

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Use of mechanical systems during construction.
- .2 Division 1 – General Requirements.
- .3 Section 21 05 01 – Common Work Results for Mechanical.

1.2 USE OF SYSTEMS

- .1 Use of new permanent heating and or ventilating systems for supplying temporary heat or ventilation is permitted only under following conditions:
 - .1 Entire system is complete, pressure tested, cleaned, flushed out.
 - .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
 - .3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
 - .4 There is no possibility of damage.
 - .5 Supply ventilation systems are protected by 60% filters, inspected daily, changed every week or more frequently as required.
 - .6 Return systems have approved filters over openings, inlets, outlets.
 - .7 Systems will be:
 - .1 Operated as per manufacturer's recommendations and instructions.
 - .2 Operated by Contractor.
 - .3 Monitored continuously by Construction Manager.
 - .8 Warranties and guarantees are not relaxed.
 - .9 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Construction Manager.
 - .10 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.
- .2 Filters specified in this Section are over and above those specified in other Sections of this project.
- .3 Exhaust systems are not included in approvals for temporary heating ventilation.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 07 84 00 – Firestopping.
- .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.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – General Requirements.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to approved metal recycling facility.

Part 2 Products

2.1 NOT USED

- .1 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 or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.2 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 and components.

3.3 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.
- .4 Drain valves: NPS 3/4 ball valves unless indicated otherwise, with hose end male thread, cap and chain.

3.4 AIR VENTS

- .1 Install automatic air vents at high points in piping systems.
- .2 Install isolating valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.

3.5 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.

3.6 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

- .7 Install concealed pipework to minimize furring space, maximize headroom and conserve space.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .10 Group piping wherever possible and as indicated.
- .11 Ream pipes, remove scale and other foreign material before assembly.
- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion as indicated.
- .14 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless otherwise indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use ball or butterfly valves at branch take-offs for isolating purposes except where otherwise specified.
 - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .8 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .15 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

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: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and un-insulated pipe or between sleeve and insulation.

- .5 Installation:
 - .1 Concrete, masonry walls and concrete floors on grade: Terminate flush with finished surface.
 - .2 Other floors: Terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
 - .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.8 ESCUTCHEONS

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

3.9 PREPARATION FOR FIRESTOPPING

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 – Firestopping.
- .2 Un-insulated unheated pipes not subject to movement: No special preparation.
- .3 Un-insulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

3.10 FLUSHING OUT OF PIPING SYSTEMS

- .1 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 Division 01 – General Requirements supplemented as specified in relevant sections of Division 21, 22, 23 and 25.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Engineer and/or Departmental Representative 48 hours' minimum prior to performance of pressure tests.
- .2 Pipework: Test as specified in relevant sections of Divisions 22 and 23.
- .3 Maintain specified test pressure without loss for 12 hours minimum unless specified for longer period of time in relevant sections of Division 22 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 Engineer and/or Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Engineer and/or Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Engineer and/or Departmental Representative.

3.12 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Engineer and/or Departmental Representative.
- .2 Request written approval 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 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 05 17.

1.2 RELATED SECTIONS

- .1 Division 01 – General Requirements.

1.3 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
 - .1 ANSI/ASME B31.1-1998, Power Piping.
 - .2 ANSI/ASME B31.3-2000 Process Piping Addenda A.
 - .3 ANSI/ASME B31.3-2001 Process Piping Addenda B.
 - .4 ANSI/ASME Boiler and Pressure Vessel Code-1998:
 - .1 Section I: Power Boilers.
 - .2 Section V: Non-destructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA):
 - .1 ANSI/AWWA C206-97 Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS):
 - .1 AWS C1.1-2000, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-1999, Safety Welding, Cutting and Allied Process.
 - .3 AWS W1-2000, Welding Inspection Handbook.
- .4 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-48.2-92, Spot Radiography of Welded Butt Joints in Ferrous Materials.
- .5 Canadian Standards Association (CSA International):
 - .1 CSA W47.1-2009.
 - .2 CSA W47.2-M1987 (R1998), Certification of Companies for Fusion Welding of Aluminum.
 - .3 CSA W48 series-01, Filler Metals and Allied Materials for Metal Arc Welding.
 - .4 CSA B51-97, Boiler, Pressure Vessel and Pressure Piping Code.
 - .5 CSA-W117.2-01, Safety in Welding, Cutting and Allied Processes.
 - .6 CSA W178.1-02, Certification of Welding Inspection Organizations.
 - .7 CSA W178.2-01, Certification of Welding Inspectors.

1.4 QUALIFICATIONS

- .1 Welders:
 - .1 Welding qualifications in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Furnish welder's qualifications to Architect of Record.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
 - .5 Certification of companies for fusion welding of steel in accordance with CSA W47.1.
 - .6 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
- .2 Inspectors:
 - .1 Inspectors qualified to CSA W178.2.

1.5 QUALITY ASSURANCE

- .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.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – General Requirements.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility as approved by Engineer.

Part 2 Products

2.1 ELECTRODES

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

Part 3 Execution

3.1 WORKMANSHIP

- .1 Welding: in accordance with ANSI/ASME B31.1, 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.

3.2 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.

3.3 INSPECTION AND TESTS - GENERAL REQUIREMENTS

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Provincial Authority before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Governmental Authorities.
- .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.

3.4 SPECIALIST EXAMINATIONS AND TESTS

- .1 General:
 - .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Provincial Authority.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - .3 Inspect and test 10% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests.
- .2 Hydrostatically test welds to requirements of 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 Governmental Authorities of up to 10% of welds, selected at random.

3.5 DEFECTS CAUSING REJECTION

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

3.6 REPAIR OF WELDS WHICH FAILED TESTS

- .1 Re-inspect and re-test repaired or re-worked welds.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 05 19 01.

1.2 SECTION INCLUDES

- .1 Materials and installation for thermometers and pressure gauges in piping systems.

1.3 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 53.01 - Mechanical Identification.

1.4 REFERENCES

- .1 American Society of Mechanical Engineers (ASME):
 - .1 ASME B40.100-01, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200-01, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.5 SUBMITTALS

- .1 Submittals in accordance with Division 01 – General Requirements.
- .2 Submit shop drawings and product data.
- .3 Submit manufacturer's product data for following items:
 - .1 Thermometers.
 - .2 Pressure gauges.
 - .3 Stop cocks.
 - .4 Syphons.
 - .5 Wells.

Part 2 Products

2.1 GENERAL

- .1 Design point to be at mid point of scale or range.
- .2 Ranges:
 - .1 Heating water: 0-180°C.

2.2 DIRECT READING THERMOMETERS (HVAC PIPING)

- .1 Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB14.4 and ASME B40.200.

2.3 THERMOMETER WELLS

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass or stainless steel.
- .3 Install thermowells for HVAC controls division where indicated, including bushings and fittings as required.

2.4 PRESSURE GAUGES (HVAC PIPING)

- .1 115 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.
- .2 Provide:
 - .1 Siphon for steam service.
 - .2 Diaphragm assembly for corrosive service.
 - .3 Gasketed pressure relief back with solid front.
 - .4 Bronze stop cock.

Part 3 Execution

3.1 GENERAL

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.
- .3 Install where shown on drawings.

3.2 THERMOMETERS

- .1 Install in wells on piping. Provide heat conductive material inside well.
- .2 Install in locations as indicated.
- .3 Install wells as indicated for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

- .1 Install in following locations:
 - .1 Suction and discharge of pumps.

- .2 Upstream and downstream of PRV's.
 - .3 Upstream and downstream of control valves.
 - .4 Inlet and outlet of coils and/or heat exchangers.
 - .5 In other locations as indicated.
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- .2 Install gauge cocks for balancing purposes, elsewhere as indicated.
 - .3 Use extensions where pressure gauges are installed through insulation.

3.4 NAMEPLATES

- .1 Install engraved lamicoid nameplates as specified in Section 23 05 53.01 - Mechanical Identification, identifying medium.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 05 23.01.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Bronze - valves.
- .2 Sustainable requirements for construction and verification. Refer to General Specs.
- .3 Related Sections:
 - .1 Division 01 – General Requirements
 - .2 Section 23 05 05 - Installation of Pipework.

1.3 REFERENCES

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME):
 - .1 ANSI/ASME B1.20.1-1983 (R2001), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM A276-04, Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283-99a, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-02, Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
 - .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-2003, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
 - .4 ASTM B584-00, Specification for Copper Alloy Sand Castings for General Applications.

1.4 SUBMITTALS

- .1 Submittals: in accordance with Division 01 – General Requirements.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets:
 - .1 Submit shop drawings and product data in accordance with Division 01 – General Requirements.

.2 Submit data for valves specified in this section.

.3 Closeout Submittals:

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

1.5 QUALITY ASSURANCE

.1 Health and Safety:

.1 Construction occupational health and safety in accordance with Division 01 – General Requirements.

.2 All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

1.6 DELIVERY STORAGE AND DISPOSAL

.1 Waste Management and Disposal:

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

.2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

1.7 MAINTENANCE

.1 Provide Maintenance Data.

Part 2 Products

General Note: All components used for the domestic water system shall be lead-free.

2.1 MATERIALS

.1 Sustainable Requirements:

.1 Materials and resources in accordance with Division 01 – General Requirements.

.2 Valves:

.1 Except for specialty valves, to be single manufacturer.

.2 All products to have CRN registration numbers.

.3 Install extension stems for insulated piping.

.3 End Connections:

.1 Connection into adjacent piping/tubing:

.1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.

.2 Copper tube systems: Solder ends to ANSI/ASME B16.18.

.1 Grooved ends to copper tube dimensions and CSA B242.

- .4 Lock shield Keys:
 - .1 Where lock shield valves are specified, provide 2 spare keys of each size to the users: malleable iron cadmium plated.

- .5 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: in accordance with MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc re-grindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel.
 - .3 NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, re-grindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel.
 - .4 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: Handwheel.
 - .5 Angle valve, NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in slip on easily removable disc holder having integral guides, re-grindable bronze seat, loosely secured to stem.
 - .3 Operator: Handwheel.

- .6 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.

- .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: re-grindable.
- .3 NPS 2 and under, swing type, bronze disc:
 - .1 Body: Y pattern with integral seat at 45 degrees, screw in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two piece hinge disc construction; seat: re-grindable.
- .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y pattern with integral seat at 45 degrees, screw in cap with hex head.
 - .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two piece hinge disc construction.
- .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
- .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .7 Silent Check Valves:
 - .1 NPS 2 and under:
 - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends in accordance with ANSI B1.20.1 and with hex shoulders.
 - .4 Disc and seat: renewable rotating disc.
 - .5 Stainless steel spring, heavy duty.
 - .6 Seat: re-grindable.
- .8 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze in accordance with ASTM B62.
 - .2 Pressure rating: Class 125.
 - .3 Connections: Screwed ends in accordance with ANSI B1.20.1 and with hexagonal shoulders.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.

- .9 Butterfly Valves:
 - .1 NPS 2-1/2 through NPS 6:
 - .1 Body: cast bronze per CDA-836 (85-5-5-5).
 - .2 Pressure rating: 2065-kPa CWP.
 - .3 Connections: copper tube dimensioned grooved ends.
 - .4 Disc: ductile iron per ASTM A536 with elastomer coating.
 - .5 Stem: integrally cast with disc.
 - .6 Stem Nuts: nickel plated 416 stainless steel.
 - .7 Operator: lever operator.
 - .8 Victaulic Series 608.

Part 3 Execution

3.1 INSTALLATION

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

3.2 VERIFICATION

- .1 Verification requirements in accordance with Division 01 – General Requirements, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Local/regional materials.
 - .6 Low-emitting materials.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 05 23 02.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Valves, gate, globe, and check.
- .2 Sustainable requirements for construction and verification.
- .3 Related Sections:
 - .1 Division 01 – General Requirements.
 - .2 Section 23 05 05 - Installation of Pipework.

