
Part 1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 - Mechanical General Requirements.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .2 National Plumbing Code of Canada - 2010.
- .3 National Building Code of Canada - 2010.

1.3 SCOPE OF WORK

- .1 This section applies to installation of piping for each of the following systems:
 - .1 Condensate drain lines.
 - .2 Fuel supply and return lines.

Part 2 Products

Not Used

Part 3 Execution

3.1 CONNECTIONS TO EQUIPMENT

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions, flanges, or mechanical couplings 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.

3.2 CLEARANCES

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

3.3 DRAINS

- .1 Install condensate drain lines from the low points in the radiator exhaust discharge plenums. Drain lines (19mm dia.) shall extend to the nearest floor drain; where floor drains are not present within the room, drains shall penetrate the exterior wall and discharge at a 45 degree elbow; the wall penetration shall be sealed watertight.
- .2 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.
- .3 Drain valves: 19mm ball valves unless indicated otherwise, with hose end male thread, cap and chain.

3.4 DI-ELECTRIC COUPLINGS

- .1 General: Compatible with system, to suit pressure rating of system.
- .2 Locations: Where dissimilar metals are joined.
- .3 50mm and under: Isolating unions.

3.5 PIPEWORK INSTALLATION

- .1 Screwed fittings (where specified) to be jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install so that equipment can be isolated and removed without interruption to operation of any other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Install piping, equipment, and similar items parallel or perpendicular to building lines.
- .6 Except where indicated otherwise, slope piping in direction of flow for positive drainage and venting.
- .7 Except where indicated, install so as to permit separate thermal insulation of each pipe.
- .8 Group piping wherever possible (and as indicated).
- .9 Ream pipes, remove scale and other foreign material before assembly.
- .10 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .11 Install copper pipe/tube so that it is not in contact with dissimilar metal and will not be kinked or collapsed.

- .12 Clean all excess flux and solder from joints.

3.6 VALVES

- .1 Install in accessible locations.
- .2 Remove interior parts before soldering.
- .3 Install with stems above the horizontal position unless otherwise indicated.
- .4 Valves to be accessible for maintenance without removing adjacent piping.

3.7 SLEEVES

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Where sleeves extend above finished floors - to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6.4mm minimum clearance all round between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.
 - .2 Other floors: Terminate 25mm 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 Provide space for firestopping. Maintain fire rating integrity.
 - .2 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
 - .3 Ensure no contact between copper pipe or tube and sleeve.

3.8 ESCUTCHEONS

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

3.9 PREPARATION FOR FIRESTOPPING

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation.
- .2 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

3.10 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Engineer 48 hours minimum prior to performance of pressure tests.
- .2 Pework: Test as specified in relevant sections of Division 21 and 23.
- .3 Maintain specified test pressure without loss for four (4) hours minimum unless specified for longer period of time in relevant sections of Division 21 and 23.
- .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 Owner's representative.
- .6 Bear costs for repairs or replacement, retesting, and making good. Engineer to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Engineer.

3.11 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by the Departmental Representative.
- .2 Request written approval ten (10) days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.
- .4 Ensure daily clean-up of existing areas.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 - Mechanical General Requirements.
- .2 Section 23 05 05 - Installation of Pipework.
- .3 Section 23 31 13 - Ductwork - Low Pressure Metallic to 500 Pa.

1.2 REFERENCES

- .1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME):
 - .1 ANSI/ASME B31.1, Power Piping, (SI Edition).
- .2 American Society for Testing and Materials (ASTM):
 - .1 ASTM A 125, Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A 563, Specification for Carbon and Alloy Steel Nuts.
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):
 - .1 MSS SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP-69, Pipe Hangers and Supports - Erection and Application.
 - .3 MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation.

