- .3 Drain valves:
 - .1 On radiation: Solid forged brass construction, solid brass body, forged brass cap, brass chain and hook, composition disc suitable for 250 °C, working pressure 200 psig at 250 °C.
 - .1 Acceptable Material: Dahl #21.616.
 - .2 On Mains: Forged brass body, brass cap, steel handle, brass stem and ball, Teflon seat, hose end, 250 psig at 250 °C.
 - .1 Acceptable Material: Dahl #50.430.

- .4 Silent check valves:
 - .1 NPS 2 and under:
 - .1 Class 125, cast steel, wafer style, brass seat rings, brass inner valve, stainless steel spring.
 - .2 Acceptable Materials: Durabla GLC, Toyo, Kitz, Crane, Jenkins, Milwaukee Valve Company, Hattersley, Parker Kaefer Inc.
- .5 Ball valves:
 - .1 NPS 2 and under: Bronze.
 - .2 Acceptable Materials: Jenkins 901FJ and 902FJ, Crane, Toyo, Kitz, Hattersley, Milwaukee Valve Company.
- .6 Lift Check Valves
 - .1 50 mm and under:
 - .1 Class 125, swing check, Y-pattern, threaded ends, bronze disc with bronze hinge and stainless steel hinge pin, screw cap.
 - .2 Acceptable Materials:
 - .1 Crane Fig 37, Jenkins Fig. 4092J, Kitz Fig 22

2.6 GROOVED END VALVES

- .1 Where grooved piping concept is used in place of welded or threaded systems, Contractor shall incorporate grooved end valves of comparable construction.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING INSTALLATION

- .1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .6 Assemble piping using fittings manufactured to ANSI standards.

- .7 Saddle type branch fittings may be used on mains if branch line is no longer than half the size of main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.

3.3 VALVE INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install gate or ball at branch take-offs and to isolate each piece of equipment, and as indicated.
- .3 Install globe valves for balancing and in by-pass around control valves as indicated.
- .4 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
- .5 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- .6 Install ball valves for glycol service.

3.4 CIRCUIT BALANCING VALVES

- .1 Install and flow balancing valves as indicated.
- .2 Remove hand wheel after installation and TAB is complete. Turn over hand wheel to the Departmental Representative.

3.5 FLUSHING AND CLEANING

- .1 Provide Departmental Representative with five (5) days notice of flushing and cleaning of system.
- .2 Flush in accordance with section 23 08 02 - Cleaning and Start Up of Mechanical Piping Systems
- .3 Re-install strainer screens/baskets.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results for Mechanical.
- .2 Section 23 05 05 – Installation of Pipework.
- .3 Section 23 05 53.01 – Mechanical Identification.
- .4 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping Systems.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9, Factory-Made Wrought Butt welding Fittings.
 - .5 ASME B18.2.1, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2, Square and Hex Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 American Water Works Association (AWWA).
 - .1 AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA B242-M, Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
 - .1 MSS SP70, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS SP71, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .3 MSS SP80, Bronze Gate, Globe, Angle and Check Valves.
 - .4 MSS SP85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results - Mechanical.

2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, Schedule 40:

2.2 PIPE JOINTS

- .1 50 mm and under: screwed fittings with PTFE tape or lead-free pipe dope.
- .2 Pipe thread: taper.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.

