

**Part 1 General**

**1.1 REFERENCES**

- .1 Reference Standards:
  - .1 National Air Duct Cleaners Association (NADCA)
    - .1 ACR Standard, 2006 edition: Assessment, Cleaning and Restoration of HVAC Systems.
  - .2 North American Insulation Manufacturers Association (NAIMA)
    - .1 NAIMA 2005, Cleaning Fibrous Glass Insulated Duct Systems - Recommended Practices.
  - .3 United States Environmental Protection Agency (US EPA)
    - .1 US EPA 1999, 40 CFR Parts 152 and 156.

**1.2 CLOSEOUT SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Post Cleaning Inspection Report: submit 4 copies of Final Inspection Report, including data collected, observations and recommendations as well as following information:
  - .1 Name and address of facility;
  - .2 Name and address of HVAC cleaning contractor;
  - .3 Description of HVAC systems with sketches identifying systems cleaned;
  - .4 Identification scheme for location points in systems that were inspected with accompanying notes describing methods of inspection or tests used;
  - .5 Identify systems tested, observations, actions taken and recommendations for future maintenance.

**1.3 QUALITY ASSURANCE**

- .1 Contractor: verification of membership in NADCA or verification of 5 years minimum experience in work similar to or exceeding work of this Section.

**Part 2 Products**

**2.1 ACCESS DOORS AND PANELS**

- .1 Equipment Access Doors and Panels: construct from same materials as equipment panelling complete with sealing gasket and positive locking device.
  - .1 Size access doors and panels in equipment to allow for inspection and cleaning.
- .2 Ductwork Access Doors: construct access doors from 1.27 mm minimum galvanized sheet steel with gasketed seal.
  - .1 Ensure access door is 25 mm greater in every dimension than access opening.
  - .2 Access door size 200mm x 200 mm minimum.

- .3 Secure access doors with sheet metal screws on 75 mm centres minimum. Ensure 3 screws per side minimum.
- .3 Access Doors and Panels Acoustic Lining:
  - .1 Install acoustic lining to match existing.
  - .2 Self-adhesive glass fibre tape capable of adhering to both acoustic lining and metal access door or panel materials.
  - .3 Water-based duct sealer for repairing cut acoustic lining.

## **2.2 AIR DUCT CLEANING EQUIPMENT**

- .1 Manually propelled full contact brushes:
  - .1 Ensure brushes are specifically manufactured and shaped to fit individual ducts, equipment and components of HVAC system.
    - .1 Ensure brushes are sized to fit various duct sizes in HVAC system.
  - .2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces to be cleaned.
- .2 Brushes: manually propelled with integrally-mounted motor and nylon or polypropylene bristles.
  - .1 Ensure motor has capacity to continue to push brush after bristles are distorted.
  - .2 Replace worn and ineffective brushes when required.

## **2.3 HEPA FILTER EVACUATION FAN**

- .1 Evacuation Fan: includes fan, HEPA filter, flexible hose and motor capable of maintaining debris and particulates airborne in airstream until they reach evacuation fan and maintaining system under negative pressure.
  - .1 Ensure HEPA filters are clean and maintain evacuation fan and HEPA filter to run efficiently.

## **2.4 HEPA VACUUM UNIT**

- .1 Vacuum Unit: includes vacuum fan, integral HEPA filter, suction hose and vacuum head, capable of maintaining HVAC System debris and particulates airborne in air stream until they reach vacuum unit and maintaining system under negative pressure.
  - .1 Ensure HEPA filters are clean and maintain vacuum unit and HEPA filter to run efficiently.