1.3 DESIGN REQUIREMENTS

- .1 Construct pipe hanger and support utilizing manufacturer's regular production components, parts and assemblies.
- .2 Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

Part 2 Products

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP-58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.2 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports used outside the building: galvanized after manufacture with hot dipped galvanizing process.
 - .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 Cold piping 50mm maximum: Malleable iron C-clamp with hardened steel cup point setscrew, locknut.
 - .1 Rod: 13mm FM approved
- .3 Upper attachment structural: Suspension from upper flange of I-Beam.
 - .1 Cold piping 50mm maximum: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS-SP-69.
- .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 6.4mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate ULC listed to MSS-SP-69.
- .5 Hanger rods: threaded rod material to MSS SP-58.
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Use 22mm hanger rod for 150mm piping, 16mm hanger rod for 100mm piping, and 9.5mm hanger rod for smaller piping.
- .6 Pipe attachments: material to MSS SP-58.
 - .1 Attachments for steel piping: carbon steel black.
 - .2 Attachments for copper piping: copper plated or epoxy coated black steel.
 - .3 Attachments for cold water pipes: oversize to accommodate insulation thickness.
- .7 U-bolts: carbon steel to MSS SP-69 with 2 nuts at each end to ASTM A 563.
 - .1 Finishes for steel pipework: black.
 - .2 Finishes for copper pipework: black, with formed portion plastic coated, epoxy coated.
- .8 Wall brackets: carbon steel prime coated; galvanized for exterior applications.

2.3 RISER CLAMPS

- .1 Steel pipe: black carbon steel to MSS-SP-58, type 42, ULC listed.
- .2 Copper pipe: carbon steel copper plated to MSS-SP-58, type 42 or epoxy coated.
- .3 Bolts: to ASTM A 307.
- .4 Nuts: to ASTM A 563.

2.4 EQUIPMENT SUPPORTS

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

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with Manufacturer's instructions and recommendations.
- .2 All pipes shall be hung securely from structure.
- .3 Vibration Control Devices:
 - .1 Install on piping systems as indicated.
- .4 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 be to industry standards.
 - .3 Steel pipes: Install below coupling or shear lugs welded to pipe.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

3.2 HANGER SPACING

- .1 Hangers shall be spaced as far apart as economically possible. Maximum spacing shall be as follows:

Material/Service	Pipe Size (mm)	Maximum Spacing (mm)
Hard Temper Copper	Less than 32	2135
	32 and Larger	3050
Soft Temper Copper	All Sizes	2440
Steel Pipe	25	2135
	32 and over	3050

- .2 Fuel Oil Piping: Shall be in accordance with CSA B139, Installation Code for Oil-Burning Equipment.

3.3 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.

3.4 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 100mm from vertical.
- .2 Where horizontal pipe movement is less than 13mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.5 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
- .1 Ensure that rod is vertical under operating conditions.
- .2 Equalize loads.
- .2 Adjustable clevis:
- .1 Tighten hanger load nut securely to ensure proper hanger performance.
- .2 Tighten upper nut after adjustment.

- .3 C-clamps:
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 - Mechanical General Requirements.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3, Identification of Piping Systems.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal nameplate with raised or recessed letters mechanically fastened to each piece of equipment by manufacturer.
- .2 Information to include, as appropriate:
 - .1 Equipment: Manufacturer's name, model, size, serial number, capacity, registration plates where specified or required (eg pressure vessel, ULC, CSA).
 - .2 Motor: voltage, Hz, phase, power, power factor, duty, frame size, rpm.

2.2 SYSTEM NAMEPLATES

- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 3.2mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:

Size #	Sizes (mm)	No. of Lines	Height of Letters
1	9.5 x 50	1	3.2mm
2	13 x 75	1	6.4mm
3	13 x 75	2	3.2mm
4	19 x 100	1	8.5mm

Size #	Sizes (mm)	No. of Lines	Height of Letters
5	19 x 100	2	6.4mm
6	19 x 200	1	8.5mm
7	25 x 125	1	13mm
8	25 x 125	2	8.5mm
9	38 x 200	1	19mm

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Equipment in Mechanical Rooms: Use size # 9.

2.3 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, stencils, and/or pictogram (as necessary) showing name and service including temperature and pressure and directional flow arrows where relevant. To CAN/CGSB 24.3 except where specified otherwise.

.2 On P.V.C. jacket use the following material:

.1 Legend Markers, Arrows and Colour Bands: Pressure sensitive plastic coated cloth vinyl with protective overcoating and waterproof contact adhesive undercoating, suitable for 100% RH and continuous operating temperature of 149°C and intermittent temperature of 204°C. Apply to dry, clean prepared surfaces. Wrap 25mm colour band around pipe or pipe covering with ends overlapping one pipe diameter.