1.3 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME):
 - .1 ANSI/ASME B 16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A 49-01, Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A 126-95 (2001), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM B 61-93, Specification for Steam or Valve Bronze Castings.
 - .4 ASTM B 62-93, Specification for Composition Bronze or Ounce Metal Castings.
 - .5 ASTM B 85-03, Specification for Aluminum-Alloy Die Castings.
 - .6 ASTM B 209-04, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
 - .1 MSS SP-70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS SP-71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .3 MSS SP-82-1992, Valve Pressure Testing Methods.
 - .4 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.4 SUBMITTALS

- .1 Submittals in accordance with Division 01 – General Requirements.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets:
 - .1 Submit shop drawings and product data in accordance with Division 01 – General Requirements.

- .2 Submit data for valves specified in this section.
- .3 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Division 01 – General Requirements.
- 1.5 QUALITY ASSURANCE**
 - .1 Health and Safety:
 - .1 Construction occupational health and safety in accordance with Division 01 – General Requirements.
- 1.6 DELIVERY STORAGE AND DISPOSAL**
 - .1 Waste Management and Disposal:
 - .1 Separate and recycle waste materials in accordance with Division 01 – General Requirements.
 - .2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- 1.7 MAINTENANCE**
 - .1 Extra Materials:
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.
- Part 2 Products**
 - 2.1 MATERIAL**
 - .1 Sustainable Requirements:
 - .1 Materials and resources in accordance with Division 01 – General Requirements.
 - .2 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
 - .3 Standard specifications:
 - .1 Gate valves: MSS SP-70.
 - .2 Globe valves: MSS SP-85.
 - .3 Check valves: MSS SP-71.
 - .4 Requirements common to valves, unless specified otherwise:
 - .1 Body, bonnet: cast iron in accordance with ASTM B209 Class B.

- .2 Connections: flanged ends with 2 mm raised face with serrated finish to ANSI B16.1.
 - .3 Inspection and pressure testing: in accordance with MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Handwheel: Die-cast aluminum alloy in accordance with ASTM B85 or malleable iron to ASTM A49. Nut of bronze in accordance with ASTM B62.
 - .9 Identification tag: with catalogue number, size and other pertinent data.
- .5 All products to have CRN registration numbers.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly. Class 125.
 - .2 Disc: solid offset taper wedge, bronze in accordance with ASTM B62.
 - .3 Seat rings: renewable bronze in accordance with ASTM B62, screwed into body.
 - .4 Stem: bronze to ASTM B62.
 - .5 Disc: solid offset taper wedge, cast iron in accordance with ASTM A126 Class B, secured to wrought steel stem.
 - .6 Seat: Integral with body.
 - .7 Stem: wrought steel.
 - .8 Operator: Handwheel.
- .2 NPS 2 1/2 - 8, outside screw and yoke (OS&Y), bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
 - .3 Seat rings: renewable bronze screwed into body.
 - .4 Stem: nickel-plated steel.
 - .5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
 - .6 Seat rings: integral with body.
 - .7 Stem: nickel-plated steel.
 - .8 Pressure-lubricated operating mechanism.
 - .9 Operator: Handwheel.

2.3 UNDERWRITERS APPROVED GATE VALVE

- .1 NPS 2 1/2 - 14, OS&Y:
 - .1 Approvals: UL and FM approved for fire service.
 - .2 UL and FM Label: on valve yoke.
 - .3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses in accordance with ANSI B16.1 and ULC 262 (B).
 - .4 Bonnet bushing, yoke sleeve: bronze, in accordance with FM requirements.
 - .5 Packing gland: bronze.
 - .6 Stem: manganese bronze. Diameter in accordance with ULC C-262 (B).
 - .7 Stuffing box dimensions, gland bolt diameter: in accordance with ULC C-262 (B).
 - .8 Bosses for bypass valve, drain: on NPS 4 and over.
 - .9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: cast iron with bronze disc rings.
 - .10 Disc seat ring: self-aligning, Millwood undercut on NPS 3 - 12.
 - .11 Pressure rating:
 - .1 NPS 2-1/2 - 12: 1.7 Mpa CWP.
 - .2 NPS 14-1.2: 1.2 MPa CWP.
 - .12 Operator: handwheel.
 - .13 Bypass: complete with union and NPS globe valve as Section 23 05 23.01 - Valves - Bronze.

2.4 GLOBE VALVES

- .1 NPS 2 1/2 - 10, OSY:
 - .1 Body: with multiple-bolted bonnet.
 - .2 WP: 860 kPa steam, 1.4 MPa CWP.
 - .3 Bonnet-yoke gasket: non-asbestos.
 - .4 Disc: bronze in accordance with ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
 - .5 Seat ring: renewable, re-grindable and screwed into body.
 - .6 Stem: bronze in accordance with ASTM B62.
 - .7 Operator: Handwheel.

2.5 VALVE OPERATORS

- .1 Install valve operators as follows: Actuators: To Division 25, EMCS.

2.6 CHECK VALVES

- .1 Swing check valves, Class 125:
 - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Flanged ends: plain faced with smooth finish.
 - .1 Up to NPS 16: cast iron in accordance with ASTM A126 Class B.
 - .2 NPS 18 and over: cast iron in accordance with ASTM A126 Class C.

- .2 Ratings:
 - .1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.
 - .2 NPS 14 - 16: 860 kPa steam; 1.03 MPa CWP.
 - .3 NPS 18 and over: 1.03 MPa CWP.
- .3 Disc: rotating for extended life.
 - .1 Up to NPS 6: bronze in accordance with ASTM B 62.
 - .2 NPS 8 and over: bronze-faced cast iron.
- .4 Seat rings: renewable bronze in accordance with ASTM B62 screwed into body.
- .5 Hinge pin, bushings: renewable bronze to ASTM B62.
- .6 Disc: A126 Class B, secured to stem, rotating for extended life.
- .7 Seat: cast iron, integral with body.
- .8 Hinge pin: exelloy; bushings: malleable iron.
- .9 Identification tag: fastened to cover.
- .10 Hinge: galvanized malleable iron.

2.7 SILENT CHECK VALVES

- .1 Construction:
 - .1 Body: malleable with integral seat.
 - .2 Pressure rating: class 125, WP = 860 kPa.
 - .3 Connections: grooved ends.
 - .4 Disc: bronze renewable rotating disc.
 - .5 Seat: renewable, EPDM.
 - .6 Stainless steel spring, heavy duty.

2.8 GROOVED END BUTTERFLY VALVES

- .1 Butterfly valves: in accordance with MSS-SP-67 Application: Isolating cells or section of multiple component equipment (e.g. multi-section coils, multi-cell cooling towers):
 - .1 NPS2" and over: Grooved ends.
 - .2 300 Psi WOG / 2068 kPa and be both bi-directional and dead end service capable to full rated pressure. Ductile iron body with blow –out proof stainless steel stems and nickel coated ductile iron disc. Seat shall be “EPDM” and have a full 360* continuous contact with the seating surface.
 - .3 Valve Operators: (Lever) or (Gear).

Part 3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Grooved end valves are acceptable on the hydronic system piping greater than NPS 2-1/2 and up to 82.2°C (180°F).

- .3 Grooved end valves to be supplied by the same manufacture of the grooved fittings.
- .4 Grooved end “valves” shall be installed in accordance with the manufacturer’s written installation instructions. Grooved ends shall be clean and free from indentations, projections. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be moulded and produced by the coupling manufacturer. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for Contractor’s field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer’s representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed by the Engineer to be improperly installed.

3.2 VERIFICATION

- .1 Verification requirements in accordance with Division 01 – General Requirements, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Local/regional materials.
 - .6 Low-emitting materials.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 05 29.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.
 - .2 Sustainable requirements for construction and verification.

1.3 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
 - .1 ANSI/ASME B31.1-04, Power Piping.
- .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A125-1996 (R2001), Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-04, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-04a, Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM).
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):
 - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6 Underwriter's Laboratories of Canada (ULC).

1.4 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
 - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP 58.

- .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

1.5 SUBMITTALS

- .1 Submittals: in accordance with Division 01 – General Requirements
- .2 Submit shop drawings and product data for following items:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .3 Quality assurance submittals: submit following in accordance with Division 01 – General Requirements:
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manuals in accordance with Division 01 – General Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Division 01 – General Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

Part 2 Products

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

- .3 All hangers must be outside insulation.

2.2 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Use electro-plating galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 9 mm UL listed.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved to MSS SP69.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed in accordance with MSS SP69.
- .5 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies.
 - .2 Steel brackets.
 - .3 Sway braces for seismic restraint systems.
 - .4 Pipe Racks.
- .6 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22mm or 28 mm rod.
- .7 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .2 Attachments for copper piping: copper plated black steel.

- .3 Use insulation shields for hot pipework.
- .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material in accordance with MSS SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis:
 - .1 Ensure "U" has hole in bottom for riveting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 U-bolts: carbon steel in accordance with MSS SP69 with 2 nuts at each end to ASTM A563:
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.3 RISER CLAMPS

- .1 Steel or cast iron pipe: black carbon steel in accordance with MSS SP58, type 42, UL listed.
- .2 Copper pipe: carbon steel copper plated in accordance with MSS SP58, type 42.
- .3 Bolts: in accordance with ASTM A307.
- .4 Nuts: in accordance with ASTM A563.

2.4 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield in accordance with MSS SP69, galvanized sheet steel. Length designed for maximum 3 m span, min. 300 mm long.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.5 EQUIPMENT SUPPORTS

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

2.6 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

- .1 Provide templates to ensure accurate location of anchor bolts.

2.7 HOUSE-KEEPING PADS

- .1 Contractor shall provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.

- .2 Housekeeping pads to be constructed as per details and specifications

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps and elsewhere as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
- .4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

- .5 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	
8	5.7 m	
10	6.6 m	
12	6.9 m	

- .6 Pipework greater than NPS 12: in accordance with MSS SP69.

3.4 HANGER INSTALLATION

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

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
- .1 Ensure that rod is vertical under operating conditions.
- .2 Equalize loads.
- .2 Adjustable clevis:
- .1 Tighten hanger load nut securely to ensure proper hanger performance.
- .2 Tighten upper nut after adjustment.
- .3 Cut-off excess rod (25 mm maximum after nut).
- .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.

3.7 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports in accordance with Division 01 – General Requirements.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .2 Verification requirements in accordance with Division 01 – General Requirement, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.
 - .7 Certified wood.
 - .8 Low-emitting materials.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Vibration isolation materials and components and their installation.

1.2 SCOPE OF WORK

- .1 All mechanical equipment, piping and ductwork as indicated on the drawings or as noted in the specifications shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
- .2 All vibration isolators described in this section or supplied by a single trade shall be the product of a single manufacturer and shall be certified by the manufacturer. Items supplied by each trade in Specification Section 23 05 48 – Vibration Controls for Piping and Equipment shall be supplied by same supplier.
- .3 Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.
- .4 The work in this section includes, but is not limited to the following:
 - .1 Vibration isolation for piping, ductwork and equipment.
 - .2 Equipment isolation bases.
 - .3 Flexible piping connections.

1.3 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA):
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems.
- .3 National Building Code of Canada (NBC) – 2010.

1.4 SUBMITTALS

- .1 Submittals: in accordance with Division 01 – General Requirements:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Division 01 – General Requirements. Include product characteristics, performance criteria, and limitations:
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Division 01 – General Requirements.
 - .2 Indicate VOC's for all adhesives and solvents during application and curing.

- .2 Quality assurance submittals: submit following in accordance with Division 01 – General Requirements:
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.
 - .4 Manufacturer's Field Reports: manufacturer's field reports specified.