## **Part 3 Execution**

### **3.1 PREPARATION**

- .1 Close down HVAC system.
- .2 Locate and identify externally visible HVAC system features which may affect cleaning process including:
  - .1 Control devices;

- .2 Fire and smoke control dampers;
- .3 Balancing dampers: indicate and record positions for resetting;
- .4 Air volume control boxes: indicate and record positions for resetting;
- .5 Fire alarm devices;
- .6 Monitoring devices and controls;
- .3 Cut openings in equipment panels and ductwork for access to system interior.
  - .1 Square or rectangular opening sizes: 200 mm minimum each side.
  - .2 Circular opening sizes: 200 mm minimum diameter.
- .4 Installation of Access Doors and Panels: install access doors and panels for equipment where required to facilitate system inspection and cleaning.
  - .1 Install access doors and panels for inspection and cleaning of equipment as follows:
    - .1 Heating and cooling coils;
    - .2 Fan units;
    - .3 Filters;
    - .4 Dampers;
    - .5 Sensors;
- .5 Installation of Access Doors in Ductwork: install access doors in ductwork where required to facilitate system inspection and cleaning.
  - .1 Access door installation is not permitted in flexible ductwork.
    - .1 Inspect flexible ductwork only by disconnecting from main duct and inspecting from open end.
- .6 When acoustically lined duct is cut for access, repair cut edges of acoustic lining using self-adhesive fibre glass tape and water based duct sealer.
  - .1 Adhere new acoustic lining to match existing to inside of access panel or door to ensure continuity of acoustic properties of system.

### **3.2 EXAMINATION / PRE-CLEANING INSPECTION**

- .1 Verification of Conditions:
  - .1 Make visual inspection of interior of HVAC system
- .2 Evaluation and Assessment:
  - .1 Identify location and type of internal components.
  - .2 Identify extent of potential problems.
  - .3 If toxic or hazardous materials or deposits are suspected after initial inspection immediately stop work and inform Departmental Representative.
    - .1 Do not proceed further with inspection operations until written approval from Departmental Representative.

### **3.3 DUCT CLEANING**

- .1 Clean ductwork and air handling unit within Mechanical Room only.

- .2 Do duct cleaning in accordance with NADCA ACR Standard.
- .3 Isolate and clean sections in zones to ensure that dirt deposits and debris from zone being cleaned does not pass through another zones which has already been cleaned.
  - .1 Isolate zone of duct using closed-cell polyurethane foam or air inflated zone bag before cleaning.
- .4 Ensure vacuum units and evacuation fans are securely in place before starting cleaning operation of isolated section of HVAC air duct system.
- .5 Install HEPA filter evacuation fan at one end of zone section and insert full contact brushes at other end.
- .6 Energize brushes to travel from insertion point to HEPA filter evacuation fan.
  - .1 Pass brushes through sections as often as necessary to achieve required cleanliness.
  - .2 Change brush sizes as required to ensure positive contact with duct and component interiors.
  - .3 Clean corners and pockets where dirt and debris can accumulate.
- .7 Advise Departmental Representative 72 hours minimum before deactivation of fire alarm and smoke detectors duct cleaning operations.

### **3.4 ACOUSTICALLY LINED DUCTWORK CLEANING**

- .1 Clean glass fibre acoustically insulated ducts to NAIMA recommended practices.
  - .1 Use specifically designed robotic apparatus that has been demonstrated not to damage acoustic glass fibre lining.
  - .2 Monitor cleaning process progress by onboard camera.

### **3.5 COMPONENTS AND EQUIPMENT CLEANING**

- .1 Brush and vacuum coils, humidifiers, air handling unit enclosures, and heat exchanger surfaces to achieve required cleanliness.
- .2 Proceed to next section in cleaning sequence only after written approval from Departmental Representative.
- .3 Compressed air and manual cleaning is acceptable only for cleaning individual components and small areas as follows and only after written approval from Departmental Representative:
  - .1 Fan blades;
  - .2 Dampers;
  - .3 Turning vanes;
  - .4 Controls;
  - .5 Sensor bulbs;
  - .6 Fire alarms;
  - .7 Smoke detectors;

**3.6 FIELD QUALITY CONTROL/FINAL INSPECTIONS**

- .1 Post Cleaning Inspection: carry out final inspection using visual inspection methods after final cleaning has been completed.

**3.7 SYSTEM STARTUP**

- .1 Cover each inspection opening with access door or panel and secure in place after inspection and cleaning are completed.
- .2 Restart each HVAC system.

**3.8 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Dispose of hazardous or toxic waste materials extracted from ductwork system to appropriate contaminated waste facility and provide proof.
- .3 Dispose of existing HVAC filter materials to landfill or appropriate contaminated waste facility.