.2 Waterproof and Heat Resistant Pressure Sensitive Plastic Marker Tags: for pipes and tubing 19mm nominal and smaller.

.3 Stencilled Identification:

.1 As an alternate to manufactured pipe markers identification may be stencilled on pipe except P.V.C. piping using a first quality oil base paint and colour bands. Letters shall be a minimum of 19mm high. Text to be black.

.4 Identification of pipe to include Pictograms where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.

.5 Use block capital letters 50mm high for pipes of 75mm nominal and larger o.d. including insulation and not less than 19mm high for smaller diameters.

.6 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75mm: 100mm long x 50mm high.

.2 Outside diameter of pipe or insulation 75mm and greater: 150mm long x 50mm high.

- .3 Use double-headed arrows where flow is reversible.
- .7 Background colour marking to be full circumference of pipe or insulation, length to accommodate pictogram, full length of legend and arrows.

.8 Colours and Legends:

.1 Where not listed, obtain direction from Engineer.

.2 Colours for legends, arrows: To following table:

Background Colour	Legend, Arrows
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background Colour Marking	Legend
Fuel Oil Supply	Green	FUEL OIL SUPPLY
Fuel Oil Return	Green	FUEL OIL RETURN
Condensate Drain Lines	Green	COND. DRAIN

2.4 IDENTIFICATION DUCTWORK SYSTEMS

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

2.5 VALVES, CONTROLLERS

- .1 Brass tags with 13mm stamped identification data filled with black paint.

2.7 EQUIPMENT

- .1 Identify Mechanical equipment with black lamicoid plates with white letters attached to equipment. Letters to be a minimum of 19mm high.
- .2 Identification to be visible by an individual standing on the floor.

2.8 LANGUAGE

- .1 Identification to be in English.

Part 3 Execution

3.1 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 respective agency.
- .3 Identify all equipment, piping and duct systems.

3.2 NAMEPLATES

- .1 Locate nameplates in conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Provide standoffs for nameplates on hot and/or insulated surfaces.
- .3 Do not paint, insulate or cover in any way.

3.3 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in equipment rooms: At not more than 7.6m 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 room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 At beginning and end points of each run and at each piece of equipment in run.
- .6 Identification to be easily and accurately readable from usual operating areas and from access points. Position of identification to be 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.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Standard 90.1 - latest edition.
- .2 American Society for Testing and Materials (ASTM):
 - .1 ASTM B 209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - .2 ASTM C 335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C 411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C 449M, Standard Specification for Mineral Fibre-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C 795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .6 ASTM C 921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-51.2, Thermal Insulation, Calcium Silicate, for Piping, Machinery and Boilers.
 - .2 CAN/CGSB-51.9, Mineral Fibre Thermal Insulation for Piping and Round Ducting.
 - .3 CAN/CGSB-51.11, Mineral Fibre Thermal Insulation Blanket.
 - .4 CAN/CGSB-51.12, Cement, Thermal Insulating and Finishing.
 - .5 CAN/CGSB-51.40, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.
 - .6 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .7 CGSB 51-GP-53M, Jacketing, Polyvinyl, Chloride Sheet, for Insulating Pipes, Vessels and Round Ducts.
- .4 Underwriters' Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .5 National Building Code of Canada - 2010.
- .6 National Plumbing Code of Canada - 2010.
- .7 National Energy Code of Canada for Buildings - 2011.
- .8 Manufacturer's Trade Associations:
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.

1.2 DEFINITIONS

- .1 For purposes of this section:
 - .1 A/C - Air Conditioned Air
 - .2 E/A Exhaust Air "EXPOSED" - will mean "not concealed" as defined herein.
 - .3 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible, chases and furred-in spaces.
 - .4 EXPOSED" - will mean "not concealed" as defined herein.
 - .5 O/A - Outside Air.
 - .6 R/A - Return Air.
 - .7 S/A - Supply Air.
- .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 21 05 01 Mechanical General requirements.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves and jointing recommendations.

