

**Part 1            General****1.1            ACTION AND INFORMATIONAL SUBMITTALS**

- .1      Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Product Data:
  - .1          Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3      Shop Drawings:
  - .1          Submit drawings in accordance with Section 01 33 00 – Submittal Procedures.
  - .2          Indicate on drawings:
    - .1              Mounting arrangements.
    - .2              Operating and maintenance clearances.
  - .3          Shop drawings and product data accompanied by:
    - .1              Detailed drawings of bases, supports, and anchor bolts.
    - .2              Certification of compliance to applicable codes.
  - .4          In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

**1.2            CLOSEOUT SUBMITTALS**

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

**1.3            MAINTENANCE MATERIAL SUBMITTALS**

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

**1.4            DELIVERY, STORAGE AND HANDLING**

- .1      Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2      Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3      Storage and Handling Requirements:
  - .1          Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2          Store and protect from nicks, scratches, and blemishes.
  - .3          Replace defective or damaged materials with new.
- .4      Develop Construction Waste Management Plan related to Work of this Section.

- 
- .5 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products**

**2.1 NOT USED**

**Part 3 Execution**

**3.1 EXAMINATION**

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

**3.2 SYSTEM CLEANING**

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

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.4 PROTECTION**

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

**END OF SECTION**

**Part 1            General****1.1            RELATED REQUIREMENTS**

- .1      Section 23 05 00 – Common Work Results for HVAC
- .2      Section 23 21 13.02 – Hydronic Systems: Steel
- .3      Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems

**1.2            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)
  - .1      Standard GS-11-2015, 2nd Edition, Environmental Standard for Paints and Coatings.
- .3      National Fire Code of Canada (NFCC 2015)

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1      Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Product Data:
  - .1      Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4            DELIVERY, STORAGE AND HANDLING**

- .1      Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2      Delivery and Acceptance Requirements:
  - .1      Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3      Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 MATERIAL**

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
  - .1 Primers, Paints, Coating: in accordance with manufacturer's recommendations for surface conditions.
  - .2 Primer: maximum VOC limit 250 g/L to Standard GS-11.
  - .3 Paints: maximum VOC limit 150 g/L to Standard GS-11.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
  - .1 Sealants: maximum VOC limit to GSES GS-36.
- .3 Sealants: maximum VOC limit to GSES GS-36.
- .4 Adhesives: maximum VOC limit to GSES GS-36.

**Part 3 Execution****3.1 APPLICATION**

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

**3.2 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.

**3.3 CLEARANCES**

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

**3.4 DIELECTRIC COUPLINGS**

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

---

**3.5 PIPEWORK INSTALLATION**

- .1 Install pipework to applicable codes.
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
  - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 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.

**3.6 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.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

---

**3.7 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK**

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .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.

**3.8 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.

**3.9 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**

---

**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 00 – Common Work Results for HVAC.
- .2 Section 23 05 05 – Installation of pipework.

**1.2 REFERENCES**

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1-2014, Power Piping.
  - .2 ANSI/ASME B31.3-2014, Process Piping.
  - .3 ANSI/ASME Boiler and Pressure Vessel Code-2015:
    - .1 BPVC 2015 Section I: Power Boilers.
    - .2 BPVC 2015 Section V: Non destructive Examination.
    - .3 BPVC 2015 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1 ANSI/AWWA C206-11, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
  - .1 AWS C1.1M/C1.1-2012, Recommended Practices for Resistance Welding.
  - .2 AWS Z49.1-2012, Safety in Welding, Cutting and Allied Process.
  - .3 AWS W1-2015, Welding Inspection Handbook..
- .4 Canadian Standards Association (CSA International)
  - .1 CSA W47.2-11 (R2015), Certification of Companies for Fusion Welding of Aluminum.
  - .2 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
  - .3 CSA B51-14, Boiler, Pressure Vessel and Pressure Piping Code.
  - .4 CSA-W117.2-12, Safety in Welding, Cutting and Allied Processes.
  - .5 CSA W178.1-14, Certification of Welding Inspection Organizations.
  - .6 CSA W178.2-14, Certification of Welding Inspectors.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

**1.4 QUALITY ASSURANCE**

- .1 Qualifications:
  - .1 Welders:
    - .1 Welding qualifications in accordance with CSA B51.