**END OF SECTION**

**Part 1            General**

**1.1            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Shop drawings to show:
  - .1        Mounting arrangements.
  - .2        Operating and maintenance clearances.
- .3        Shop drawings and product data accompanied by:
  - .1        Detailed drawings of bases, supports, and anchor bolts.
  - .2        Acoustical sound power data, where applicable.
  - .3        Points of operation on performance curves.
  - .4        Manufacturer to certify current model production.
  - .5        Certification of compliance to applicable codes.
- .4        In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .5        Closeout Submittals:
  - .1        Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
  - .2        Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
  - .3        Operation data to include:
    - .1        Control schematics for systems including environmental controls.
    - .2        Description of systems and their controls.
    - .3        Description of operation of systems at various loads together with reset schedules and seasonal variances.
    - .4        Operation instruction for systems and component.
    - .5        Description of actions to be taken in event of equipment failure.
    - .6        Valves schedule and flow diagram.
    - .7        Colour coding chart.
  - .4        Maintenance data to include:
    - .1        Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
    - .2        Data to include schedules of tasks, frequency, tools required and task time.
  - .5        Performance data to include:
    - .1        Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
    - .2        Equipment performance verification test results.
    - .3        Special performance data as specified.

- .4 Testing, adjusting and balancing reports as specified in Section 23 05 93  
- Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
  - .1 Submit Electronic Copy in PDF format and 2 hard copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
  - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .7 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
  - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
  - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
  - .3 Submit to Departmental Representative for approval and make corrections as directed.
  - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
  - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

## **1.2 QUALITY ASSURANCE**

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

## **1.3 MAINTENANCE**

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
  - .1 One set of packing for each pump.

- .2 One casing joint gasket for each size pump.
- .3 One glass for each gauge glass.
- .4 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

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

#### **Part 2 Products**

- .1 Not Used.

#### **Part 3 Execution**

##### **3.1 PAINTING REPAIRS AND RESTORATION**

- .1 Prime and touch up marred finished paintwork to match original.
- .2 Restore to new condition, finishes which have been damaged.

##### **3.2 CLEANING**

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

##### **3.3 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.



**3.4 DEMONSTRATION**

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Departmental Representative will record these demonstrations on video tape for future reference.

**3.5 PROTECTION**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Green Seal Environmental Standards (GSES)
  - .1 Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.
- .3 National Fire Code of Canada (NFCC 2005)
- .4 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
  - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 DELIVERY, STORAGE AND HANDLING**

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

**Part 2 Products**

**2.1 MATERIAL**

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
  - .1 Primers, Paints, and Coating: in accordance with manufacturer's recommendations for surface conditions.
  - .2 Primer: maximum VOC limit 250 g/L to Standard GS-11 and SCAQMD Rule 1113.

- .3 Paints: maximum VOC limit 150 g/L to Standard GS-11 and SCAQMD Rule 1113.
- .2 Sealants: maximum VOC limit to SCAQMD Rule 1168 and GSES GS-36.
- .3 Adhesives: maximum VOC limit to SCAQMD Rule 1168 and to GSES GS-36.

### **Part 3 Execution**

#### **3.1 APPLICATION**

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

#### **3.2 CONNECTIONS TO EQUIPMENT**

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

#### **3.3 CLEARANCES**

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

#### **3.4 DRAINS**

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

#### **3.5 AIR VENTS**

- .1 Install manual air vents to 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.

### **3.6 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.

### **3.7 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 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .6 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .7 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .8 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .9 Group piping wherever possible and as indicated.
- .10 Ream pipes, remove scale and other foreign material before assembly.
- .11 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .12 Provide for thermal expansion as indicated.
- .13 Valves:
  - .1 Install in accessible locations.
  - .2 Remove interior parts before soldering.
  - .3 Install with stems above horizontal position unless indicated.
  - .4 Valves accessible for maintenance without removing adjacent piping.
  - .5 Install globe valves in bypass around control valves.
  - .6 Use ball or butterfly valves at branch take-offs for isolating purposes except where 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.
- .14 Check Valves:
  - .1 Install silent check valves on discharge of pumps, in vertical pipes with downward flow, and as indicated.