1.4 MANUFACTURER'S INSTRUCTIONS

- .1 Manufacturer's installation instructions to be submitted to the Departmental Representative upon request.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

1.5 QUALIFICATIONS

- .1 Installer to be specialist in performing work of this section, and have at least three years successful experience in this size and type of project.
- .2 Approved Contractors: Guilfords (2000) Inc., Scotia Insulations Ltd., Twin City Insulation, Zink's Mechanical Insulation, Pro-Insul Ltd., Parker Kaefer Inc., Safway.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather, construction traffic, and against damage from any source.

- .3 Store at temperatures and conditions required by manufacturer.

Part 2 Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C 335.
- .3 Rigid Duct Insulation:
 - .1 Rigid duct insulation will be, rigid fibre glass board, having a minimum density of 96 kg/m³.
 - .2 Rigid duct insulation vapour jacket will be factory applied foil-scrim-kraft facing consisting of aluminum foil reinforced with fibre glass yarn mesh and laminated to 2.7kg chemically treated fire resistant kraft.

2.3 JACKETS

- .1 Canvas:
 - .1 8 oz. cotton, plain weave, treated with ULC listed dilute fire retardant lagging adhesive to ASTM C 921.
- .2 Lagging adhesive: Compatible with insulation.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
 - .2 Acceptable Products Permastik 2001, Sealfast 30.36.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Acceptable Products Benjamin Foster 82-07 or Flintkote 230-04.
- .3 Tape: self-adhesive, aluminum, reinforced, 50mm wide minimum.
- .4 Contact adhesive: quick-setting.

- .5 Canvas adhesive: washable.
- .6 Galvanized wire, 15 gauge, annealed.
- .7 Galvanized mesh, hexagonal mesh, 15 gauge, galvanized annealed.
- .8 Fasteners: 4.1mm diameter pins with 38mm square clips, length to suit thickness of insulation.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

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

3.2 INSTALLATION

- .1 Apply materials in accordance with manufacturers instructions and this specification.
- .2 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .3 Supports, Hangers in accordance with Section 23 05 29 Bases, Hangers and Supports
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .4 Install in accordance with TIAC National Standards.

3.3 RIGID DUCT INSTALLATION

- .1 Rigid duct insulation with canvas covering and lagging will be used on exposed ducts.
- .2 Insulation will be applied with edges tightly butted and sealed with a 75mm wide strip of the vapour barrier material, applied with a compatible adhesive.
- .3 The insulation will be impaled on stick clips or pins welded to the duct, and secured with speed washers. Maximum spacing of pins will be 10 pin per square meter.
- .4 Penetrations of the vapour barrier will be patched with a strip of vapour barrier material.
- .5 Duct insulation and vapour barrier, where applicable, shall be continuous through walls and floor openings, except at fire dampers.
- .6 Where more than one thickness of insulation is required, stagger both longitudinal and

horizontal joints.

3.4 DUCTWORK INSULATION SCHEDULE

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

Service	TIAC Code	Vapour Retarder	Insulation Thickness
E/A Ducts/Plenums	C-1	yes	50mm
O/A Ducts/Plenums	C-1	yes	50mm

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME-B16.3, Malleable-Iron Threaded Fittings.
 - .2 ASME-B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
- .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 B61, Standard Specification for Steam or Valve Bronze Castings.
 - .4 ASTM B75M, Standard Specification for Seamless Copper Tube.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA-B139, Installation Code for Oil Burning Equipment.
 - .2 CSA-B140.0, Oil Burning Equipment: General Requirements.
- .4 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
 - .1 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.2 SUBMITTALS

- .1 Submittals in accordance with Section 21 05 01 - Mechanical General Requirements.
- .2 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 21 05 01 - Mechanical General Requirements.

Part 2 Products

2.1 FITTINGS

- .1 Steel:
 - .1 Malleable iron: screwed, banded, Class 150 to ASME-B16.3.
 - .2 Welding: butt-welding to ASME-B16.9.
 - .3 Unions: malleable iron, brass to iron, ground seat, screwed, to ASTM A47/A47M.
 - .4 Nipples: Schedule 40, to ASTM A53/A53M.

2.2 BALL VALVES

- .1 50mm and under:
 - .1 Bronze body, screwed ends, TFE seal, hard chrome ball, 4 MPa, WOG.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

- .1 Install piping in accordance with Section 23 05 01 - Installation of Pipework, supplemented as specified.
- .2 Install oil piping system in accordance with CSA -B139 and CSA-B140.0.
- .3 Slope piping down in direction of day tank unless otherwise indicated.
- .4 Suction and return piping inside building:
 - .1 Generator Equipment Room: steel, with screwed fittings.