2.4 VALVES

- .1 Connections: 50 mm and smaller: screwed ends.
- .2 Globe valves: to MSS-SP-80 or MSS-SP-85 Application: Throttling, flow control, emergency bypass:
 - .1 50 mm and under:
 - .1 Mechanical Rooms: bronze with PTFE disc
 - .2 Elsewhere: bronze, with composition disc.
 - .3 Acceptable Product: Crane Fig.5TF, Kitz #03.
- .3 Balancing, for TAB:
 - .1 50 mm and under shall be Y-pattern style design and all metal parts of non-ferrous pressure die cast, non-porous copper alloy. IPS connections unless otherwise noted. The valve shall have four 360 degrees adjustment turns of hand wheel for maximum setting.
 - .2 Acceptable Products: Armstrong, Taco, Bell & Gossett, Tour & Anderson, Danfoss Victaulic.
- .4 Drain valves: Bronze gate valve, Class 125, non-rising stem, solid wedge disc.
 - .1 On radiation: Solid forged brass construction, solid brass body, forged brass cap, brass chain and hook, composition disc suitable for 480°F, working pressure 200 psi at 480°F.
 - .1 Acceptable Product: Dahl #21.616; Parker Kaefer Inc.
 - .2 On Mains: Forged brass body, brass cap, steel handle, brass stem and ball, Teflon seat, hose end, 250 psig at 480°F
 - .1 Acceptable Product: Dahl #50.430; Parker Kaefer Inc.
- .5 Ball valves:
 - .1 50 mm and under:
 - .1 Acceptable Product: Crane Fig 9202, Kitz #58.

- .6 Coil Connections:
 - .1 The Contractor may install in lieu of standard malleable iron or copper fittings the following component system consisting of the following:
 - .1 A complete three-component multi-functioned packaged.
 - .2 Rated for 120 degrees C up to 300 psi.
 - .3 Suitable for hot, cold, treated, and untreated water.
 - .4 UP union port fitting and STADK CBV to have unions sized to accommodate standard modulating valves.
 - .2 Acceptable Materials: Victaulic 78K Koil - Kit.

3 Execution

3.1 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 05 - Installation of Pipe Work.
- .2 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage, and installation instructions, and datasheets.

3.2 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and when TAB is complete. Turn over handwheel to the Departmental Representative.

3.3 CLEANING, FLUSHING AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

3.4 TESTING

- .1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.

3.5 BALANCING

- .1 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- .1 Specification 21 05 01 – Common Work Results – Mechanical.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME-04 (2007), Boiler and Pressure Vessel Code.
- .2 ASTM International Inc.
 - .1 ASTM A47/A47M-99 (2004), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278/A278M-01 (2006), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .3 ASTM A516/A516M-06, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A536-84(2004), Standard Specification for Ductile Iron Castings.
 - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results - Mechanical.

2 Products

2.1 AUTOMATIC AIR VENT

- .1 Standard float vent: brass body and NPS 1/8.
- .2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.
- .3 Float: solid material suitable for 115 degrees C working temperature.
- .4 Acceptable Materials: Amtrol, Armstrong, Braukmann, Taco, ITT Bell & Gossett, Honeywell, Maidomist

2.2 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B62, (solder end) connections, Y pattern.

- .2 Screen: stainless steel or brass with 1.19 mm perforations.
- .3 Working pressure: 860 kPa.
- .4 Acceptable Materials: Mueller, Parker Kaefer Inc., Spriax/Sarco, Victaulic; Style 732

2.3 PRESSURE SAFETY RELIEF VALVES

- .1 Safety valves of the correct rating for equipment to be protected.
- .2 Standard of Acceptance: Consolidated Fig. 1541 or Fig. 1511
- .3 Acceptable Materials: Armstrong, Faries 1855-OL and 1900 Series, ITT, Kunkle, Parker Kaefer Inc, Spirax-Sarco Fig. 6000 or Fig. 252, Watts Fig. 174A

2.4 PIPE PENETRATION SEALS

- .1 Modular, thru-the-wall and thru-the-floor, core-drilled, pipe penetration seals:
 - .1 Rubber links to make water-tight/continuously fill the annular space between the pipe and the core-drilled wall opening.
 - .2 Size: NPS 6 (nominal 150 mm diam., Schedule 40 ductile iron piping).
 - .3 Rated at 14.1 m head (20 psig).
 - .4 Carbon steel nuts and bolts per ASTM B633 with 2 part zinc plated dichromate hardware c/w corrosion resistant organic coating.
 - .5 Black EPDM seal element.
 - .6 Temperature range: -40 to 121 deg.C.
 - .7 Tensile strength: 413.4 MPa (60,000 psig).
 - .8 Composite pressure plates molded of glass reinforced nylon.
 - .9 Tested in accordance with ASTM B-117 to pass a 1,500-hour salt spray test.
 - .10 Manufactured with materials conforming to ASTM D-256, ASTM D-297, ASTM S-395, ASTM D-412, ASTM D-638, ASTM D-790, ASTM D-792 and ASTM D-2240.
 - .12 Penetration/hole size: 254 mm (10" diam.).
10 links per seal.
 - .13 Acceptable Materials: PSI-Thunderline/ Link-Seal® Modular Seal, Series "C", Model "LS-410-C", as manufactured by Pipeline Seal & Insulator, Inc, Houston, TX, or approved equivalent.