## PIPE WELDING

- 
- .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
  - .3 Submit welder's qualifications to Departmental Representative.
  - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
  - .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
  - .2 Inspectors:
    - .1 Inspectors qualified to CSA W178.2.
  - .3 Certifications:
    - .1 Registration of welding procedures in accordance with CSA B51.
    - .2 Copy of welding procedures available for inspection.
    - .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 ELECTRODES**

- .1 Electrodes: in accordance with CSA W48 Series.

**Part 3 Execution****3.1 APPLICATION**

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

**3.2 QUALITY OF WORK**

- .1 Welding: in accordance with ANSI/ASME B31.1, B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and applicable requirements of provincial authority having jurisdiction.



---

**3.3 INSTALLATION REQUIREMENTS**

- .1 Identify each weld with welder's identification symbol.
- .2 Backing rings:
  - .1 Where used, fit to minimize gaps between ring and pipe bore.
  - .2 Do not install at orifice flanges.
- .3 Fittings:
  - .1 NPS 2 and smaller: install welding type sockets.
  - .2 Branch connections: install welding tees or forged branch outlet fittings.

**3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS**

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

**3.5 SPECIALIST EXAMINATIONS AND TESTS**

- .1 General:
  - .1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Departmental Representative.
  - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
- .2 Hydrostatically test welds to ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
  - .1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative of total of up to 10 Departmental Representative particle tests.
- .5 Magnetic particle tests for glycol piping systems.

**3.6 DEFECTS CAUSING REJECTION**

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.

**3.7 REPAIR OF WELDS WHICH FAILED TESTS**

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

---

**3.8            CLEANING**

- .1      Clean in accordance with Section 01 74 11 - Cleaning.
- .2      Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**

**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 00 – Common Work Results for HVAC.

**1.2 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B31.1-2014, Power Piping.
- .2 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
- .3 Underwriter's Laboratories of Canada (ULC)
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 SYSTEM DESCRIPTION**

- .1 Design Requirements:
  - .1 Construct pipe support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.

- 
- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
  - .3 Ensure that supports do not transmit excessive quantities of heat to building structure.
  - .4 Design 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 supports in accordance with MSS SP58.

## **2.3 DUCTWORK SUPPORTS**

- .1 Bases:
  - .1 Install double base trapeze support as indicated on drawings. Material: Hot-Dipped Galvanized. Maximum uniform load per base of 68kg.
- .2 Ductwork support:
  - .1 Galvanized steel U-channel as per SMACNA.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.

### **3.3 FINAL ADJUSTMENT**

- .1 Adjust supports:
  - .1 Equalize loads.

### **3.4 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

- .2      Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**



**Part 1            General****1.1               RELATED REQUIREMENTS**

- .1       Section 23 05 00 – Common Work Results for HVAC.

**1.2               REFERENCES**

- .1       Canadian General Standards Board (CGSB)
  - .1       CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.

**1.3               ACTION AND INFORMATIONAL SUBMITTALS**

- .1       Product Data:
- .2       Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .3       Product data to include paint colour chips, other products specified in this section.
- .4       Samples:
  - .1       Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
  - .2       Samples to include nameplates, labels, tags, lists of proposed legends.

**1.4               QUALITY ASSURANCE**

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

**1.5               DELIVERY, STORAGE, AND HANDLING**

- .1       Packing, shipping, handling and unloading:
  - .1       Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2       Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2       Waste Management and Disposal:
  - .1       Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .2       Dispose of unused paint, coating material at official hazardous material collections site approved by Departmental Representative.
  - .3       Do not dispose of unused paint, coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

---

**Part 2            Products**
**2.1            SYSTEM NAMEPLATES****.1            Colours:**

- .1            Hazardous: red letters, white background.
- .2            Elsewhere: black letters, white background (except where required otherwise by applicable codes).

**.2            Construction:**

- .1            3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

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

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

**.2            Use maximum of 25 letters/numbers per line.****.4            Locations:**

- .1            Terminal cabinets, control panels: use size # 5.
- .2            Equipment in Mechanical Rooms: use size # 9.