3.3 VALVES

- .1 Install valves with stems upright or horizontal unless approved otherwise by Departmental Representative.
 - .1 Install ball valves at branch take-offs, to isolate pieces of equipment and as indicated.

3.5 CLEANING

- .1 Flush after pressure test with number 2 fuel oil for a minimum of two hours. Clean strainers and filters.
 - .1 Dispose of fuel oil used for flushing out in accordance with requirements of authority having jurisdiction.
 - .2 Check entire installation is approved by authority having jurisdiction.
 - .3 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools, and equipment.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 - Mechanical General Requirements.

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM A 480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A 635/A635M, Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A 653/A653M, Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .2 National Fire Protection Agency (NFPA):
 - .1 NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
 - .3 NFPA 91, Standard for Exhaust System for Air Conveying of Vapours, Gases, Mists, and Non-combustible Particle Solids.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
 - .2 SMACNA HVAC Duct Leakage Test Manual.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 21 05 01- Mechanical General Requirements.
- .2 Indicate following:
 - .1 Sealants.
 - .2 Tape.
 - .3 Proprietary Joints.

1.4 CERTIFICATION OF RATINGS

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

Part 2 Products

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure	SMACNA Seal Class
500 Pa	C
250 Pa	C
125 Pa	C
<125 Pa	Unsealed
- .2 Seal classification:
 - .1 Class C: transverse joints and connections made air tight with gaskets or sealant and tape. Longitudinal seams unsealed.

2.2 SEALANT

- .1 Sealant: oil resistant, polymer type, water based, high pressure, non-toxic, flame resistant duct sealant. Temperature range of minus 29⁰C to plus 79⁰C.

2.3 TAPE

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

2.4 DUCT LEAKAGE

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

2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Transitions:
 - .1 Diverging: 20⁰ maximum included angle, unless indicated.
 - .2 Converging: 30⁰ maximum included angle, unless indicated.
- .3 Offsets:
 - .1 Full radiused elbows or as indicated.
- .4 Obstruction deflectors: maintain full cross-sectional area. Maximum included angles: as for transitions.

2.6 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A 653, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA HVAC duct construction standards.

- .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered a Class A seal.

2.7 HANGERS AND SUPPORTS

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

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
Up to 750	25 x 25 x 3.2	6.3
775 - 1050	32 x 32 x 3.2	6.3
1075 - 1500	38 x 38 x 3.2	9.5
1525 - 2075	50 x 50 x 3.2	9.5

2.8 SHEET METAL PLENUMS

- .1 Nominal 18 ga. galvanized steel sheet re-squared and formed into 610mm 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.

2.9 DUCT JOINTS

- .1 Ductwork is to be prefabricated using drive slip joints sized 450mm or greater. Joints 375mm or larger are to be reinforced.

Part 3 Execution

3.1 GENERAL

- .1 Do work in accordance with CSA B228.1 and SMACNA and as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.

- .3 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .4 Clean all ductwork and plenums prior to system start-up. Submit report to Departmental Representative for review.
- .5 Duct size 475mm wide and larger with more than 1 sq.m. or embraced panel shall be beaded or cross broken. This shall also apply to 20 gauge or less thickness and 750 Pa w.c. or less.
- .6 Ductwork at all intakes, all exhaust and other places where water from condensation may occur shall be watertight. At these places, ductwork shall be sloped towards a low point where a 32mm copper pipe connection for (i.e. tailpiece with trap) drainage purposes shall be installed.
- .7 Where ducts over 610mm wide are shown passing through masonry walls provide lintels and a continuous 32mm x 32mm x 6.4mm galvanized steel angle frame which shall be bolted to the construction and made air-tight to the same by applying caulking compound. Sheet metal at these locations shall be bolted to the angle iron.

3.2 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with ASHRAE and SMACNA as follows:

Duct Size	Spacing
to 1500mm	3050mm
1525mm and Over	2440mm

3.3 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Outside air intake plenums.
 - .2 Exhaust air discharge plenums.
- .2 Form bottom of horizontal duct without longitudinal seams. Solder, weld joints of bottom and side sheets. Seal other joints with duct sealer.
- .3 Install drains at base of risers, where noted on drawings, and other places where water may gather.