**3.8 FLUSHING OUT OF PIPING SYSTEMS**

- .1 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

**3.9 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK**

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative\.

**3.10 EXISTING SYSTEMS**

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

**3.11 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 90.1-10, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .3 Closeout Submittals
  - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**1.3 QUALITY ASSURANCE**

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

**1.4 DELIVERY, STORAGE, AND HANDLING**

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

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

- .1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

**2.2 MOTORS**

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 373 W: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 575 V, unless otherwise indicated.

**2.3 TEMPORARY MOTORS**

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

**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 Fasten securely in place.
- .2 Make removable for servicing, easily returned into, and positively in position.

**3.3 FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

**3.4 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.

- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



**Part 1            General**

**1.1                REFERENCES**

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME Boiler and Pressure Vessel Code-2007:
    - .1 BPVC 2007 Section I: Power Boilers.
    - .2 BPVC 2007 Section V: Nondestructive Examination.
    - .3 BPVC 2007 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1 ANSI/AWWA C206-03, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
  - .1 AWS C1.1M/C1.1-2000(R2006), Recommended Practices for Resistance Welding.
  - .2 AWS Z49.1-2005, Safety in Welding, Cutting and Allied Process.
  - .3 AWS W1-2000, Welding Inspection Handbook..
- .4 Canadian Standards Association (CSA International)
  - .1 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
  - .2 CSA B51-03(R2007), Boiler, Pressure Vessel and Pressure Piping Code.
  - .3 CSA-W117.2-2006, Safety in Welding, Cutting and Allied Processes.
  - .4 CSA W178.1-2008, Certification of Welding Inspection Organizations.
  - .5 CSA W178.2-2008, Certification of Welding Inspectors.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3                QUALITY ASSURANCE**

- .1 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 Submit welder's qualifications to Departmental Representative.
    - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
  - .2 Inspectors:
    - .1 Inspectors qualified to CSA W178.2.
  - .3 Certifications:

- .1 Registration of welding procedures in accordance with CSA B51.
- .2 Copy of welding procedures available for inspection.
- .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

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

### **Part 2 Products**

#### **2.1 ELECTRODES**

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

### **Part 3 Execution**

#### **3.1 APPLICATION**

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

#### **3.2 QUALITY OF WORK**

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

#### **3.3 INSTALLATION REQUIREMENTS**

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

### **3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS**

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

### **3.5 SPECIALIST EXAMINATIONS AND TESTS**

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

### **3.6 DEFECTS CAUSING REJECTION**

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

### **3.7 REPAIR OF WELDS WHICH FAILED TESTS**

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

### **3.8 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition 1971.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1 Submit copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Submittals to include:
  - .1 Piping configuration and sizing - straight pipe upstream and downstream, distances to first weld, protrusion, thermowell, pressure tap.
  - .2 Service conditions.
  - .3 Full details of primary element - standard of design and construction, materials, type serial number, flow rate, differential pressure, irrecoverable head loss (IHL), calculation sheets.
  - .4 Accuracy statements for each component at specified flow rates and other conditions.
  - .5 Flow and temperature ranges.
  - .6 Signal processor calibration data.
  - .7 Minimum turndown ratio.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
- .5 Closeout Submittals:

- .1 Submit maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

### **1.3 DELIVERY, STORAGE, AND HANDLING**

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

## **Part 2 Products**

### **2.1 ACCURACY**

- .1 Calculate overall accuracy of each installation using following expression: Overall accuracy =  $(E (\text{accuracy of individual components of system})^2)^{1/2}$ .
- .2 Components to include:
  - .1 Primary flow measuring elements.
  - .2 Transmitters: flow, differential pressure, pressure, temperature, temperature difference.
  - .3 RTD's.
  - .4 Signal processors, recorders.
  - .5 Calibration of signal processors: assume 0.20% per processor.
  - .6 Installation tolerances: assume 1% for concentricity of pipe, difference in height of transmitter piping.
- .3 Show in proposal overall accuracy at 100%, 70%, 10%, minimum specified design flow rate.
- .4 Indicate minimum measurable flow rate.