**.5            Identification for PWGSC Preventive Maintenance Support System (PMSS):**

- .1            Use arrangement of Main identifier, Source identifier, Destination identifier.
- .2            Equipment in Mechanical Room:
  - .1            Main identifier: size #9.
  - .2            Source and Destination identifiers: size #6.
  - .3            Terminal cabinets, control panels: size #5.
- .3            Equipment elsewhere: sizes as appropriate.



## 2.2 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting work, obtain written approval of identification system from Departmental Representative.

## 2.3 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
  - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
  - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
  - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
  - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
  - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
  - .1 To full circumference of pipe or insulation.
  - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
  - .1 Pipes and tubing 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.
- .7 Colours and Legends:
  - .1 Where not listed, obtain direction from Departmental Representative.
  - .2 Colours for legends, arrows: to following table:

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

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

Contents	Background colour marking	Legend
Glycol Supply	Green	GLYCOL SUPPLY
Glycol Return	Green	GLYCOL RETURN

## **2.4 IDENTIFICATION DUCTWORK SYSTEMS**

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

## **2.5 LANGUAGE**

- .1 Identification in English.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 INSTALLATION**

- .1 Provide ULC CSA registration plates as required by respective agency.
- .2 Identify systems, equipment to conform to PWGSC PMSS.

### **3.3 NAMEPLATES**

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

### **3.4 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS**

- .1 On long straight runs in open areas; at no more than 17m 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 On both sides of visual obstruction or where run is difficult to follow.
- .4 Where system is installed at entry and exit points, and at access openings.
- .5 At beginning and end points of each run and at each piece of equipment in run.

.6 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

### **3.5 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**



---

**Part 1            General****1.1            RELATED REQUIREMENTS**

- .1      Section 23 05 00 – Common Work Results for HVAC.
- .2      Section 23 31 13.01 – Metal Ducts – Low Pressure to 500 Pa.

**1.2            REFERENCES**

- .1      Definitions:
  - .1          For purposes of this section:
    - .1              "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
    - .2              "EXPOSED" - means "not concealed" as previously defined.
    - .3              Insulation systems - insulation material, fasteners, jackets, and other accessories.
  - .2          TIAC Codes:
    - .1              CRD: Code Round Ductwork,
    - .2              CRF: Code Rectangular Finish.
- .2      Reference Standards:
  - .1          American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
    - .1              ANSI/ASHRAE/IESNA 90.1-13, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - .2          ASTM International Inc.
    - .1              ASTM B209-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
    - .2              ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finish Cement.
    - .3              ASTM C335-10, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
    - .4              ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .3          Canadian General Standards Board (CGSB)
    - .1              CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .4          Green Seal Environmental Standards (GSES)
    - .1              Standard GS-36-13, Commercial Adhesives.
  - .5          Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

## DUCT INSULATION

- .6 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.
- .3 Packaging Waste Management: remove for reuse of pallets, crates, padding packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 FIRE AND SMOKE RATING**

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

**2.2 INSULATION**

- .1 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .2 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with or without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).

**2.3 JACKETS**

- .1 Aluminium:
  - .1 To ASTM B209 with or without moisture barrier as scheduled in PART 3 of this section.
  - .2 Thickness: 0.50mm sheet.
  - .3 Finish: Stucco embossed.
  - .4 Jacket banding and mechanical seals: 19mm wide, 0.5mm thick stainless steel.

---

**2.4 ACCESSORIES**

- .1 Vapour retarder lap adhesive:
  - .1 Water based, fire retardant type, compatible with insulation.
    - .1 Maximum VOC limit 200 g/L to GSES GS-36.
- .2 Indoor Vapour Retarder Finish:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
- .5 Contact adhesive: quick-setting
  - .1 Maximum VOC limit 250 g/L to GSES GS-36.
- .6 Tie wire: 1.5 mm stainless steel.
- .7 Banding: 19mm wide, 0.5mm thick stainless steel.
- .8 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