1.5 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Division 01 – General Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Division 01 – General Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

1.7 MANUFACTURER'S RESPONSIBILITY

- .1 Manufacturer's Responsibility:
 - .1 Manufacturer of vibration isolation equipment shall have the following responsibilities:
 - .1 Determine vibration isolation restraint sizes and locations.
 - .2 Provide vibration isolation as scheduled or specified.
 - .3 Provide calculations and materials if required for restraint of un-isolated equipment.
 - .4 Provide installation instructions, drawings and trained field supervision to ensure proper installation and performance.

1.8 RELATED WORK

- .1 Supplementary Support Steel:
 - .1 Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. as required.
- .2 Attachments:
 - .1 Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Division 01 – General Requirements.

2.2 GENERAL

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

2.3 NEOPRENE PAD ISOLATORS

- .1 Two layers of 19mm thick neoprene pad consisting of 50mm square waffle modules separated horizontally by a 1.5mm gauge galvanized shim. Load distribution plates shall be used as required.

2.4 NEOPRENE MOUNT

- .1 Bridge-bearing neoprene mountings shall have a minimum static deflection of 5mm and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing moulded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Pre-approval Number from a recognized government agency verifying the maximum certified horizontal and vertical load ratings.

2.5 SHEET METAL SUPPORT ATTACHMENT ISOLATORS

- .1 Neoprene bushing cushioned between 2 steel sleeves. Steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. All neoprene shall be bridge bearing quality.

2.6 OPEN SPRING ISOLATORS

- .1 Spring isolators shall be free standing and laterally stable without any housing and complete with a moulded neoprene cup or 6mm neoprene acoustical friction pad between the base plate and the support. All mountings shall have levelling bolts that must be rigidly bolted to the equipment.
- .2 Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

2.7 RESTRAINED SPRING ISOLATORS

- .1 Restrained spring mountings shall have a mounting as described in Paragraph 2.7, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. A minimum clearance of 12mm shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation.

Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces.

- .2 Mountings shall have Anchorage Pre-approval Number from a recognized government agency certifying the maximum certified horizontal and vertical load ratings.

2.8 HOUSED SPRING ISOLATORS

- .1 Spring mountings as described in Paragraph 2.7 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 6mm travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Pre-approval number from a recognized government agency verifying the maximum certified horizontal and vertical load ratings.

2.9 SPRING AND NEOPRENE HANGERS

- .1 Hangers shall consist of rigid steel frames containing minimum 32mm thick neoprene elements at the top and a steel spring with general characteristics as described in Paragraph 2.7 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the rod bushing and short circuiting the spring.

2.10 STRUCTURAL STEEL BASE

- .1 Provide integral structural steel bases to maintain alignment of component parts (motors, drives, equipment, and isolators) and to support equipment, vibration isolation and seismic restraint devices. Pump bases for split case pump shall include supports for suction and discharge elbows.
- .2 All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 350 mm provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 25 mm.
- .3 Type B1 – Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.
- .4 Type B2 – Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.
- .5 Bases to clear housekeeping pads by 25 mm minimum.

2.11 METAL FLEXIBLE HOSES

- .1 Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 75mm and larger shall be flanged. Smaller sizes shall have male nipples. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.

2.12 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

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

2.13 HORIZONTAL THRUST RESTRAINT

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

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 All vibration isolators systems must be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
- .2 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.
- .5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.
- .6 At locations where seismic restraints are located, the support rods must be braced when necessary to accept compressive loads with Hanger Seismic Restrain Clamps.
- .7 At all locations where seismic restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with Clevis Seismic Braces.

- .8 Vibration isolation manufacturer shall furnish integral structural steel bases or reinforced concrete inertia bases as required. Independent steel rails are not permitted on this project.
- .9 Use In-Line Pump Securement Brackets for in-line pump installation.
- .10 Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight by Horizontal thrust restraints.
- .11 Locate isolation hangers as near to the overhead support structure as possible.

3.3 VIBRATION ISOLATION OF PIPING

- .1 Horizontal pipe isolation:
 - .1 The first three pipe hangers in the main lines near the mechanical equipment shall be pre-compressed Spring and Neoprene Hangers.
 - .2 This type of pre-compressed spring hangers must also be used in all transverse braced isolated locations. Brace hanger rods with seismic restraint clamps. Horizontal runs in all other locations throughout the building shall be isolated by Spring and Neoprene Hangers. Floor supported piping shall rest on Restrained Spring Isolators. The first pipe support isolators from the isolated equipment will have the static deflection twice the deflection as specified for the mountings under the connected equipment and 25mm deflection for pipe support isolators thereafter.
 - .3 Provide spring isolators for pipe support at first three supports for piping up to NPS 4; first four supports.
 - .4 Where piping connects to mechanical equipment install Metal Flexible Hoses. Isolate, with acoustic barrier material, at anchors and guides within pipe shafts, duct shafts, equipment and fan rooms, and up to first anchor outside these rooms or areas.
- .2 Riser Isolation:
 - .1 Risers shall be suspended from Spring and Neoprene Hangers or supported by Open Spring Isolators, anchored with Acoustical Pipe Anchors, and guided with Acoustical Pipe Guides. Steel springs shall be a minimum of 19mm except in those expansion locations where additional deflection is required to limit load changes to $\pm 25\%$ of the initial load.

3.4 VIBRATION ISOLATION OF DUCTWORK

- .1 All discharge runs for a distance of 15m from the connected equipment shall be isolated from the building structure by means of Spring and Neoprene Hangers or Open Spring Isolators. Spring deflection shall be a minimum of 19mm.
- .2 All duct runs having air velocity of 5 m/s or more shall be isolated from the building structure by specification Pre-compressed Spring and Neoprene Hangers or Open Spring Isolators. Spring deflection shall be a minimum of 19mm.

3.5 LIFE SAFETY SYSTEMS

- .1 All mechanical equipment shall be vibration isolated and seismically restrained.

3.6 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After preparatory work is complete but before installation commences.
 - .2 Twice during the installation, at 25% and 60% completion stages.
 - .3 Upon completion of installation.
 - .3 Submit manufacturer's reports to Departmental representative and Engineer within 3 days of manufacturer representative's review.
 - .4 Make adjustments and corrections in accordance with written report.
- .2 Inspection and Certification:
 - .1 Experienced and competent sound and vibration testing company to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .2 Take vibration measurements for equipment as per Manufacturer's recommendations.
 - .3 Provide Departmental representative and Engineer with notice 24 h in advance of commencement of tests.
 - .4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
 - .5 Submit complete report of test results.
- .3 Verification requirements in accordance with Division 01 – General Requirements.

3.7 CLEANING

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

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 05 53 01.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Materials and requirements for the identification of piping systems, valves and controllers, including the installation and location of identification systems.
 - .2 Sustainable requirements for construction and verification.

1.3 REFERENCES

- .1 Canadian Gas Association (CGA):
 - .1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA):
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems.

1.4 SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Division 01 – General Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.
 - .2 Dispose of unused paint, coating material at official hazardous material collections site.

- .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 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer. Metal plates shall be provided for all for equipment operating over 60°C (140°F).
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 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	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.
 - .3 All other equipment: use size #5.

- .5 Equipment Identification:
 - .1 The contractor shall supply and install tags for each piece of equipment.

2.3 EXISTING IDENTIFICATION SYSTEMS

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

2.4 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Sprinklers: in accordance with NFPA 13.

2.5 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 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°C and intermittent temperature of 200°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
Hot Water Heating Supply	Yellow	HEATING SUPPLY
Hot Water Heating Return	Yellow	HEATING RETURN
Natural Gas	To Codes	-
Gas Regulator	To Codes	-
Vent		
Domestic Cold Water Supply	Green	DOM. COLD WATER
Make-up Water	Green	MAKE-UP WTR.
Trap Primer	Green	TRAP PRIMER
Sanitary	Green	SAN
Plumbing Vent	Green	VENT
Fire protection water	Red	FIRE PROT. WTR.
Sprinklers	Red	SPRINKLERS
Conduit for Low Voltage	To Section 25	

2.6 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high. Identify associated system and service.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.
- .3 Identify Supply/Exhaust/Return System with labels as indicated on Mechanical Drawings prepared as part of Existing Design e.g. "RTU-1 Supply"
- .4 Identify "Supply/Return/Exhaust" systems with directional arrows as indicated e.g. "RTU-1 Supply".

2.7 VALVES, CONTROLLERS

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

2.8 CONTROLS COMPONENTS IDENTIFICATION

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

2.9 LANGUAGE

- .1 Identification in English.

2.10 CEILINGS

- .1 Identify equipment and valve location on ceiling or access doors.
- .2 Tags shall be engraved, laminate, colored to match the services plastic.
- .3 Size: 20 mm x 50 mm.

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 TIMING

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

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and/or CSA registration plates as required by respective agency.
- .3 Identify systems, equipment to conform to users requirements.

3.4 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.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

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

3.6 VALVES, CONTROLLERS

- .1 Valves and operating controllers, except at plumbing fixtures, radiators, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

3.7 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Division 01 – General Requirements, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.

- .6 Local/regional materials.
- .7 Certified wood.
- .8 Low-emitting materials.

3.8 CLEANING

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

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 05 93.

1.2 SUMMARY

- .1 "TAB" is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.3 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Engineer within 90 days of Execution Date.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing - 2002.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract:
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 PURPOSE OF TAB

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

1.5 EXCEPTIONS

- .1 TAB of systems and equipment regulated by Governmental Authorities shall be to satisfaction of such Governmental Authorities.

1.6 CO-ORDINATION

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

1.7 PRE-TAB REVIEW

- .1 Review Contract Documents before Construction Work is started and confirm in writing to Architect of Record adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative and Engineer in writing proposed procedures which vary from this Section.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.8 START-UP

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

1.9 OPERATION OF SYSTEMS DURING TAB

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

1.10 START OF TAB

- .1 Notify Engineer 14 days prior to start of TAB.
- .2 Start TAB when project is Substantially Complete. TAB shall include, without limitation:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weather stripping, sealing, and caulking.
 - .3 Pressure, leakage, other tests specified elsewhere Division 23.
 - .4 Provisions for TAB installed and operational.
- .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .9 Duct system leakage test is complete.
 - .10 HVAC controls system complete, operational.
 - .3 Water systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.
 - .7 HVAC controls system complete, operational.

1.11 APPLICATION TOLERANCES

- .1 Perform TAB to following tolerances of design values:
 - .1 HVAC systems: plus or minus 5%.
 - .2 Hydronic systems: plus or minus 10%.

1.12 ACCURACY TOLERANCES

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

1.13 INSTRUMENTS

- .1 Prior to TAB, submit to Engineer list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 28 days of TAB. Provide certificate of calibration to Engineer.

1.14 SUBMITTALS

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

1.15 PRELIMINARY TAB REPORT

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

1.16 TAB REPORT

- .1 Submit format for approval with referenced standard.
- .2 TAB report to show results in English units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit 4 bound copies of TAB Report in English to Departmental Representative and Engineer for verification and approval.

1.17 VERIFICATION

- .1 Reported results subject to verification by Engineer.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Engineer.
- .4 Repeat TAB as required to satisfaction of Departmental Representative and Engineer.

1.18 SETTINGS

- .1 After TAB is completed to satisfaction of Departmental Representative and Engineer, replace drive guards, close access doors, lock devices in set positions and ensure sensors are at required settings.

- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.19 COMPLETION OF TAB

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

1.20 AIR SYSTEMS

- .1 Standard: TAB to AABC, SMACNA and ASHRAE.
- .2 Do TAB of systems, equipment, components, controls specified Division 23 following systems, equipment, components, controls:
 - .1 Terminal Units.
 - .2 All grilles and diffusers as indicated.
 - .3 Fans.
- .3 Qualifications: personnel performing TAB/current member in good standing of AABC qualified to standards of AABC.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dew point), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.21 HYDRONIC SYSTEMS

- .1 Standard: TAB to most stringent of this section of TAB standards of AABC, NEBB, SMACNA and ASHRAE.
- .2 Qualifications: personnel performing TAB current member in good standing of AABC.
- .3 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
- .4 Measurements: to include as appropriate for systems, equipment, components, controls: flow, pressure, temperature, specific gravity, RPM, electrical power (voltage current draw).