### **2.2 VENTURI FLOW METERS**

- .1 Acceptable Manufacturers and Products: Preso, Gerand
- .2 Type: Venturi style flow metering to measure rate of volume flow.
- .3 Accuracy:  $\pm 1\%$  with pressure drop not more than 10% of the differential pressure reading.
- .4 Suitable for 1725 kPa operating pressure at 150°C.
- .5 Each unit complete with nipples, needle valves and push type quick disconnect.

- .6 Chained metal tag showing venturi size, location, flow rate and differential pressure for listed flow.
- .7 Materials of construction: Steel body suitable for butt welding to flanges.
- .8 Portable liquid filled bellows differential meter to include:
  - .1 115 mm dial with 90° sweep range on needle with suitable range, graduated in kPa.
  - .2 3 metre long hoses with vent valve, connectors.
  - .3 Carrying case.
  - .4 Flow conversion charts suitable for media in piping systems (i.e., water, glycol).

### **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 PREPARATION**

- .1 Before final calculations for orifice diameter, and before purchase of venturi measure:
  - .1 Internal diameter of main at the primary element to +/-0.01 mm accuracy.
  - .2 For concentricity of pipe.

#### **3.3 INSTALLATION OF PRIMARY ELEMENT**

- .1 Follow manufacturer's instructions.

#### **3.4 INSTALLATION OF DIFFERENTIAL PRESSURE TAPS AND PIPING**

- .1 Differential pressure taps horizontal and level with each other to within +/- 1.5 mm.
- .2 Tubing: straight, supported throughout its length, sloped 5%-10% upward to main for drainage and venting, without air pockets, with blowdown valves at bottom.

#### **3.5 INSTALLATION OF TRANSMITTERS NOT FORMING INTEGRAL PART OF PRIMARY ELEMENT**

- .1 Mount on pipe stand installed and located to ensure no damage by passing traffic.

#### **3.6 INSTALLATION OF SIGNAL TRANSMISSION CABLE**

- .1 Ground shielding at one point only.
- .2 Protect against RF interference.
- .3 Cross electrical cables, conduits at 90 degrees leaving at least 150 mm space between.

#### **3.7 START-UP**

- .1 Follow manufacturer's recommendations.

**3.8 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B40.100-2005, Pressure Gauges and Gauge Attachments.
  - .2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for thermometers and pressure gauges and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates:
  - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Test and Evaluation Reports:
  - .1 Submit certified test reports for thermometers and pressure gauges from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

**1.3 DELIVERY, STORAGE AND HANDLING**

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



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

- .1 Design point to be at mid-point of scale or range.
- .2 Ranges: as indicated.

**2.2 DIRECT READING THERMOMETERS**

- .1 Industrial, variable angle type, mercury-free, liquid filled, 225 mm scale length: to ASME B40.200.
  - .1 Resistance to shock and vibration.

**2.3 THERMOMETER WELLS**

- .1 Fitting to allow a 3 mm O.D. plug-in gauge to measure temperature or pressure.
  - .1 Maximum pressure: 3450 kPa
  - .2 Maximum temperature: 135°C
- .2 Fitting constructed of:
  - .1 13 mm NPT brass body with hex head screw cap.
  - .2 Two self-closing valves constructed of nodel.
- .3 Test kit including the following:
  - .1 One 65 mm diameter compound pressure gauge with 3 mm O.D. plug in stem.
  - .2 One 125 mm diameter temperature gauge with 3 m O.D. plug-in stem, range 0-110°C.
  - .3 One 125 mm diameter temperature gauge with 3 mm O.D. plug-in stem, range 0-50°C.

**2.4 PRESSURE GAUGES**

- .1 112 mm, dial type: to ASME B40.100, Grade 2A, phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.
- .2 Provide:
  - .1 Gasketed pressure relief back with solid front.
  - .2 Bronze stop cock.

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

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
  - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

- .2 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 GENERAL**

- .1 Install thermometers and gauges so they can be easily read from floor or platform.
- .2 Install between equipment and first fitting or valve.

### **3.3 THERMOMETERS**

- .1 Install in wells on piping. Include heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
  - .1 Water boilers.
- .3 Install wells as indicated for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

### **3.4 PRESSURE GAUGES**

- .1 Install in locations as follows:
  - .1 Suction and discharge of pumps.
  - .2 Upstream and downstream of PRV's.
  - .3 Outlet of boilers.
  - .4 In other locations as indicated.
- .2 Install gauge cocks for balancing purposes, elsewhere as indicated.
- .3 Use extensions where pressure gauges are installed through insulation.