**Part 3 Execution****3.1 APPLICATION**

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

**3.2 PRE-INSTALLATION REQUIREMENTS**

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

**3.3 INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

## DUCT INSULATION

- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

### 3.4 DUCTWORK INSULATION SCHEDULE

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

	Code	Vapour Retarder	Thickness (mm)
Round ducts outside	C-1	yes	50

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

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

- .1 Finishes: conform to following table:

	TIAC Code	TIAC Code
	Rectangular	Round
Outdoor, exposed to precipitation	CRF/3	CRD/4

### 3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**



**Part 1        General****1.1        RELATED REQUIREMENTS**

- .1        Section 23 05 00 – Common Work Results for HVAC.
- .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 90.1-01, 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 B209-14, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
  - .2        ASTM C177-13, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus.
  - .3        ASTM C518-15, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - .4        ASTM C534M-14, Standard Specification for Performed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
  - .5        ASTM E84-15b, Standard Test Method for Surface Burning Characteristics of Building Materials.
  - .6        ASTM C1534-14, Standard Specification for Flexible Polymeric Foam Sheet Insulation Used as a Thermal and Sound Absorbing Liner for Duct Systems.
  - .7        ASTM D1056-14, Standard Specification for Flexible Cellular Material – Sponge or Expanded Rubber.
- .3        Canadian General Standards Board (CGSB)
  - .1        CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4        Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1        Material Safety Data Sheets (MSDS).
- .5        Manufacturer's Trade Associations
  - .1        Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .6        Underwriters' Laboratories of Canada (ULC)
  - .1        CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.

- .2 CAN/ULC-S702-09 AMT1, Thermal Insulation, Mineral Fibre, for Buildings.

### 1.3 DEFINITIONS

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

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

### 1.5 QUALITY ASSURANCE

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

### 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
  - .1 Protect from weather, construction traffic.
  - .2 Protect against damage.
  - .3 Store at temperatures and conditions required by manufacturer.
- .3 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

- .2 Place excess or unused insulation and insulation accessory materials in designated containers.
- .3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
- .4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

## **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 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C177 or C518. Thermal conductivity of 0.25 (Btu•in./h•ft<sup>2</sup>•°F) for 50mm insulation.
- .2 Code A-3: black flexible closed-cell elastomeric, unicellular insulating sheet, with built-in vapor barrier eliminating need for additional vapor retarder. Maximum flame spread rating: 25. Maximum smoke density rating: 50. Insulation to meet ASTM C534, ASTM E84, ASTM C1534, ASTM D1056.

### **2.3 INSULATION SECUREMENT**

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Tie wire: 1.5mm diameter stainless steel.
- .4 Bands: stainless steel, 19mm wide, 0.5mm thick.

### **2.4 JACKETS**

- .1 Aluminum:
  - .1 To ASTM B209
  - .2 Thickness: 0.50mm sheet.
  - .3 Finish: stucco embossed.
  - .4 Joining: longitudinal and circumferential slip joints with 50mm laps.
  - .5 Fittings: 0.5mm thick die-shaped fitting covers with factory-attached protective liner.
  - .6 Metal jacket banding and mechanical seals: stainless steel, 19mm wide, 0.5mm thick at 300mm spacing.

---

**2.5 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS**

- .1 Caulking to: Section 07 92 00 - Joint Sealants.

**Part 3 Execution****3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 PRE-INSTALLATION REQUIREMENT**

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

**3.3 INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Install hangers, supports outside vapour retarder jacket.

**3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES**

- .1 Application: at valves, flanges and unions at equipment.
- .2 Design: to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
  - .1 Insulation, fastenings and finishes: same as system.
  - .2 Jacket: stainless steel.

**3.5 INSTALLATION OF ELASTOMERIC INSULATION**

- .1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

**3.6 PIPING INSULATION SCHEDULES**

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

.2 TIAC Code: A-3.

- .1 Securements: SS bands at 300 mm on centre.
- .2 Seals: VR lap seal adhesive, VR lagging adhesive.
- .3 Installation: TIAC Code: 1501-C.

.3 Thickness of insulation as listed in following table.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8	up to 175
Glycol		A-3	25	25	38	38	38	38

.4 Finishes:

- .1 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
- .2 Outdoors: SS jacket.
- .3 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.
- .4 Installation: to appropriate TIAC code CRF/1 through CPF/5.