- .5 Locations of equipment measurements: to include as appropriate:
 - .1 Pumps, Control valves and other auxiliary equipment.
 - .2 At controllers, controlled device.
- .6 Locations of system measurements to include as appropriate.

1.22 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.
- .2 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Division 01 – General Requirements.
- .2 Specification Section 21 05 01 – Common Work Results for Mechanical.
- .3 Related Sections:
 - .1 Section 23 31 13 01 – Metal Ducts – Low Pressure to 500 Pa.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA):
 - .1 SMACNA HVAC Air Duct Leakage Test Manual, 1985.

1.3 SUBMITTALS

- .1 Make submittals in accordance with Division 01 – General Requirements.
- .2 Co-ordinate submittal requirements and provide submittals in accordance with Division 01 – General Requirements.
- .3 Test Reports: submit certified test reports from approved testing agency indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:
 - .1 Submit proposed report form and test report format to Engineer for approval at least one month before proposed date of first series of tests. Do not start tests until approval received in writing from Engineer.
 - .2 Prepare report of results and submit to Engineer within 24 hours of completion of tests. Include:
 - .1 Schematic of entire system.
 - .2 Schematic of section under test showing test site.
 - .3 Required and achieved static pressures.
 - .4 Orifice differential pressure at test sites.
 - .5 Permissible and actual leakage flow rate (L/s) for test sites.
 - .6 Witnessed certification of results.
 - .3 Include test reports in final TAB report.

1.4 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning on-site installations in accordance with Division 01 – General Requirements:

- .1 Verify project requirements.
- .2 Review installation and substrate conditions.
- .3 Co-ordination with other building sub-trades.
- .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Division 01 – General Requirements.
- .3 Sustainable Requirements:
 - .1 Construction requirements: in accordance with Division 01 – General Requirements.
 - .2 Verification: contractor's verification in accordance with Division 01 – General Requirements.

1.5 TESTING AGENCY

- .1 TAB Contractor on this project.

Part 2 Products

2.1 TEST INSTRUMENTS

- .1 Test apparatus to include:
 - .1 Fan capable of producing required static pressure.
 - .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
 - .3 Flow measuring instrument compatible with the orifice plate.
 - .4 Calibration curves for orifice plates used.
 - .5 Flexible duct for connecting to ductwork under test.
 - .6 Smoke bombs for visual inspections.
- .2 Test apparatus: accurate to within +/- 3% of flow rate and pressure.
- .3 Submit details of test instruments to be used to Engineer at least one month before anticipated start date.
- .4 Test instruments: calibrated and certificate of calibration deposited with Departmental representative and Engineer no more than 28 days before start of tests.

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 TEST PROCEDURES

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

3.3 SITE TOLERANCES

- .1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates:
 - .1 Small duct systems up to 250 Pa: leakage 2%.
 - .2 Large low pressure duct systems up to 500 Pa: leakage 2%.
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

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

3.5 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Division 01 – General Requirements.
- .2 Performance Verification:
 - .1 Engineer to witness tests and to verify reported results.
 - .2 To be certified by same TAB agency on this project.

3.6 CLEANING

- .1 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 SUMMARY

- .1 Division 01 – General Requirements.
- .2 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

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

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
 - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
 - .2 Verify performance of hydronic system, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying:
 - .1 Pump operation.
 - .2 Boiler operation.
 - .3 Pressure bypass open/closed.
 - .4 Control pressure failure.
 - .5 Maximum heating demand.
 - .6 Maximum cooling demand.
 - .7 Boiler and/or chiller failure.
 - .8 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.5 HYDRONIC SYSTEM CAPACITY TEST

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.
 - .3 Verification of primary and secondary pump flow rates.
 - .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.

- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Heating system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
 - .2 Reducing space temperature by turning off heating system for sufficient period of time before starting testing.
 - .2 Test procedures:
 - .1 Open fully heating coil and radiation control valves.
 - .2 With hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.

1.6 POTABLE WATER SYSTEMS

- .1 When cleaning is completed and system filled:
 - .1 Verify performance of equipment and systems as specified elsewhere in Division 23.
 - .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut off water immediately. If water hammer occurs, replace water hammer arrestor. Repeat for each outlet and flush valve.
 - .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.7 SANITARY DRAINAGE SYSTEMS

- .1 Ensure that traps are fully and permanently primed.
- .2 Ensure that fixtures are properly anchored, connected to system.
- .3 Operate each fixture to verify drainage and no leakage.

1.8 REPORTS

- .1 In accordance with Division 01 – General Requirements: Reports, supplemented as specified herein.

1.9 TRAINING

- .1 In accordance with Division 01 – General Requirements.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 08 02.

1.2 SUMMARY

- .1 Section includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.
 - .2 Sustainable requirements for construction and verification.
 - .3 Related Sections:
 - .1 All heating and cooling water systems.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM E202-00, 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).
- .3 CSA Z317.13-17.

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Division 01 – General Requirements. Include product characteristics, performance criteria, and limitations.
- .2 Quality assurance submittals: submit following in accordance with Division 01 – General Requirements.
 - .1 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Division 01 – General 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 Division 01 – General Requirements.

- .2 Waste Management and Disposal:
 - .1 Construction Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Division 01 – General Requirements.

2.2 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 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, flow rates, 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 Visit site one week in advance of planned cleaning start date to ensure following 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.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on completion of cleaning:
 - .1 Within 10 working day of cleaning completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
 - .1 Fill system with water and ensure air is vented from system.
 - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
 - .3 Use water metre to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier.
 - .5 Closed loop systems: circulate system cleaner at 60°C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .7 Add chemical solution to system.
 - .8 Establish circulation, raise temperature slowly to maximum design. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38°C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

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 over a 48 hour period.
- .10 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .11 Adjust pipe supports, hangers and springs as necessary.
- .12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .13 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
- .14 Check operation of drain valves.
- .15 Adjust valve stem packings as systems settle down.
- .16 Fully open balancing valves (except those that are factory-set).
- .17 Check operation of over-temperature protection devices on circulating pumps.
- .18 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Division 01 – General Requirements, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.
 - .7 Certified wood.
 - .8 Low-emitting materials.

3.5 CLEANING

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for piping, valves and fittings for gas fired equipment.
- .2 Related Sections:
 - .1 Division 01 – General Requirements.
 - .2 Section 23 05 05 – Installation of Pipework.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A47/A47M 99 (2004), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M 04, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
- .2 Canadian Standards Association (CSA International):
 - .1 CSA W47.1 03, Certification of Companies for Fusion Welding of Steel.
- .3 Canadian Standards Association (CSA)/Canadian Gas Association (CGA):
 - .1 CAN/CSA B149.1HB 00, Natural Gas and Propane Installation Code Handbook.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submittals in accordance with Division 01 – General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
 - .2 Indicate on manufacturer's catalogue literature following: valves.
 - .3 Submit WHMIS MSDS in accordance with Division 01 – General Requirements and Division 21 – Common Work Results for Mechanical. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved testing agent indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Closeout Submittals: submit maintenance and engineering data for incorporation into manual in accordance with Division 01 – General Requirements.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Division 01 – General Requirements.
- .2 Construction requirements: in accordance with Division 01 – General Requirements.
- .3 Verification: contractor's verification in accordance with Division 01 – General Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

Part 2 Products

2.1 MATERIALS

- .1 Materials and products in accordance with Division 01 – General Requirements.

2.2 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Schedule 40, as follows:
 - .1 NPS 1/2 to 2, screwed.
 - .2 NPS 2 1/2 and over, plain end.

2.3 JOINTING MATERIAL

- .1 NPS 1/2 to 2: Screwed fittings: pulverized lead paste.
Note: Where pipes will be concealed, pipes and fittings shall be welded.
- .2 NPS 2-1/2 and over: Welded fittings: to CSA W47.1.
- .3 Flange gaskets: non-metallic flat.
- .4 Brazing: to ASTM B837.

2.4 FITTINGS

- .1 Steel pipe fittings, screwed (NPS ½ to 2), flanged or welded (NPS 2-1/2 and over):
 - .1 Malleable iron: screwed, banded, Class 150.
 - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 - .3 Welding: butt welding fittings.
 - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 - .5 Bolts and nuts: to ASME B18.2.1.
 - .6 Nipples: schedule 40, to ASTM A53/A53M.

2.5 VALVES

- .1 Provincial Code approved, lubricated ball type.

2.6 NATURAL GAS SUB-METER

- .1 The Natural Gas Sub-Meter shall be CSA/ULC certified, temperature compensating, and positive displacement diaphragm type with the following features:
 - .1 3-chamber design.
 - .2 Wearless orbital valve.
 - .3 One piece, seamless, convoluted diaphragm.
 - .4 Neoprene gasket.
 - .5 Lubrication Free Bearings.
 - .6 EZ-VU adjustment port.
 - .7 Tamper Resistant Design.
 - .8 Instrumentation compatible.
 - .9 Easy turn (ET) top for simple installation.
 - .10 Reversible top mount index.
 - .11 Index drive: 0.3 cubic meter/revolution.
 - .12 AMR/AMI compatible (all meter reading systems that use a reading initiator).
 - .13 Meets ANSI B109.1 and ANSI B109.2.
 - .14 Product approvals: Canada AG-0298, AG-0385.
- .2 Size, Capacity, Performance:
 - .1 Meter units: Metric - Cubic Meters.
 - .2 Meter Capacity: 62.58 cubic meters/hour @ 13.8 kPa with a pressure drop of 0.52kPa.
 - .3 Max pressure: 172 kPa.
 - .4 Temp range: -34°C to +49°C.
 - .5 38 mm (1-1/2") pipe connections.
- .3 The meter shall be c/w a pulse device that will send a pulse signal to the BMS. The pulse device shall have the following features:
 - .1 Maximum Switching voltage: D.C.: +/- 30 volts.
 - .2 Maximum Switching current: D.C.: +/- 0.01 amps.
 - .3 Maximum Switching watts: D.C.: 0.30 watts.
 - .4 Minimum voltage breakdown: D.C.: +/- 150 volts.
 - .5 Contact resistance: 0.5 ohms.
 - .6 Open circuit resistance: > 100,000,000 ohms.
 - .7 Maximum rate contact closure: 1000 pulses/sec.
 - .8 Maximum bounce time: 0.2 ms max.
 - .9 Resistance: 100 ohms standard electric throughput resistance for interference suppression. Custom series and parallel values available.

- .10 Temperature:
 - .1 -40°C to +115°C

- .4 Wiring from pulse device to BMS shall be supplied and installed by controls contractor. Coordinate on site.

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 in accordance with Section 23 05 05 Installation of Pipework, CAN/CSA B149.1, supplemented as specified.
- .2 Install drip points:
 - .1 At low points in piping system.
 - .2 At connections to equipment.

3.3 VALVES

- .1 Install valves with stems upright or horizontal.
- .2 Install valves at branch take offs to isolate pieces of equipment, and as indicated.

3.4 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
 - .1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.
- .2 Obtain reports within 3 days of review and submit immediately to Departmental Representative and Engineer.
- .3 Verification requirements in accordance with Division 01 – General Requirements.

3.5 ADJUSTING

- .1 Purging: purge after pressure test in accordance with CAN/CSA B149.1.
 - .1 Pre Start-up Inspections:
 - .1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
 - .2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.6 GROUNDING

- .1 Provide Grounding for natural gas piping system within the boiler room. Ground the new piping for boiler HB-1 to HB-4.