### **3.5 NAMEPLATES**

- .1 Install engraved lamoid nameplates in accordance with Section 23 05 53.01 - Mechanical Identification, identifying medium.

### **3.6 CLEANING**

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

### **3.7 PROTECTION**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
  - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
  - .1 ASTM A276-08, Standard Specification for Stainless Steel Bars and Shapes.
  - .2 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .3 ASTM B283-08a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
  - .4 ASTM B505/B505M-08a, Standard 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-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit data for valves specified in this Section.

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials/Spare Parts:
  - .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.
- .2 Tools:
  - .1 Furnish special tools for maintenance of systems and equipment.
  - .2 Include following:
    - .1 Lubricant gun for expansion joints.

## **1.5 DELIVERY, STORAGE AND HANDLING**

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

## **Part 2 Products**

### **2.1 ACCEPTABLE MANUFACTURERS AND PRODUCTS**

- .1 Globe Valves: Crane, Hattersley, Jenkins, Lunkenheimer, Crane McAvity, Persta, Rockwell, Velan, Walworth, Toyo, Watts, Kitz, Milwaukee, MAS, Nibco, Vogt, RP&C, Bonney Forge
- .2 Ball Valves: Jenkins, Toyo, Crane, Hattersley, MAS, Kitz, Milwaukee, Nibco, Grinnell, American Valve (Series 4000), Apollo, Fortune
- .3 Butterfly Valves: Crane, Demco, DeZurik, ITT Grinnell, Jenkins, Keystone, Norris, Victaulic, Toyo, Hattersley, Milwaukee, Bray, Nibco, Flowseal, Mueller, Apollo, Kitz
- .4 Check Valves: Center Line, DeZurik, Mueller, Singer, Watts, Moygro, Milwaukee, Val-Matic, Nibco, Victaulic, Apollo, Duo-Check II, Conbraco, Newman Hattersley, Mueller Steam Specialties, Bonney Forge
- .5 Relief Valves: Consolidated, Crosby Aston, Farris, Kunkle, Singer, Watts
- .6 Suction Guides/Combination Valves: Armstrong, B&G, Taco

### **2.2 BALL VALVES**

- .1 DN 50 and under:
  - .1 Body and cap: cast high tensile bronze to ASTM B62.
  - .2 Pressure rating: Class125.

- .3 Connections: solder ends to ANSI.
- .4 Stem: tamperproof ball drive.
- .5 Stem packing nut: external to body.
- .6 Ball and seat: replaceable hard chrome solid ball and Teflon seats.
- .7 Stem seal: TFE with external packing nut.
- .8 Operator: removable lever handle.

## **2.3 BUTTERFLY VALVES - RESILIENT SEAT**

- .1 Pressure rating: Class 150.
- .2 To be suitable for dead-end service.
- .3 CRN registration number required for products.
- .4 Minimum seat temperature ratings to 121 degrees C.
- .5 Application: on-off operation.
- .6 Grooved or flanged ends.
- .7 Operators:
  - .1 Handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.
- .8 Designed to comply with MSS SP-67 and API 609.
- .9 Compatible with ANSI Class 125/Class 150 flanges.
- .10 Construction:
  - .1 Body ductile iron.
  - .2 Disc: aluminum bronze
  - .3 Seat: EPDM to ASTM D2000, Grade E.
  - .4 Shaft: 316 stainless steel.
  - .5 Taper pin: 316 SS.
  - .6 Key: carbon steel.
  - .7 O-Ring: EPDM to ASTM D2000, Grade E.
  - .8 Bushings: Teflon.

## **2.4 CHECK VALVES**

- .1 DN 65 and over, flanged ends, Class 150: swing check.
  - .1 Body and multiple-bolted cap: cast steel to ASTM A216/A216M WCB.
  - .2 Cap studs: to ASTM A193/A193M Type B7.
  - .3 Cap nuts: to ASTM A194/A194M Type 2H.
  - .4 Body/cap joint: male-female face with corrugated metallic gasket.
  - .5 Disc: heat treated corrosion and heat resistant 13% chromium steel.