3 Execution

3.1 GENERAL

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Run drain lines and blow off connections to terminate above nearest drain.

- .3 Maintain adequate clearance to permit service and maintenance.
- .4 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .5 Check shop drawings for conformance of tapplings for ancillaries and for equipment operating weights.

3.2 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each automatic control valve larger than NPS 1, at radiation, and as indicated.

3.3 AIR VENTS

- .1 Install at high points of systems.
- .2 Install stop cock on automatic air vent inlet. Run discharge to nearest drain or service sink.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 07 84 00 - Firestopping.
- .2 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .3 Section 23 05 53.01 – Mechanical Identification.
- .4 Section 23 07 13 – Duct Insulation.

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .2 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for the 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.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual.

1.3 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Sections 01 33 00 - Submittal Procedures and 21 05 01 – Common Work Results – Mechanical.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Protect stored or installed material from moisture damage and dirt.

2 Products

2.1 DUCT CONSTRUCTION

- .1 Galvanized Steel Duct
 - .1 Round ductwork
 - .1 Construction shall be of galvanized steel of the following US Standard Gauges:

Duct Diameter (mm)	Spiral Duct Work	Plain Duct Gauge
< 200	28	24
225 – 350	26	24
375 – 650	24	22
675 – 900	22	20

- .2 Transverse joints beaded crimp joints with at least 1" lap to accommodate screws at a maximum of 15" centers. Minimum of three (3) screws per joint.

- .2 Square / Rectangular Duct

- .1 Construction shall be of galvanized steel of the following US Standard Gauges :

Longest Duct side (mm)	Duct Ga	Transverse Joints		Reinforcing	
		Short Side	Long Side	Size	Spacing
< 300	28	T1,T6	T1,T6	none	
325 – 450	22				

2.2 SEAL CLASSIFICATION

- .1 Classification as follows:
Maximum Pressure Pa

500
250
125
125

SMACNA Seal Class
C
C
C
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, tape or combination thereof.
 - .3 Class C: transverse joints and connections made air tight with gaskets, sealant, tape or combination thereof. Longitudinal seams unsealed.

2.3 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 Acceptable Materials: Bakor Duct-Seal, Duro Dyne DSW, Ductmate PROseal, Foster.

2.4 TAPE

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.
- .2 Acceptable Materials: Bakor 990-06, Duro Dyne FT-2

2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
 - .1 Rectangular: standard radius (Centreline radius: 1.5 times width of duct) or short radius with single thickness turning vanes.
 - .2 Round: smooth radius, five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .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 to have 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 balancing damper unless shown otherwise..
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets: As required; confirm on site.
- .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 in accordance with Section 07 84 00 - Firestopping.
- .2 Fire stopping material and installation must not distort duct.

2.7 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A653M, Z90 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 A seal.
- .4 Acceptable Materials: Ductmate Canada Ltd., Exanno Nexus

2.8 HANGERS AND SUPPORTS

- .1 Hanger Configuration to SMACNA.