3.7 CLEANING

- .1 Cleaning: in accordance with Section 23 08 02 - Cleaning and Start Up of Mechanical Piping Systems, supplemented as specified.
- .2 Perform cleaning operations as specified in Section and in accordance with manufacturer's recommendations.
- .3 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 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 21 13.

1.2 SUMMARY

- .1 Section includes:
 - .1 Materials and installation for steel piping, valves and fittings for hydronic systems.
 - .2 Sustainable requirements for construction and verification.
- .2 Related Sections:
 - .1 Division 01 – General Requirements.
 - .2 Section 23 05 05 - Installation of Pipework.
 - .3 Section 23 05 23.01 - Valves - Bronze.
 - .4 Section 23 05 23.02 - Valves - Iron.
 - .5 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .6 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME):
 - .1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3-98, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9-01, Factory-Made Wrought Butt welding Fittings.
 - .5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2-87 (R1999), Square and Hex Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-84 (1999) e1, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 American Water Works Association (AWWA):
 - .1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

- .4 Canadian Standards Association (CSA International):
 - .1 CSA B242-M1980 (R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS):
 - .1 MSS-SP-67-025, Butterfly Valves.
 - .2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85-02, Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.4 SUBMITTALS

- .1 Submit shop drawings in accordance with Division 01 – General Requirements.
- .2 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Division 01 – General Requirements and include following:
 - .2 Contractor to submit grooved product submittals. Grooved product to be of one manufacture, and must have current CRN #'s.
 - .3 Grooved product Manufacture to supply on site tool and products installation training.

1.5 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Construction occupational health and safety in accordance with Division 01 – General Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Fold up metal and plastic banding, flatten and place in designated area for recycling.

1.7 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide following spare parts:

- .1 Valve seats: one for every ten valves, each size. Minimum one.
- .2 Discs: one for every ten valves, each size. Minimum one.
- .3 Stem packing: one for every ten valves, each size. Minimum one.
- .4 Valve handles: two of each size.
- .5 Gaskets for flanges: one for every ten flanges.

Part 2 Products

2.1 PIPE

- .1 Steel pipe: in accordance with ASTM A53/A53M, Grade B, as follows:
 - .1 To NPS8: Schedule 40, unless otherwise noted.

2.2 PIPE JOINTS

- .1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.
- .2 NPS2-1/2 and over: welding fittings and flanges to CAN/CSA W48.
- .3 Roll grooved: standard rigid coupling to CSA B242:
 - .1 Flexible couplings: Size NPS 2-8; to be used as indicated on drawings.
 - .2 Rigid Couplings: Size NPS 2-8; to be used as standard method of installation; unless otherwise noted.
- .4 Flanges: raised face, weld neck in accordance with AWWA C111.
- .5 Orifice flanges: slip-on raised face, 2100 kPa.
- .6 Flange gaskets: in accordance with AWWA C111.
- .7 Pipe thread: taper.
- .8 Bolts and nuts: in accordance with ASME B18.2.1 and ASME B18.2.2.
- .9 Roll grooved coupling gaskets: type EPDM. (-30° C To + 110°C for continuous operation). Acceptable on hot water in all areas.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, in accordance with ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: in accordance with ASME B16.1, Class 125.
 - .2 Steel: in accordance with ASME B16.5.
- .3 Butt-welding fittings: steel, in accordance with ASME B16.9.

.4 Unions: malleable iron, in accordance with ASTM A47/A47M and ASME B16.3.

.5 Fittings for roll grooved piping: malleable iron in accordance with ASTM A47/A47M.

2.4 VALVES

.1 Connections:

.1 NPS2 and smaller: screwed ends.

.2 NPS2-1/2 and larger: Flanged ends or rolled grooved.

.2 Gate valves: to MSS-SP-80 Application: Isolating equipment, control valves, pipelines:

.1 NPS2 and under:

.1 Mechanical Rooms: Class 125, rising stem, wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS2-1/2 and over:

.1 Mechanical Rooms: rising stem, wedge disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Iron.

.2 Elsewhere: Non-rising stem, solid wedge disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Iron.

.3 Butterfly valves: to MSS-SP-67 Application: Isolating cells or section of multiple component equipment (e.g. multi-section coils, multi-cell cooling towers):

.1 NPS2-1/2 and over: Lug type or Grooved ends.

.4 Globe valves: to MSS-SP-80 Application: Throttling, flow control, emergency bypass.

.1 NPS2 and under:

.1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: Globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS2-1/2 and over:

.1 With composition bronze disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Iron.

.5 Balancing, for TAB:

.1 General:

.1 Y style globe valve, designed to provide precise flow measurements and control.

.2 Valve shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel.

.3 Valves shall have a minimum of five full 360° handwheel turns. 90° 'circuit-setter' style ball valves are not acceptable.

- .4 Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced.
- .2 NPS2 and under:
 - .1 Valves shall be furnished with precision machined Venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The Venturi shall have two, 6mm threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve.
 - .2 Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar.
 - .3 The valve body, stem and plug shall be brass.
 - .4 The handwheel shall be high-strength resin.
- .6 Drain valves: Full port bronze ball valve type, as specified in Section 23 05 23.01 - Valves - Bronze.
- .7 Swing check valves: to MSS-SP-71:
 - .1 NPS2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS2-1/2 and over:
 - .1 Flanged or Grooved ends: as specified Section 23 05 23.02 - Valves - Iron.
- .8 Silent check valves:
 - .1 NPS2 and under:
 - .1 As specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS2-1/2 and over:
 - .1 Flanged or Grooved ends: as specified Section 23 05 23.02 - Valves - Iron.
- .9 Ball valves:
 - .1 NPS2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

2.5 STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern.
- .2 Blowdown connection: NPS 1.
- .3 Screen: brass with 1.19 mm perforations.
- .4 Working pressure: 860 kPa.

Part 3 Execution

3.1 PIPING INSTALLATION

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

3.2 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Lock set screws to final balanced position.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.3 STRAINER

- .1 Install strainer upstream of all control valves and as indicated.

3.4 CLEANING, FLUSHING AND START-UP

- .1 In accordance with Division 01 – General Requirements.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 21 14.

1.2 SUMMARY

- .1 Section includes:
 - .1 The supply and installation of hydronic specialties equipment.
 - .2 Materials, equipment selection, installation and start-up for hydronic system.
- .2 Sustainable requirements for construction and verification.
- .3 Related Sections:
 - .1 Division 01 – General Requirements.

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME):
 - .1 ASME-04, Boiler and Pressure Vessel Code.
- .2 American Society for Testing and Materials (ASTM):
 - .1 ASTM A47/A47M-99, Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278M-01, Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650°F (345°C).
 - .3 ASTM A516/A516M-96 (e1), Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A536-84 (1999) e1, Specification for Ductile Iron Castings.
 - .5 ASTM B62-93, Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International):
 - .1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CAN/CSA-B214-01, Installation Code for Hydronic Heating Systems.
- .4 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE):
 - .1 Standard 90.1-2001 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .5 Electrical Equipment Manufacturers Advisory Council (EEMAC).
- .6 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA MG 1-2003, Motors and Generators.

1.4 SUBMITTALS

- .1 Submittals in accordance with Division 01 – General Requirements.

- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets:
 - .1 Submit shop drawings and product data in accordance Division 01 – General Requirements.
 - .2 Indicate on product data expansion tanks, air vents, separators, valves, strainers.
- .3 Closeout Submittals:
 - .1 Submit maintenance data in accordance with Division 01 – General Requirements.

1.5 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Construction occupational health and safety in accordance with Division 01 – General Requirements.

1.6 DELIVERY STORAGE AND DISPOSAL

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.
 - .2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

1.7 EXTRA MATERIAL

- .1 Provide maintenance materials in accordance with Division 01 – General Requirements.
- .2 Furnish following spare parts: Seals, gaskets (one for every ten items installed).

Part 2 Products

2.1 MATERIAL

- .1 Sustainable Requirements:
 - .1 Materials and resources in accordance with Division 01 – General Requirements.
 - .2 Do component selection and siting to: CAN/CSA-B214.

2.2 BLADDER TYPE EXPANSION TANK

- .1 Vertical steel bladder type expansion tank shall be ASME rated, CRN number, CSA B51 and be in accordance with all Applicable Laws.
- .2 Full acceptance, heavy duty, replaceable butyl bladder suitable for 116°C operating temperature.
- .3 Free-standing on integral welded ring base.
- .4 Maximum working pressure: 860 kPa.
- .5 Maximum working temperature: 116°C

- .6 Factory pre-charged at 87.7 kPa.
- .7 Access port at top, 25 mm (1") pipe and spare connections, lifting lugs.
- .8 Tank Volume: 300 litres.
- .9 Tank diameter: 610 mm.
- .10 Tank height: 1308 mm.

2.3 COMBINATION AIR, DIRT, HYDRAULIC AND MAGNETIC SEPARATOR

- .1 Designed and constructed per ASME Codes c/w CRN registration.
- .2 Construction: epoxy resin coated steel body.
- .3 Stainless steel internal coalescing mesh.
- .4 Pre-formed insulation.
- .5 Neodymium magnet.
- .6 Automatic air vent with shut-off valve.
- .7 Drain valve.
- .8 4" ANSI 150 flange connections.
- .9 Particle separation capacity: to 5 µm (0.2 mil).
- .10 Max working pressure: 1034 kPa (150 psi).
- .11 Temperature range: 0 –104°C (32 – 220°F).

2.4 AUTOMATIC AIR VENT

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 1034 kPa working pressure.

2.5 HYDRONIC BALANCING VALVES

- .1 NPS 1/2 to 2: Refer to spec Section 23 21 13 – Hydronic System: Steel.
- .2 NPS 2 1/2 to 12:
 - .1 Valves are to be of the 'Y' pattern, equal percentage globe-style.
 - .2 Valve shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel.
 - .3 Valves shall have a minimum of five full 360° handwheel turns.
 - .4 90° 'circuit-setter' style ball valves are not acceptable.
 - .5 Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced.

- .6 Valve body shall be either cast iron with integrated cast iron flanges (2½" to 12") or ductile iron with industrial standard grooved ends (2½" to 12").
- .7 Valve stem and plug disc shall be bronze with ergonomically designed handwheel that permits multi-turn adjustments.
- .8 Armstrong flange adapters shall be supplied, to prevent rotation.
- .9 The valve shall be installed with flow in the direction of the arrow on the valve body and installed at least five pipe diameters downstream from any fitting, and at least ten pipe diameters downstream from any pump.
- .10 Two pipe diameters downstream from the CBV should be free of any fittings.
- .11 When installed, easy and unobstructed access to the valve handwheel and metering ports for adjustment and measurement are to be provided.
- .12 Mounting of valve in piping must prevent sediment build-up in metering ports
- .13 Refer to schedule on drawings for model and sizes.

2.6 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern.
- .2 NPS 2 1/2 to 12: cast iron body to ASTM, Class 30 flanged connections (or grooved type).
- .3 NPS 2 to 12: T type with ductile iron body to ASTM A536 malleable iron body to ASTM A47M, grooved ends.
- .4 Blowdown connection: NPS 1.
- .5 Screen: brass with 1.19 mm perforations.
- .6 Working pressure: 860 kPa.

Part 3 Execution

3.1 GENERAL

- .1 Install as indicated on drawings and to manufacturer's recommendations.
- .2 Run drain lines and blow off connections to terminate above nearest drain.
- .3 Maintain proper clearance to permit service and maintenance.
- .4 Should deviations beyond allowable clearances arise, request and Engineer's directive.
- .5 Check shop drawings for conformance of all tappings for ancillaries and for equipment operating weights.

3.2 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.

- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve.

3.3 AIR VENTS

- .1 Install at high points of systems.
- .2 Install gate valve on automatic air vent inlet.