### 3.7 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**



CLEANING AND START-UP OF MECHANICAL  
PIPING SYSTEMS

**Part 1            General****1.1               RELATED REQUIREMENTS**

- .1            Section 23 05 00 – Common Work results for HVAC.

**1.2               REFERENCES**

- .1            American Society for Testing and Materials International (ASTM)
  - .1            ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2            Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1            Material Safety Data Sheets (MSDS).

**1.3               ACTION AND INFORMATIONAL SUBMITTALS**

- .1            Product Data:
  - .1            Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2            Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1            Instructions: submit manufacturer's installation instructions.
    - .1            Departmental Representative will make available 1 copy of systems supplier's installation instructions.

**1.4               QUALITY ASSURANCE**

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

**1.5               DELIVERY, STORAGE, AND HANDLING**

- .1            Packing, shipping, handling and unloading:
  - .1            Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2            Waste Management and Disposal:
  - .1            Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**CLEANING AND START-UP OF MECHANICAL  
PIPING SYSTEMS**

---

**Part 2            Products****2.1            CLEANING SOLUTIONS**

- .1      Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2      Sodium carbonate: 0.40 kg per 100 L water in system.
- .3      Low-foaming detergent: 0.01 kg per 100 L water in system.

**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            CLEANING HYDRONIC AND STEAM SYSTEMS**

- .1      Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2      Cleaning Agency:
  - .1      Retain qualified water treatment specialist to perform system cleaning.
- .3      Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4      Cleaning procedures:
  - .1      Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
    - .1      Cleaning procedures, elapsed time.
    - .2      Chemicals and concentrations used.
    - .3      Inhibitors and concentrations.
    - .4      Specific requirements for completion of work.
    - .5      Special precautions for protecting piping system materials and components.
    - .6      Complete analysis of water used to ensure water will not damage systems or equipment.
- .5      Conditions at time of cleaning of systems:
  - .1      Systems: free from construction debris, dirt and other foreign material.
  - .2      Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
  - .3      Strainers: clean prior to initial fill.



**CLEANING AND START-UP OF MECHANICAL  
PIPING SYSTEMS**

- 
- .6 Report on Completion of Cleaning:
    - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
  - .7 Glycol Systems:
    - .1 In addition to procedures specified above perform specified procedures.
    - .2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

### **3.3 START-UP OF HYDRONIC SYSTEMS**

- .1 After cleaning is completed and system is filled:
  - .1 Establish circulation and expansion tank level, set pressure controls.
  - .2 Ensure air is removed.
  - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
  - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
  - .5 Clean out strainers repeatedly until system is clean.
  - .6 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
  - .7 Repeat with water at design temperature.
  - .8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
  - .9 Bring system up to design temperature and pressure slowly.
  - .10 Adjust pipe supports, hangers, springs as necessary.
  - .11 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
  - .12 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

### **3.4 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**



**Part 1        General****1.1        RELATED REQUIREMENTS**

- .1        Section 23 05 00 – Common Work Results for HVAC.
- .2        Section 23 05 05 – Installation of Pipework.
- .3        Section 23 08 02 – Cleaning and Start-Up of Mechanical Piping Systems.

**1.2        REFERENCES**

- .1        ASTM International
  - .1        ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
  - .2        ASTM E202-12, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .2        CSA International
  - .1        CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.

**1.3        ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for glycol piping and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4        CLOSEOUT SUBMITTALS**

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

**1.5        DELIVERY, STORAGE AND HANDLING**

- .1        Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2        Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3        Storage and Handling Requirements:
  - .1        Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2        Store and protect hydronic systems from nicks, scratches, and blemishes.
  - .3        Replace defective or damaged materials with new.
- .4        Develop Construction Waste Management Plan related to Work of this Section.

- 
- .5 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **Part 2 Products**

### **2.1 PIPE**

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
- .1 To NPS 6: Schedule 40.

### **2.2 PIPE JOINTS**

- .1 NPS 2 and under: screwed fittings with PTFE tape.
- .2 NPS 2-1/2 and over: welding to CSA W48.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic systems installation in accordance with manufacturer's written instructions.
- .1 Visually inspect substrate in presence of Departmental Representative.
- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 PIPING INSTALLATION**

- .1 Install pipework in accordance with Section 23 05 05 - Installation of Pipe Work.