- .2 Hanger rods to be galvanized steel rods sized as per tables below
- .3 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp.
 - .3 For steel beams: manufactured beam clamps:
 - .4 Acceptable Materials:
 - .1 Myatt 492/494; Fig 586; Fig. 586
 - .2 Grinnell Fig. 86.
- .4 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
 - .1 Maximum size duct supported by strap hanger: 500 mm dia. or longest side of rectangular duct to be 500 mm.
- .5 Wire Hangers:
 - .1 Maximum size duct supported by strap hanger: 500 mm dia. or longest side of rectangular duct to be 500 mm.
 - .2 Acceptable manufacturers : Ductmate, Gripple
- .6 Rectangular Duct:
 - .1 Hangers: galvanized steel angle with galvanized steel rods to SMACNA following table:

Duct Width Size (mm)	Angle Size (mm)	Rod Size (mm)	Spacing (mm)
up to 750	25 x 25 x 3	6	3000

- .7 Round / Oval Duct
 - .1 Hanger construction and spacing to the following table

Duct Dia (mm)	Rod dia, (mm)	Strap	Wire dia (mm)	Spacing (mm)
< 250	1 x 6.4 mm	25 mm x 22 ga	1 x 12 ga	3700
275 – 460			2 x 12 ga	
485 – 610			2 x 10 ga	

2.9 SHEET METAL PLENUMS

- .1 Nominal 18 ga. galvanized steel sheet re-squared and formed into 600mm wide panels with 50mm deep standing seams in accordance with SMACNA HVAC equipment and casings standard.
- .2 Formed channel sections top and bottom of vertical sections and at all wall and floor intersections.
- .3 Galvanized 50mm x 50mm x 3.2mm thick angle frames around all duct and access door openings.

2.10 DUCT JOINTS

- .1 Ductwork is to be prefabricated using drive slip joints sized 450mm or greater. Joints 350mm or larger are to be reinforced.
- .2 Ductmate 25 and 35 and Nexus G and J shall be approved as an acceptable equal to the above requirements, with neoprene gaskets and HM572 sealant for bolted assembly.

2.11 ROUND DUCTS

- .1 Concealed round branch ducts up to 400mm diameter may be constructed with longitudinal seams.
- .2 Concealed round branch ducts over 400mm and all exposed round ducts shall be factory fabricated conduit consisting of helically wound galvanized iron strips with spiral lock seams. Fittings for these conduits shall be fabricated of 20 gauge galvanized sheet steel with butt welded seams.

3 Execution

3.1 GENERAL

- .1 Do work in accordance with SMACNA.
- .2 Support risers in accordance with SMACNA.
- .3 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .4 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.
- .5 Provide sealed access patches in ductwork every 10 m to allow for cleaning.
- .6 The following table outlines the type of ductwork required in each system:

Name of System	Description	Material
Fresh Air Ducting	Duct from Plenum to AHU	Galvanized Steel
General S/A	Ductwork between Heat Pumps and diffusers unless noted otherwise	Galvanized Steel
General Return / Exhaust	Ductwork between grilles and exhaust fan and from fan to outside the building unless noted otherwise	Galvanized Steel

3.2 HANGERS

- .1 Strap / Wire hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.

- .3 Trim hanger rods so that rods are no further than 25 mm below supported element.

3.3 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.

3.4 LEAKAGE TESTS

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results – Mechanical.
- .2 Section 23 31 13.01 – Metal Ducts – Low Pressure to 500 Pa.
- .3 Section 23 31 13.02 – Metal Ducts – High Pressure to 2500 Pa.

1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results - Mechanical.

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.
- .3 Acceptable Materials: Duro-Dyne, Dyn-Air, Metal Fab

2.3 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.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.2 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: 100 mm.
 - .3 Minimum distance between metal parts when system in operation: 75 mm.
 - .1 Install in accordance with recommendations of SMACNA.
 - .2 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.

3.3 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.
 - .1 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.
 - .2 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.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results for Mechanical.
- .2 Section 23 31 13.01 – Metal Ducts – Low Pressure to 500 Pa.

1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results - Mechanical.

2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.
- .2 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.