3.4 EXPANSION TANKS

- .1 Adjust expansion tank pressure to suit design criteria.
- .2 Install Lockshield type valve at inlet to tank.

3.5 VERIFICATION

- .1 Verification requirements in accordance with Division 01 – General Requirements.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Division 01 – General Requirements.
- .2 Section 21 05 01 – Common Work Results for Mechanical.
- .3 Section 23 05 48 – Vibration Controls for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE):
 - .1 Standard 90.1-2001 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers Advisory Council (EEMAC).
- .3 Canadian Standards Association (CSA International):
 - .1 CAN/CSA-B214-01, Installation Code for Hydronic Heating Systems.
- .4 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA MG 1-2003, Motors and Generators.

1.3 SUBMITTALS

- .1 Submittals in accordance with Division 01 – General Requirements.
- .2 Submit Manufacturer printed shop drawings and product data in accordance with Division 01 – General Requirements.
- .3 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.
- .4 Submit product data of pump curves for review showing point of operation.
- .5 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.
- .6 Provide maintenance data for incorporation into manual in accordance with Division 01 – General Requirements.

1.4 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Division 01 – General Requirements.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

1.6 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Division 01 – General Requirements.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and resources in accordance with Division 01 – General Requirements.

2.2 EQUIPMENT

- .1 Do component selection and sizing to: CAN/CSA-B214.

2.3 IN-LINE CIRCULATORS

- .1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.
- .2 Impeller: 30% Glass-Fiber Reinforced Polyethersulfone.
- .3 Gasket: EPDM Rubber.
- .4 Coupling: rigid self-aligning.
- .5 Motor: to Section 21 05 01 – Common Work Results for Mechanical.
- .6 Capacity: 2.4 l/s @ 427 mm (38 gpm @ 1.4 feet) of head.
- .7 Electrical: 115 Volt/ 60 Hz.
- .8 Power: 120W.
- .9 Rated Current: 1.7 Amps.
- .10 Max Load: 7 Amps.
- .11 Max pressure: 1034 kPa (150 PSI).
- .12 Max Temp: 110°C (230°F).
- .13 Flange size: 38mm (1-1/2”).

Part 3 Execution

3.1 INSTALLATION

- .1 Do Work in accordance with CAN/CSA-B214.
- .2 In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible.

- .3 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.
- .4 Pipe drain tapping to floor drain, if required.
- .5 Install volute venting pet cock in accessible location.
- .6 Check rotation prior to start-up.
- .7 Install pressure gauge test cocks.

3.2 **START-UP**

- .1 General:
 - .1 In accordance with Division 01 – General Requirements; supplemented as specified herein.
 - .2 In accordance with Manufacturer's recommendations.
- .2 Procedures:
 - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
 - .2 After starting pump, check for proper, safe operation.
 - .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
 - .4 Check base for free-floating, no obstructions under base.
 - .5 Run-in pumps for 12 continuous hours.
 - .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .7 Eliminate air from scroll casing.
 - .8 Adjust water flow rate through water-cooled bearings.
 - .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
 - .10 Adjust alignment of piping and conduit to ensure true flexibility at all times.
 - .11 Eliminate cavitation, flashing and air entrainment.
 - .12 Adjust pump shaft seals, stuffing boxes, glands.
 - .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
 - .14 Replace seals if pump used to degrease system or if pump used for temporary heat.
 - .15 Verify lubricating oil levels.

3.3 **PERFORMANCE VERIFICATION (PV)**

- .1 General:
 - .1 In accordance with Division 01 – General Requirements: supplemented as specified herein.
 - .2 In accordance with manufacturer's recommendations.

- .2 Exclusions:
 - .1 This paragraph does not apply to small in-line circulators.
- .3 Assumptions: these PV procedures assume that:
 - .1 Manufacturer's performance curves are accurate.
 - .2 Valves on pump suction and discharge provide tight shut-off.
- .4 Multiple Pump Installations - Series and Parallel:
 - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .5 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .6 Start-up/Commissioning Reports: In accordance with Division 01 – General Requirements. Reports supplemented as specified herein. Reports to include:
 - .1 Record of point(s) of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
 - .2 Report forms Division 01 – General Requirements: Report Forms and Schematics.
 - .3 Pump performance curves (family of curves).

3.4 OPERATION REQUIREMENTS

- .1 Operational requirements in accordance with Division 01 – General Requirements.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 25 00.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Materials, components, equipment and chemicals for installation of complete HVAC water treatment system.
- .2 Related Sections:
 - .1 Division 01 – General Requirements.
 - .2 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping Systems.

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME):
 - .1 ASME Boiler and Pressure Vessel Code, Section VII-2004.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Division 01 – General Requirements. Include product characteristics, performance criteria, and limitations.
 - .1 Submit required copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Division 01 – General Requirements. Indicate VOC's for adhesives and solvents during application and curing.
- .2 Shop Drawings:
 - .1 Submit Manufacturer printed shop drawings in accordance with Division 01 – General Requirements.
- .3 Quality assurance submittals: submit following in accordance with Division 01 – General Requirements.
- .4 Closeout Submittals:
 - .1 Submit operation and maintenance data for incorporation into manual in accordance with Division 01 – General Requirements.

1.5 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Division 01 – General 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.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Division 01 – General Requirements.

2.2 MANUFACTURER

- .1 Equipment, chemicals, service provided by one supplier.

2.3 CHEMICAL FEED PIPING

- .1 Resistant to chemicals employed. Pressure rating: 860 kPa.

2.4 WATER TREATMENT FOR HYDRONIC SYSTEMS

- .1 Hot water heating system.
- .2 Micron filter for each pot feeder:
 - .1 Capacity 2% of pump recirculating rate at operating pressure.
 - .2 Six (6) sets of filter cartridges for each type, size of micron filter.

2.5 CHEMICALS

- .1 Provide 1 years supply.

2.6 TEST EQUIPMENT

- .1 Provide one set of test equipment for each system to verify performance.
- .2 Complete with carrying case, reagents for chemicals, specialized or supplementary equipment.

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 HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
- .2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.3 CHEMICAL FEED PIPING

- .1 Install crosses at changes in direction. Install plugs in unused connections.

3.4 CLEANING OF MECHANICAL SYSTEM

- .1 Scope of Cleaning: All new piping systems (other than domestic water piping).
- .2 Provide copy of recommended cleaning procedures and chemicals for approval by Engineer.
- .3 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.
- .4 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.
- .5 Drain and flush system(s) until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
- .6 Disposal of cleaning solutions approved by authority having jurisdiction.

3.5 WATER TREATMENT SERVICES

- .1 Provide water treatment monitoring and consulting services for period of one year after system start-up. Service to include:
 - .1 Initial water analysis and treatment recommendations.
 - .2 System start-up assistance.
 - .3 Operating staff training.
 - .4 Visit plant every 5 days during period of operation and as required until system stabilizes, and advise on treatment system performance.
 - .5 Provide necessary recording charts and log sheets for one year operation.

- .6 Provide necessary laboratory and technical assistance.
- .7 Provide clear, concise, written instructions and advice to operating staff.

3.6 FIELD QUALITY CONTROL

- .1 Start-up:
 - .1 Start up water treatment systems in accordance with manufacturer's instructions.
- .2 Commissioning:
 - .1 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After start-up and before TAB of connected systems.
 - .2 Pre-commissioning Inspections: verify:
 - .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
 - .2 Suitability of log book.
 - .3 Currency and accuracy of initial water analysis.
 - .4 Required quality of treated water.
 - .3 Commissioning procedures - applicable to Water Treatment Systems:
 - .1 Establish, adjust as necessary and record automatic controls and chemical feed rates.
 - .2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.
 - .3 Establish test intervals, regeneration intervals.
 - .4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.
 - .5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.
 - .6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).
 - .7 Advise Departmental Representative and Engineer in writing on matters regarding installed water treatment systems.
 - .4 Commissioning procedures - Closed Circuit Hydronic Systems:
 - .1 Analyze water in system.
 - .2 Based upon an assumed rate of loss approved by Engineer, establish rate of chemical feed.
 - .3 Record types, quantities of chemicals applied.
 - .5 Training:
 - .1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.

- .2 Train O&M personnel in softener regeneration procedures.
- .6 Certificates:
 - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .7 Commissioning Reports:
 - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative and Engineer.
- .8 Commissioning activities during Warranty Period:
 - .1 Check out water treatment systems on regular basis and submit written report to Departmental Representative and Engineer.
- .3 Verification requirements in accordance with Division 01 – General Requirements.

3.7 CLEANING

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

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 31 13 01.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.
 - .2 Sustainable requirements for construction and verification.
- .2 Related Sections:
 - .1 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.3 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM A480/A480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A653/A653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA):
 - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-02, Standard for 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, 2nd Edition 1995 and Addendum No. 1, 1997.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
 - .3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

1.4 SUBMITTALS

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

- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Division 01 – General Requirements for the following:
 - .1 Sealants.
 - .2 Tape.
 - .3 Proprietary joints.
- .3 Co-ordinate submittal requirements and provide submittals required by Division 01 – General Requirements.
- .4 Submit Indoor Air Quality (IAQ) Management Plan in accordance with Division 01 – General Requirements.
- .5 Indicate VOC's for adhesives and solvents during application and curing.

1.5 QUALITY ASSURANCE

- .1 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.
- .2 Health and Safety:
 - .1 Construction occupational health and safety in accordance with Division 01 – General Requirements.
- .3 Indoor Air Quality (IAQ) Management Plan:
 - .1 Develop and implement an Indoor Air Quality (IAQ) Management Plan in accordance with Division 01 – General Requirements.
 - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.
- .4 Sustainable Requirements:
 - .1 Construction requirements: in accordance with Division 01 – General Requirements.
 - .2 Verification: Contractor's verification in accordance with Division 01 – General Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Store and manage hazardous materials in accordance with Division 01 – General Requirements.
- .3 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers steel, metal, plastic waste in accordance with Waste Management Plan.
- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA and Applicable Laws.
- .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and resources in accordance with Division 01 – General Requirements.

2.2 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	A – All HVAC supply and return duct unless noted
250	B – All exhaust Ducts unless noted

- .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.

2.3 SEALANT

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30°C to plus 93°C.
- .2 Indicate VOC's during application and curing.

2.4 TAPE

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

2.5 DUCT LEAKAGE

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

2.6 FITTINGS

- .1 Fabrication: in accordance with SMACNA.

- .2 Radiused elbows:
 - .1 Rectangular: standard radius Centreline radius: 1.5 times width of duct.
 - .2 Round: five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm (16"): with double thickness turning vanes.
 - .2 Over 400 mm (16"): with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45° entry on branch.
 - .2 Round main and branch: enter main duct at 45° with concentric conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct unless otherwise noted.
 - .4 Main duct branches: with splitter damper.
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
 - .1 Full radius elbows.
- .7 Obstruction deflectors: maintain full cross-sectional area:
 - .1 Maximum included angles: as for transitions.

2.7 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Firestopping.
- .2 Fire stopping material and installation must not distort duct.

2.8 GALVANIZED STEEL

- .1 Lock forming quality: in accordance with ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: in accordance with SMACNA.
- .3 Joints: in accordance with SMACNA proprietary manufactured duct joint.
- .4 Round Duct: Spiral wound locked seam; made for high static ventilation system.

2.9 HANGERS AND SUPPORTS

- .1 Hangers and Supports: Refer to 23 05 29 – Hangers and Supports for HVAC Piping and Equipment for General Requirements:
 - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

- .1 Maximum size duct supported by strap hanger: 500mm round or single side.
- .2 Hanger configuration: in accordance with ASHRAE and SMACNA.
- .3 Hangers: galvanized steel angle with galvanized steel rods shall be in accordance with the following table:

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

- .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp.
 - .3 For steel beams: manufactured beam clamps.