### **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 23 05 00 - Common Work Results for HVAC.
- .2 For glycol systems, retest with ethylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

### **3.5 GLYCOL CHARGING**

- .1 Include mixing tank and positive displacement pump for glycol charging (50% Ethylene Glycol).
- .2 Retest for concentration to ASTM E202 after cleaning.

---

**3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.7 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by hydronic systems installation.

**END OF SECTION**



**Part 1        General****1.1        RELATED REQUIREMENTS**

- .1        Section 23 05 00 – Common Work Results for HVAC.
- .2        Section 23 05 29 – Hangers and support for HVAC piping and equipment.

**1.2        REFERENCES**

- .1        American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2        ASTM International
  - .1        ASTM A635/A635M-15, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
- .3        Green Seal Environmental Standards (GS)
  - .1        GS-36-13, Standard for Adhesives for Commercial Use.
- .4        National Fire Protection Association (NFPA)
  - .1        NFPA 90A-15, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2        NFPA 90B-15, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .5        Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1        SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
  - .2        SMACNA HVAC Air Duct Leakage Test Manual, 2012.
  - .3        IAQ Guideline for Occupied Buildings Under Construction 2007.

**1.3        ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4        DELIVERY, STORAGE AND HANDLING**

- .1        Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2        Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

- 
- .3 Storage and Handling Requirements:
    - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
    - .2 Store and protect metal ducts from nicks, scratches, and blemishes.
    - .3 Replace defective or damaged materials with new.
  - .4 Develop Construction Waste Management Plan related to Work of this Section.
  - .5 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **Part 2 Products**

### **2.1 SEAL CLASSIFICATION**

- .1 Classification as follows:

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

- .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.

### **2.2 SEALANT**

- .1 Sustainability Characteristics:
  - .1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.
  - .2 Adhesives and sealants: VOC limit 250 g/L maximum to GS-36.
- .2 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

### **2.3 TAPE**

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

### **2.4 DUCT LEAKAGE**

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



---

**2.5 FITTINGS**

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
  - .1 Rectangular: centreline radius: 1.5 times width of duct.
  - .2 Round: smooth radius, five piece, centreline radius: 1.5 times diameter.
- .3 Transitions:
  - .1 Diverging: 20 degrees maximum included angle.
  - .2 Converging: 30 degrees maximum included angle.
- .4 Offsets:
  - .1 As indicated, Full radiused elbows.

**2.6 GALVANIZED STEEL**

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

**2.7 HANGERS AND SUPPORTS**

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

**Part 3 Execution****3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metal duct installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

**3.2 GENERAL**

- .1 Do work in accordance with NFPA 90A, NFPA 90B, SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
  - .1 Insulate strap hangers 100 mm beyond insulated duct.

**3.3 SEALING AND TAPING**

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

**3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1        General****1.1        RELATED REQUIREMENTS**

- .1        Section 23 05 00 – Common Work Results for HVAC.
- .2        Section 23 31 13.01 – Metal Ducts – Low Pressure to 500 PA.

**1.2        REFERENCES**

- .1        Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1        SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

**1.3        ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2        Indicate:
    - .1        Duct access doors.

**1.4        DELIVERY, STORAGE AND HANDLING**

- .1        Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2        Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3        Storage and Handling Requirements:
  - .1        Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2        Store and protect air duct accessories from nicks, scratches, and blemishes.
  - .3        Replace defective or damaged materials with new.
- .4        Develop Construction Waste Management Plan related to Work of this Section.
- .5        Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan, Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

---

**Part 2 Products****2.1 GENERAL**

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

**2.2 ACCESS DOORS IN DUCTS**

- .1 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .2 Gaskets: neoprene.
- .3 Hardware:
  - .1 Re-use existing access doors.

**Part 3 Execution****3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air duct accessories installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

**3.2 INSTALLATION**

- .1 Access Doors:
  - .1 Size:
    - .1 Re-install existing access door.
  - .2 Locations:
    - .1 See drawings.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**