3.4 SEALING AND TAPING

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

manufacturers recommendations.

3.5 SHEET METAL PLENUMS

- .1 Add sealant during closure of standing seams and channel sections and fasten with bolts or blind rivets at 305mm on centre.
- .2 Secure angle frames to wall or floor at 610mm on centre and caulk air-tight.
- .3 Provide light metal channel at wall and floor into which insulation can be finished.

3.6 LEAKAGE TESTS

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

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 - Mechanical General Requirements.

1.2 REFERENCES

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

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 21 05 01 - Mechanical General Requirements.
- .2 Indicate the following:
 - .1 Flexible connections.
 - .2 Duct access doors.

1.4 CERTIFICATION OF RATINGS

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

Part 2 Products

2.1 GENERAL

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards and CSA B228.1.

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: nominal 24 ga. galvanized sheet metal frame, minimum 75mm wide with fabric clenched by means of double locked seams.
- .2 Material:
 - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 4.4⁰C to plus 90⁰C, density of 3.2 kg/m².

2.3 ACCESS DOORS IN PLENUMS

- .1 Insulated: Sandwich construction of same material as plenum wall (nominal 22 ga.) Complete with 16 ga. Sheet metal angle frame and 50mm thick rigid glass fibre insulation.

- .2 Gaskets: Neoprene.
- .3 Hardware:
 - .1 Piano hinge and two "T" handle cam-locks operable from both sides, corrosion resistant materials.
 - .2 Hold open device.
 - .3 305mm x 305mm wired glass viewing panel.
 - .4 Minimum size: 915mm x 915mm.

Part 3 Execution

3.1 INSTALLATION

- .1 Flexible connections:
 - .1 Install in following locations:
 - .1 Connection to generator radiator.
 - .2 Length of connection: 100mm.
 - .3 Minimum distance between metal parts when system in operation: 50mm.
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
- .2 Access doors and viewing panels:
 - .1 Size:
 - .1 305mm x 305mm for servicing entry.
 - .2 Locations:
 - .1 Motorized dampers.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 - Mechanical General Requirements.
- .2 Section 23 33 00 - Duct Accessories.

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

1.3 SHOP DRAWINGS

- .1 Submit product data in accordance with Section 21 05 01 - Mechanical General Requirements.
- .2 Indicate the following:
 - .1 Performance data.
 - .2 Dimensions, quantity.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 21 05 01 - Mechanical General Requirements.

1.5 CERTIFICATION OF RATINGS

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

Part 2 Products

2.1 MULTI-LEAF DAMPERS

- .1 Opposed blade type as indicated.
- .2 Extruded aluminum, interlocking blades, complete with internal polyurethane blade insulation, extruded EPDM elastomer seals, extruded thermoplastic frame seals, extruded aluminum frame complete with polystyrene insulation. Low leakage construction.
- .3 Bearings comprised of a celcon inner bearing fixed to a 11mm aluminum hexagon blade pin rotating within a polycarbonate outer bearing inserted in the frame, no metal-to-metal or metal-to-plastic contact.

- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod. Linkage hardware is installed in frame side and constructed of aluminum and corrosion resistant zinc and nickel-plated steel, complete with cup-point trunnion screws for a slip-proof grip.
- .5 Operator: as specified in the controls specification sections.
- .6 Performance: leakage in closed position to be less than 20 L/s/m² at 1000Pa w.c. differential across damper. Pressure drop at full open position for a 1220mm x 1220mm damper to be less than 75Pa w.c. differential across damper at 5.1m/s air flow.

Part 3 Execution

3.1 INSTALLATION

- .1 Opposed blade balancing dampers with locking quadrant shall be provided.
- .2 Install insulated dampers at fresh air intakes and exhaust louvers.
- .3 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .4 Seal multiple damper modules with silicon sealant. Seal air tight between duct and damper frame for tight close-off.
- .5 Install access door adjacent to each damper, see Section 23 33 00 Duct Accessories, so that each damper is observable, serviceable, and accessible.
- .6 Extend damper control rod or jackshaft through damper casing to the outside of the duct or equipment casing to allow proper connection of direct-coupled damper actuator.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM E 90, Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

1.2 SHOP DRAWINGS

- .1 Submit product data in accordance with Section 21 05 01 - Mechanical General Requirements.
- .2 Indicate the following:
 - .1 Pressure drop.
 - .2 Face area.
 - .3 Free area.
 - .4 dimensions and weights.
 - .5 Installation directions.
 - .6 Finishes and materials of construction.