2.10 FLEXIBLE DUCTWORK

- .1 Underwriters Laboratories UL 181 and CUL S110 listed, and complies with NFPA Standards 90A and 90B.
- .2 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.
- .3 Duct shall be factory made and composed of a resilient calendared film liner duct permanently bonded to a coated spring steel wire helix and supporting a fiberglass insulating blanket. Low permeability outer vapor barrier of fiberglass reinforced film laminate shall complete the composite.

Part 3 Execution

3.1 GENERAL

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

- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.2 HANGERS

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

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

3.3 SEALING AND TAPING

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

3.4 LEAKAGE TESTS

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Do leakage tests in sections.
- .4 Make trial leakage tests as instructed to demonstrate workmanship.
- .5 Do not install additional ductwork until trial test has been passed.
- .6 Test section minimum of 30 m (98 feet) long with not less than three branch takeoffs and two 90 degree elbows.
- .7 Complete test before performance insulation or concealment Work.

3.5 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Division 01 – General Requirements, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.
 - .7 Low-emitting materials.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 33 00.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.
 - .2 Sustainable requirements for construction and verification.

1.3 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.

1.4 SUBMITTALS

- .1 Submittals in accordance with Division 01 – General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.
 - .2 Submit WHMIS MSDS in accordance with Division 01 – General Requirements. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties:
 - .1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Manufacturer's Field Reports: manufacturer's field reports specified.

- .7 Closeout submittals: submit maintenance and operations data for incorporation into manual as specified in Division 01 – General Requirements.

Part 2 Products

2.1 GENERAL

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

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame 18 ga. with fabric clenched by means of double locked seams.
- .2 Material:
 - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40°C to plus 90°C, density of 1.3 kg/m².

2.3 ACCESS DOORS IN DUCTS

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

2.4 TURNING VANES

- .1 Factory or shop fabricated double thickness without trailing edge, in accordance with recommendations of SMACNA and as indicated.
- .2 Install turning vane in elbows which do not have radius elbows meeting SMACNA standard or square elbows.

2.5 INSTRUMENT TEST

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.

- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

2.6 TAKE-OFFS ON BRANCH DUCTS

- .1 Pre-fabricated eccentric conical branch takeoff with flange to main duct.
- .2 Spin-in collars not permitted.

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 data sheet.

3.2 INSTALLATION

- .1 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated on the drawings.
 - .2 Length of connection: 100 mm.
 - .3 Minimum distance between metal parts when system in operation: 75 mm.
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
 - .1 Size:
 - .1 600 x 600 mm for person size entry.
 - .2 300 x 300 mm for servicing entry, viewing.
 - .3 As indicated on the drawings.
 - .2 Locations:
 - .1 Fire dampers (both sides).
 - .2 Control dampers (both sides).
 - .3 Devices requiring maintenance.
 - .4 Reheat coils (both sides).
 - .5 Elsewhere as indicated and as required by Engineer for inspections.
 - .6 All access as required for duct cleaning. Cooperate with duct cleaner and make duct cleaning complete.

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

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Have manufacturer of products supplied under this Section review Work involved in the handling, installation/application, protection and cleaning of its products and submit written reports in format acceptable to the Engineer.
 - .2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits by manufacturer to review Work at a minimum at the stages listed:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of the Work, after cleaning is carried out.
- .2 Verification requirements in accordance with Division 01 – General Requirements, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.

- .3 Construction waste management.
- .4 Resource reuse.
- .5 Recycled content.
- .6 Local/regional materials.
- .7 Certified Wood.
- .8 Low-emitting materials.

3.4 CLEANING

- .1 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 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 33 14.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.
 - .2 Operating dampers for mechanical forced air ventilation and air conditioning systems.

1.3 REFERENCES

- .1 Sheet Metal and Air Conditioning National Association (SMACNA):
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-1985.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .3 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Division 01 – General Requirements. Include product characteristics, performance criteria, and limitations.

Part 2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.
- .2 Materials and products in accordance Division 01 – General Requirements.

2.2 SPLITTER DAMPERS

- .1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Double thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.

.5 Pivot: piano hinge.

.6 Folded leading edge.

2.3 SINGLE BLADE DAMPERS

.1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA.

.3 Locking quadrant with shaft extension to accommodate insulation thickness.

.4 Inside and outside bronze end bearings.

.5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

.3 Maximum blade height: 100 mm.

.4 Bearings: pin in bronze bushings.

.5 Linkage: shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

2.5 MULTI-LEAF DAMPERS

.1 Opposed or parallel blade type as indicated.

.2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals extruded aluminum frame.

.3 Pressure fit self-lubricated bronze bearings.

.4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.

.5 Operator: Refer to Section 25 05 01 – EMCS.

.6 Performance:

.1 Leakage: in closed position less than 2% of rated air flow at 200 Pa differential across damper.

.7 Insulated aluminum dampers:

.1 Frames: insulated with extruded polystyrene foam with RSI 0.88.

- .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

2.6 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, centre pivoted or counterweighted, as required.

2.7 OPERATING DAMPERS

- .1 Insulated Opposed and Parallel Blade Dampers:
 - .1 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, extruded aluminum frame.
 - .2 Pressure-fit self-lubricated bronze bearings.
 - .3 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
 - .4 Performance Characteristics:
 - .1 Leakage: in closed position to be less than 2% of rated air flow at 1.0 kPa differential across damper.
 - .2 Pressure drop: at full open position to be less than 8.0 Pa differential across damper at 5.08 m/s.
 - .5 Opposed blade damper for all modulating services unless otherwise indicated.
 - .6 Parallel blade dampers for all two position services unless otherwise indicated.
 - .7 Frames: insulated with extruded polystyrene foam with R factor of 5.0.
 - .8 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, R factor of 5.0 parallel or opposed as indicated on schematics.

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 where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 Dampers: vibration free.

- .6 Ensure damper operators are observable and accessible.
- .7 Corrections and adjustments conducted by Engineer.
- .8 Seal multiple damper modules with silicon sealant.
- .9 Install access door adjacent to each damper.

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 The Contractor shall be responsible to carry out all the Work set out or referred to in this Section 23 33 16.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Fire and smoke dampers, and fire stop flaps.

1.3 REFERENCES

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA):
 - .1 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .3 Underwriters Laboratories of Canada (ULC):
 - .1 CAN4-S112-M1990, Fire Test of Fire Damper Assemblies.
 - .2 CAN4-S112.2-M84, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
 - .3 ULC-S505-1974, Fusible Links for Fire Protection Service.

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed Shop Drawings, Product Literature, Specifications and Datasheet in accordance with Division 01 - General Requirements. Include product characteristics, performance criteria, and limitations.
 - .1 Submit required copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Division 01- General Requirements. Indicate VOC's for adhesives and solvents during application and curing.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Operators.
 - .3 Fusible links.
 - .4 Design details of break-away joints.
- .2 Quality assurance submittals: submit following in accordance with Division 01- General Requirements.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual in accordance with Division 01- General Requirements.

1.5 QUALITY ASSURANCE

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

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Division 01- General Requirements.
 - .2 Provide following:
 - .1 6 fusible links of each type.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Division 01- General Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Division 01- General Requirements.

Part 2 Products

2.1 FIRE DAMPERS

- .1 Fire dampers: Dynamic fire dampers shall be furnished and installed where shown on plans and/or as described on schedules. Dampers shall meet the requirements of NFPA80, 90A and 101, bear label of ULC meet requirements of provincial fire authority Fire Commissioner of Canada (FCC) ANSI/NFPA 90A and authorities having jurisdiction and further shall be tested, rated and labelled in accordance with the latest edition of UL Standard 555.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation:

- .1 Fire dampers shall have a UL555 fire rating of 1 1/2 hours unless otherwise indicated.
- .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: offset single damper, round or square; sized to maintain full duct cross section as indicated.
- .4 Dampers shall have a minimum UL555 differential pressure rating of 1000 Pa and minimum velocity rating of 10.16 m/s
- .5 Fusible link actuated, weighted to close and lock in closed position when released or having negator spring closing operator for multi leaf type or roll door type in horizontal position with vertical air flow.
- .6 40 x 40 x 3mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .7 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- .8 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .9 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area. The damper blades shall be out of the air stream.
- .10 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
- .11 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

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 ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Co-ordinate with installer of firestopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

3.3 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Division 01- General Requirements.

3.4 CLEANING

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 The work to be performed consists of providing all labor, equipment, materials, etc. to furnish and commission new factory assembled, low pressure full condensing hot water boilers as described in the specifications herein.

1.2 REFERENCES

- .1 American Boiler Manufacturer's Association (ABMA).
- .2 American National Standards Institute (ANSI):
 - .1 ANSI Z21.13 2004/CSA 4.9 2004, Gas Fired Low Pressure Steam and Hot Water Boilers.
- .3 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME):
 - .1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV, 2004.
- .4 Canadian Gas Association (CGA):
 - .1 CAN1 3.1 77 (R2001), Industrial and Commercial Gas Fired Package Boilers.
 - .2 CAN/CSA B149.1 05, Natural Gas and Propane Installation Code.
- .5 Canadian Standards Association (CSA International):
 - .1 CSA B51 03, Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CSA B139 04, Installation Code for Oil Burning Equipment.
 - .3 CSA B140.7-05, Oil Burning Equipment: Steam and Hot-Water Boilers.
- .6 Electrical and Electronic Manufacturer's Association of Canada (EEMAC).
- .7 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 Division 01 – General Requirements and Other Submittal procedures. Include product characteristics, performance criteria, and limitations.
 - .2 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Division 01 – General Requirements and Other Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Division 01 – General Requirements and Other Submittal Procedures.

- .2 Indicate the following:
 - .1 General arrangement showing terminal points, instrumentation test connections.
 - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
 - .3 Foundations with loadings, anchor bolt arrangements.
 - .4 Piping hook ups.
 - .5 Equipment electrical drawings.
 - .6 Burners and controls.
 - .7 All miscellaneous equipment.
 - .8 Flame safety control system.
 - .9 Breeching and stack configuration.
- .3 Engineering data to include:
 - .1 Boiler efficiency at 25%, 50%, 75% and 100% of design capacity.
 - .2 Radiant heat loss at 100% design capacity.
- .3 Quality assurance submittals: submit following in accordance with Division 01 – General Requirements and Other Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals:
 - .1 Submit operation and maintenance data for incorporation into manual specified in Division 01 – General Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Division 01 – General Requirements.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.5 MAINTENANCE

- .1 Extra materials:
 - .1 Spare parts for 1 year of operation.
 - .2 Spare gaskets.
 - .1 Gasket, Flame Sensor.
 - .2 Gasket set, Burner, Heat Exchanger, Sight Glass – Lower.
 - .3 Gasket, Fan.
 - .3 Probes and sealants for electronic indication.
 - .4 Ignitor, Spark w/ Gasket.
 - .5 Condensate Neutralization Kit.

Part 2 Products

2.1 HEATING BOILERS HB-1 TO HB-4 (IDENTICAL)

- .1 Contractor shall furnish natural gas fired, hot water boilers with an input of 117.2 kW (399 MBH).
- .2 The Boiler shall have a modulating burner input and shall be operated on Natural Gas. The Boiler shall be capable of full modulation firing down to 20% of rated input with a turndown ratio of 5:1.
- .3 The Boiler shall bear the ASME "H" stamp for 552 kPa (80 psi) working pressure and shall be National Board listed. There shall be no banding material, bolts, gaskets or "O" rings in the header configuration. The Boiler shall have a 316L stainless steel heat exchanger. The combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly including a condensate trap. The complete heat exchanger assembly shall carry a fifteen (15) year limited warranty.
- .4 The Boiler shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The Boiler shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the ASHRAE 103 Standard. The Boiler shall operate at a minimum of 94.4% thermal efficiency. The Boiler shall be certified for indoor installation.
- .5 The Boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The Boiler shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The Boiler shall operate in a safe condition at a derated output with gas supply pressures as low as 995 Pa (4 inches of water column).
- .6 The Boiler shall utilize a 24 VAC control circuit and components. The control system shall have a Liquid Crystal touch screen display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front of the jacket. The Boiler shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 345 kPa (30 psi); outlet water temperature sensor; return water temperature sensor; outdoor air sensor, flue temperature sensor; low water cut off with manual reset, system supply sensor and bulbwell, and a condensate trap for the heat exchanger condensate drain.
- .7 Remote, wall mount boiler control panels are not acceptable. The boiler shall feature the "SMART SYSTEM™" control which is standard and factory installed with 128 x 128 resolution display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay featuring six steps, domestic hot water prioritization with limiting capabilities, USB drive for simple uploading of parameters and a PC port connection for connection to a local computer for programming and trending.