2.2 SINGLE BLADE DAMPERS

- .1 V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Channel frame of same material as adjacent duct, complete with angle stop.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 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 recommendations of SMACNA and in accordance with manufacturer's instructions.
- .2 Locate balancing dampers in each branch duct, for supply, return, and exhaust systems, where indicated, and in such other locations where required to properly balance the systems. In all cases, sufficient dampers shall be installed in the ducts so that the dampers installed in the diffusers are for 'fine tuning' only.
- .3 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .4 Dampers: vibration free.
- .5 Ensure damper operators are observable and accessible.
- .6 Corrections and adjustments conducted by Engineer.

END OF SECTION

1 General

1.1 REFERENCES

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
 - .1 ANSI/NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

1.2 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate the following:
 - .1 Fire dampers.
- .2 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 Certificates:
 - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.4 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide following:
 - .1 Six fusible links of each type.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction Demolition Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic waste in designated containers.

2 Products

2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type B, listed and bear label of ULC, meet requirements of Fire Commissioner of Canada (FCC). Fire damper assemblies 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: round or square; guillotine type; sized to maintain full duct cross section as indicated.
- .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 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
- .10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.
- .11 Acceptable Materials:
 - .1 Ruskin.
 - .2 Controlled Air.
 - .3 AMI.
 - .4 Nailor Ind.
 - .5 Hart & Cooley.

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 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 - Air Duct Accessories.
- .5 Co-ordinate with installer of firestopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results – Mechanical.
- .2 Section 23 31 13.01 – Metal Ducts – Low Pressure to 500 Pa.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-02, 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.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction.
- .4 Underwriters' Laboratories Inc. (UL).
 - .1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.
- .5 Underwriters' Laboratories of Canada (ULC).
 - .1 CAN/ULC-S110, Fire Tests for Air Ducts.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results - Mechanical.
- .2 Include the following product performance criteria, and limitations.
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.

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 NON-METALLIC – INSULATED

- .1 Non-collapsible, coated aluminum foil/Mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, 37 mm thick flexible mineral fibre thermal insulation with vapour barrier and reinforced Mylar/neoprene laminate jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop co-efficient: 3.
- .3 Acceptable Material: Atlas, Duro-Dyne, Flexible Technologies MKE, Flexmaster FAB 3T, Thermaflex M-KE.

3 Execution

3.1 INSTALLATION

- .1 Install in accordance with: CAN/ULC-S110, UL-181, NFPA 90A, NFPA 90B, SMACNA.
- .2 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 – Common Work Results - Mechanical.
- .2 Section 23 31 13.01 – Metal Ducts – Low Pressure to 500 Pa.

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM C916, Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C1071, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .4 ASTM C1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .5 ASTM G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .3 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).
 - .1 SMACNA, HVAC DCS, HVAC, Duct Construction Standards, Metal and Flexible.
- .4 Underwriter's Laboratories of Canada (ULC).
 - .1 CAN/ULC-S102, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results – Mechanical.

2 Products

2.1 DUCT LINER

- .1 General:
 - .1 Mineral Fibre duct liner: air surface coated mat facing.
 - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102 and NFPA 90A, NFPA 90B.

- .3 Recycled Content: EcoLogo certified with minimum 35 % by weight recycled content.
- .4 Fungi resistance: to ASTM C1338 and ASTM G21.
- .2 Rigid:
 - .1 Use on flat surfaces where indicated.
 - .2 25 mm thick, to ASTM C1071, Type 2, fibrous glass rigid board duct liner.
 - .3 Density: 48 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.76 (m². degrees C)/W for 25 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.
 - .5 Maximum velocity on faced air side: 20.3 m/sec.
 - .6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C423.
 - .7 Recycled Content: EcoLogo certified containing minimum 45 % by weight recycled content.

2.2 ADHESIVE

- .1 Adhesive: to NFPA 90A, NFPA 90B, and ASTM C916.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degreesC to plus 93 degreesC.
- .3 Water-based fire retardant type.

2.3 FASTENERS

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.

2.4 JOINT TAPE

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.5 SEALER

- .1 Meet requirements of NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

3 Execution

3.1 INSTALLATION

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Do work in accordance with SMACNA HVAC DCS and as indicated except as specified otherwise.

- .3 Line inside of ducts where indicated.
- .4 Duct dimensions, as indicated, are clear inside duct lining.