1.3 TEST REPORTS

- .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E 90.

1.4 CERTIFICATION OF RATINGS

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

Part 2 Products

2.1 FIXED LOUVRES - ALUMINUM

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500mm.
- .4 Frame, head, sill and jamb: 150mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.

- .5 Mullions: at 1500mm maximum centres.
- .6 Fastenings: stainless steel (Society of Automotive Engineers) SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 13mm exhaust, 13mm intake mesh, 2 mm diam wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .8 Finish: Fluoropolymar, Kynar or Durmar. Colour to be closely match existing stonework on building.
- .9 Louvres shall have extended sill frame.

Part 3 Execution

3.1 INSTALLATION

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace for wind speed in accordance with NBC.
- .3 Anchor securely into opening. Seal with caulking all around to ensure weather tightness.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials, accessories and installation for breechings, chimneys and stacks.

1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
- .2 Underwriters' Laboratories of Canada (ULC).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 21 05 01 - Mechanical General Requirements. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 21 05 01 - Mechanical General Requirements.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 21 05 01 - Mechanical General Requirements.
 - .2 Indicate following:
 - .1 Methods of sealing sections.
 - .2 Methods of expansion.
 - .3 Details of thimbles.
 - .4 Explosion (pressure) relief vent.
 - .5 Supports.
 - .6 Guy details.
 - .7 Rain caps.
 - .8 Bellow joints.
- .3 Closeout Submittals
 - .1 Submit operation and maintenance data for incorporation into manual specified in Section 21 05 01 - Mechanical General Requirements.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial /Territorial regulations.

- .2 Certificates:
 - .1 Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling, and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions.

Part 2 Products

2.1 DIESEL GENERATOR EXHAUST

- .1 Provide factory built exhaust system that is tested and listed by the Underwriter's Laboratories, Inc. For use with medium heat equipment which produce exhaust flue gas temperatures not exceeding 760°C under continuous operating conditions.
- .2 The double wall exhaust system shall have a 316 stainless steel inner liner and 304 stainless outer jacket. The fibre insulation between the inner and outer jacket shall be a nominal 50mm thick.
- .3 The exhaust system shall be designed and installed to be gas tight and thus prevent leakage of combustion products. The exhaust system shall be U.L. tested and listed to 15 kPa internal water column pressure.
- .4 Inner pipe joints shall be securely connected and sealed with factory supplied over-lapping V-bands and appropriate sealant as specified in the manufacturer's installation instructions.
- .5 Connections to generator and expansion joints shall be made with matching flanges. Matching flanges shall be of the same size, bolt hole spacing and pressure rating as the flanges to which the connections are made.
- .6 The exhaust system shall be designed to compensate for all flue gas induced thermal expansion.
- .7 The exhaust system shall be complete with all required accessories including: lined bellows joints, 45 degree lateral tees, drain tee caps, 45 degree elbows, tapered increaser/reducer, angle rings, plate support assemblies, wall support assemblies, wall guide assemblies, flange adapters, flip top, explosion (pressure) relief valve, V-bands, and sealant.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 DIESEL GENERATOR EXHAUST

- .1 Inner pipe joints shall be sealed by use of factory supplied overlapping V-bands and sealant as specified in the manufacturer's installation instructions.
- .2 The exhaust piping and its supporting system shall resist side loads at least 1.5 times greater than the weight per foot of the piping for both horizontal and vertical portions.
- .3 The exhaust system shall be installed according to the manufacturer's installation instructions.
- .4 Provide all supports, guides, bellows type expansion joints, pressure relief valves, and flip top terminations as required to provide a complete system per the manufacturer's installation instructions.
- .5 The Mechanical Contractor shall confirm the exact chimney lengths on site prior to submitting shop drawings; coordinate measurements with the chimney manufacturer's representative.

END OF SECTION