Three programmable parameters shall be built into the SMART SYSTEM integrated control package to help minimize potential boiler on-off cycling issues:

- .1 Ramp delay
- .2 Programmable Modulation Aggressiveness Factor
- .3 Programmable Anti-Cycle Time

A secondary operating control that is field mounted outside or inside the appliance is not acceptable. The boiler shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The boiler shall have a built-in “Cascade” with leader redundancy to sequence and rotate while maintaining modulation of up to eight boilers of different Btu inputs without utilization of an external controller. The internal “Cascade” function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours. The boiler shall be capable of remote communication via optional CON-X-US™ Remote Connectivity with the capability of historical trending and sending text message or email alerts to notify the caretaker of a boiler alarm and remote programming of onboard boiler control. The boiler shall have an optional gateway device which will allow integration with BACnet protocols.

The “SMART SYSTEM™” control shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation. A 0-10 VDC output signal shall control a variable speed boiler pump (pump shall be supplied by manufacturer) to keep a fixed Delta T across the boiler regardless of the modulation rate. The boiler shall have the capability to receive a 0-10 VDC input signal from a variable speed system pump to anticipate changes in system heat load in order to prevent flow related issues such as erratic temperature cycling.

- .8 The boiler shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 46 connection points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Low Water Cut Off, Louver Proving Switch, Tank Thermostat, Domestic Hot Water Building Recirculation Pump Contacts, Domestic Hot Water Building Recirculation Temperature Sensor Contacts, Remote Enable/Disable, System Supply Temperature Sensor, Outdoor Temperature Sensor, Tank Temperature Sensor, BACnet MS/TP Building Management System Signal and Cascade Control Circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt / 60 hertz / single phase on all models. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pump, the Boiler pump and the Domestic Hot Water pump.
- .9 The boiler shall be installed and vented with a direct vent system with horizontal sidewall termination of both the exhaust vent and combustion air. The flue shall be Category IV approved material constructed of CPVC or Stainless Steel. A separate pipe shall supply combustion air directly to the boiler from the outside. The boiler’s total combined air intake length shall not exceed 30.5 equivalent meters (100 equivalent feet). The boiler’s total combined exhaust venting length shall not exceed 30.5 equivalent meters (100 equivalent feet).

- .10 The Boiler shall have an independent laboratory rating for Oxides of Nitrogen (NO_x) of 30 ppm or less corrected to 3% O₂. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping.
- .11 The Boiler shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments.
- .12 Boiler unit(s) schedule:
 - .1 Input Capacity: 117 kW.
 - .2 Output Capacity: 111kW.
 - .3 Thermal Efficiency: 94.4.
 - .4 Turndown Ratio: 5:1.
 - .5 Gas Train Max Inlet Pressure: 3.48 kPa.
 - .6 Gas Train Min Inlet Pressure: 0.995 kPa.
 - .7 Gas Connection: 19 mm (3/4").
 - .8 Vent Size: 100 mm (4").
 - .9 Air Inlet Size: 100 mm (4").
 - .10 Flow at 11.1°C: 2.4 L/s (38 gpm).
 - .11 Pressure Drop: 4.24 kPa.
 - .12 Max Working Pressure: 552 kPa.
 - .13 Water Connection: 38mm (1-1/2").
 - .14 Water Capacity: 24.6 Litres.
 - .15 Dimensions: 901.7 mm High, 635 mm Wide, 552.5 mm Deep.
 - .16 Weight: 96.6 kg.
 - .17 Volt/Phase/Hz/MCA: 120/1/60/4.5.
- .13 Each boiler shall be c/w the following:
 - .1 Welded Stainless steel condensate collection basin.
 - .2 CPVC side wall concentric vent termination (To be CSA/ULC Certified).
 - .3 Condensate trap and condensate neutralization kit.
 - .4 ECM variable speed boiler circulating pump.
 - .5 Flow switches.
 - .6 Direct Spark Ignition.
 - .7 Multi-color graphic LCD display with navigation.
 - .8 Cascading sequencer with built-in redundancy.
 - .9 BACnet MSTP Communication kit.
 - .10 Built-in cascade of up to 8 boilers.
 - .11 Three boiler setpoint temperature inputs w/ three programmable indoor-outdoor curves.
 - .12 Wall mounting brackets.

- .13 BMS Integration including but not limited to:
 - .1 Plant enable.
 - .2 Plant heating supply setpoint.
 - .3 General alarms.
 - .4 Boiler output.

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 ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- .4 Mount unit level.
- .5 Pipe hot water relief valves full size to nearest drain.
- .6 Pipe blow down/drain to blow down tank/floor drain.
- .7 Natural gas fired installations in accordance with CAN/CSA B149.1.

3.3 MOUNTING AND ACCESSORIES

- .1 Safety valves and relief valves:
 - .1 Run separate discharge from each valve.
 - .2 Terminate discharge pipe as indicated.
 - .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.
- .2 Blow down valves:
 - .1 Run discharge to terminate as indicated.

3.4 FIELD QUALITY CONTROL

- .1 Commissioning:
 - .1 Manufacturer to:
 - .1 Certify installation.

- .2 Start-up and commission installation.
- .3 Carry out on site performance verification tests.
- .4 Demonstrate operation and maintenance.
- .2 Provide Departmental Representative at least 24 hours' notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.
- .2 Verification requirements in accordance with Division 01 – General Requirements.

3.5 MANUFACTURER'S FIELD SERVICE

- .1 General: The boiler supplier's factory authorized service organization shall be responsible for performance of inspections, start up and testing of the package boiler, and accessory equipment and materials furnished under this Section. A detailed written record of the start-up performance, including burner setting data over the entire load range shall be furnished to the engineer before final acceptance. All labour, equipment and test apparatus shall be furnished by the authorized service organization. All equipment defects discovered by the tests shall be rectified either by the service organization or boiler manufacturer.
- .2 Equipment inspection and pre-start walk through services are as identified in specification sections.
- .3 Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the authorized service organization and shall include:
 - .1 Demonstrate that boiler, burner, controls and accessories comply with requirements of this Section as proposed by the boiler and accessories supplier. Pre-test all items prior to the scheduling the final testing that will be witnessed by the test engineer.
 - .2 Readings at different firing rates 20, 50, 75 and 100% of load for the modulating burner shall be taken with a written report of the tests submitted to the engineer. The reports shall include readings for each firing rate tested and include stack temperatures, O₂, CO, NO_x and overall boiler efficiency.
 - .3 Auxiliary Equipment and Accessories: Observe and check all valves, draft fans, electric motors and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects and non-compliance with referenced standards or overloading as applicable.
 - .4 Commissioning Requirements:
 - .1 Fireside inspection.
 - .2 Set up fuel train and combustion air system.
 - .3 Set up operating set points.
 - .4 Check all safeties, including Flame safeguard, LWCO, Airflow, Fuel pressures and High limits.
 - .5 Set up and verify efficiencies at 25%, 50%, 75% and 100%.
 - .6 Set up and verify burner turndown.
- .4 Training to include all safety procedures, maintenance procedures, control operations and diagnostic procedures.

3.6 CLEANING

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Division 01 – General Requirements.
- .2 Section 21 05 01 – Common Work Results for Mechanical.
- .3 Section 23 05 48 – Vibration Controls for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE):
 - .1 Standard 90.1-2001 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers Advisory Council (EEMAC).
- .3 Canadian Standards Association (CSA International):
 - .1 CAN/CSA-B214-01, Installation Code for Hydronic Heating Systems.
- .4 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA MG 1-2003, Motors and Generators.

1.3 SUBMITTALS

- .1 Submittals in accordance with Division 01 – General Requirements.
- .2 Submit Manufacturer printed shop drawings and product data in accordance with Division 01 – General Requirements.
- .3 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.
- .4 Submit product data of pump curves for review showing point of operation.
- .5 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.
- .6 Provide maintenance data for incorporation into manual in accordance with Division 01 – General Requirements.

1.4 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Division 01 – General Requirements.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

1.6 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Division 01 – General Requirements.

Part 2 Products

2.1 HORIZONTAL UNIT HEATERS

- .1 General:
 - .1 Contractor shall furnish and install hot water unit heaters. Performance shall be as indicated on the equipment schedule in the plans. Unit heaters shall listed by CSA as certified.
- .2 Units:
 - .1 Self-contained, factory assembled, pre-wired unit consisting of cabinet with supply fan, motor, and condenser.
- .3 Casing:
 - .1 Casings shall be 18 gauge steel and consist of front and back halves. Both halves are joined together at the top and bottom utilizing the condenser mounting screws. Casing top is provided with threaded hanger connections for unit suspension. Fan Venturi is formed in casing back half.
- .4 Coating:
 - .1 Electrostatically applied baked on grey green corrosion resistant, polyester powder coat paint that meets the following tests:
 - .1 500 hours of salt spray as defined in ASTM B117.
 - .2 Adhesion/crosshatch tape tests as defined in ASTM D3359, Method B, Rating 5B.
 - .3 Will not crack or peel when test panel is bent around a 1/8 inch arbor.
- .5 Condenser:
 - .1 Condenser coils are of the extended surface type of serpentine design, utilizing aluminum fins and DLP-type copper tubes with cast bronze supply and return connections. Tubes are mechanically bonded to the collars of the fins. The condensers are warranted for operation at steam or hot water pressures up to 1034 kPa and/or temperatures up to 191°C. All coils are leak tested at 1138 to 1379 kPa, air under water. Fins are continuous across the width and depth of the condenser and are vertically oriented to minimize the collection of dirt and dust.
 - .2 Coils are of serpentine design with horizontal tubes, vertical fins and side supply and return. All tube bends are brazed. All tubes have individual expansion bends. Copper tubes are 25mm O.D. with 0.76mm wall thickness.
- .6 Motor:
 - .1 Single motor with a supply voltage of 115/60/1 and horsepower as indicated on the equipment schedule and manufactured in accordance with NEMA standards for continuous fan duty type applications. Must be totally enclosed and single phase motors will have built in thermal overload protection.

Will be mounted to the unit with rubber vibration absorbing material. The entire length of the line voltage motor leads will be shielded and terminate in a factory supplied junction box mounted on the unit or integral to the motor.

- .7 Fan/Fan Guards:
 - .1 Fans AMCA rated direct drive, aluminum blade, steel hub propeller will be statically and dynamically balanced. Unit shall be equipped with a safety fan guard.
 - .2 The unit shall be furnished with vertical deflector blades which are individually adjustable to provide four way directional discharge air control coated to match casing finish.
- .8 Performance: Refer to schedule on drawings for additional accessories to be c/w the heater and other information.

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Provide double swing pipe joints.
- .3 Check final location with Engineer if different from that indicated prior to installation.
- .4 For each unit, install gate valve on inlet and outlet of each unit. Install drain valve at low point:
 - .1 Install manual air vent at high point.
- .5 Clean finned tubes and comb straight.
- .6 Provide supplementary suspension steel as required.
- .7 Before acceptance, set discharge patterns and fan speeds to suit requirements.

END OF SECTION