3.2 DUCT LINER

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100 % coverage of adhesive to ASTM C916.
 - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres, impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.
 - .1 Spacing of mechanical fasteners in accordance with SMAC HVAC DCS.
- .2 In systems, where air velocities exceeds 20.3 m/sec, install galvanized sheet metal nosing to leading edges of duct liner.

3.3 JOINTS

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply two coats of sealer over tape.
- .2 Replace damaged areas of liner at discretion of Consultant.
- .3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

END OF SECTION

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 23 32 48 - Acoustic Air Plenums.
- .2 Section 23 33 00 - Air Duct Accessories.
- .3 Section 23 31 14 - Metal Duct Low Pressure to 500 kPa.

1.2 REFERENCES

- .1 ANSI/AMCA 210-1985, Laboratory Methods of Testing Fans for Rating.
- .2 ANSI/ASHRAE 51-1985, Laboratory Methods of Testing Fans for Rating.
- .3 ANSI/NFPA 90A-1989, Installation of Air Conditioning and Ventilating Systems.
- .4 ISO 3741-1988, Acoustics-Determination of Sound Power Levels of Noise Sources-Precision Methods for Broad-band Sources in Reverberation Rooms.
- .5 UL 181-1981, Factory-Made Air Ducts and Connectors.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 013300 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Capacity.
 - .2 Pressure drop.
 - .3 Noise rating.
 - .4 Leakage.

1.4 MANUFACTURED ITEMS

- .1 Terminal units of the same type to be product of one manufacturer.

PART 2 PRODUCTS

2.1 VARIABLE VOLUME BOXES

- .1 Pressure independent factory set to air flow between minimum and maximum air volume.
- .2 Sizes, capacities, differential pressures and sound ratings: as indicated.
- .3 Differential pressure not to exceed 27 Pa at inlet air velocity of 10.2 m/s.
- .4 Casing: constructed of 22 gauge thick galvanized steel, internally lined with 13mm thick fibrous glass, to UL181 and ANSI/NFPA 90A. Provide a protective metal

shroud to cover control components.

- .5 Damper: galvanized steel with peripheral gasket and self lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 747 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.
- .6 Hot Water Coil: Copper tube heat exchanger with aluminum fins contained in an galvanized steel casing. Provide access panel for inspection and cleaning of the coils.
- 7 Acceptable material: EH Price SDV, Titus

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of ductwork.
- .3 Install with at least four duct diameters of straight inlet duct, same size as inlet.
- .4 Locate so that controls, dampers and access panels are easily accessible.

3.2 INSTALLATION OF CONTROLLER

- .1 The air terminal box manufacturer shall take delivery of control components shipped to his designated manufacturing facility and shall mount the components, make all connections and do all wiring for a complete fully functional unit. He shall set up, test and calibrate and ship to the site.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 - Common Work Results – Mechanical.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI/NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 International Organization of Standardization (ISO)
 - .1 ISO 3741, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.
- .3 Underwriter's Laboratories (UL)
 - .1 UL 181, Factory-Made Air Ducts and Air Connectors.

1.3 SUBMITTALS

- .1 Provide Shop Drawing and Maintenance Manual submittals in accordance with Section 01 33 00 - Submittal Procedures and section 21 05 01 – Common Work Results – Mechanical.

2 Products

2.1 GENERAL

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- .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: White.
- .5 Acceptable Materials: Air Vector, Anemostat, Construction Specialties, E.H. Price, Krueger, Metalaire, Nailor, Titus, Tuttle and Bailey.

2.2 MANUFACTURED UNITS

- .1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.3 DIFFUSERS

- .1 General: volume control dampers with flow straightening devices and blank-off quadrants and gaskets.
- .2 Acceptable Materials:
 - .1 Tuttle & Bailey
 - .2 Titus
 - .3 Nailor Ind.
 - .4 E.H Price

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 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 manufacturer's instructions.
- .2 Install with oval head screws in countersunk holes where fastenings are visible.

END OF SECTION