- .6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.
- .7 Hinge: ASTM A182/A182M.
- .8 Hinge pin: ASTM A182/A182M.
- .9 Hinge pin plugs: ASTM A182/A182M.

## **2.5 SILENT CHECK VALVES**

- .1 Construction:
  - .1 Body: cast steel with integral seat.
  - .2 Pressure rating: Class 125.
  - .3 Connections: flanged or grooved ends.
  - .4 Double bronze disc with SS seat and stem. Renewable disc, seat, stem and spring. Spring rating must match system design for silent operation and installation.
  - .5 Seat: regrindable.

## **2.6 NATURAL GAS PLUG COCKS**

- .1 Pressure rating: Class 125.
- .2 50 mm and smaller:
  - .1 Body: cast iron
  - .2 Plugs and Washers: brass
  - .3 Connection: screwed ends
- .3 65 mm and larger:
  - .1 Body: cast iron
  - .2 Plug: cast iron
  - .3 Lubrication: pressure lubricated
  - .4 Connection: flanged ends

## **Part 3 Execution**

### **3.1 INSTALLATION**

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

### **3.2 VALVE OPERATORS**

- .1 Provide suitable die-cast handwheels for globe, radiation, drain valves and inside hose bibbs.
- .2 Supply one plug cock wrench for every ten plug cocks 50 mm and smaller; supply wrench and set screws with each plug cock 65 mm and larger.

- .3 Provide latch lock throttling handle for butterfly valves 150 mm and smaller and gear operators for 200 mm and larger.

### **3.3 VALVE SCHEDULE**

- .1 Provide valves as indicated on the drawings and as outlined in the following schedule:

- .1 Globe and Angle Globe Valves:
  - .1 Throttling service
  - .2 Control device
  - .3 Meter bypass
- .2 Swing Check Valves:
  - .1 Discharge of pumps
- .3 Non-Lubricated Plug Cocks:
  - .1 Gas service
- .4 Drain Valve:
  - .1 Near main shut-off valves
  - .2 Low points in piping systems
  - .3 At equipment
- .5 Butterfly Valves:
  - .1 Interchangeable with gate and globe valves
- .6 Ball Valves:
  - .1 Shut-off and isolation
  - .2 Isolating service
  - .3 Low water cut-offs
  - .4 Boiler drains
  - .5 Chemical pot feeders
  - .6 Heating system water

### **3.4 CLEANING**

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

**END OF SECTION**



**Part 1 General****1.1 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B31.1-07, Power Piping.
- .2 ASTM International
  - .1 ASTM A125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
  - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 Underwriter's Laboratories of Canada (ULC)

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

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

**Part 2 Products****2.1 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 SP58.
  - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
  - .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
  - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

**2.2 GENERAL**

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58.

**2.3 PIPE HANGERS**

- .1 Finishes:
  - .1 Pipe hangers and supports: steel, prime coated or hot dip galvanized
  - .2 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut 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.
- .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.
  - .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 to MSS SP69.
- .5 Hanger rods: threaded rod material to MSS SP58:
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
- .6 Pipe attachments: material to MSS SP58:
  - .1 Attachments for steel piping: carbon steel black
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Use insulation shields for hot pipework.
  - .4 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to 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 rivetting to insulation shields.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .9 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
  - .1 Finishes for steel pipework: black.
  - .2 Finishes for copper, glass, brass or aluminum pipework: black
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

## **2.4 EQUIPMENT SUPPORTS**

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

## **2.5 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

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

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

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

**3.2 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
  - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and 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.

**3.3 HANGER SPACING**

- .1 Plumbing piping: to Canadian Plumbing Code.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m

5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

- .7 Pipework greater than NPS 12: to 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 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 CLEANING

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 National Building Code of Canada (NBC) - 1995

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Manufacturer's Field Reports: manufacturer's field reports specified.

**1.3 DELIVERY, STORAGE, AND HANDLING**

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

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

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

**2.2 ELASTOMERIC PADS**

- .1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.
- .2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30durometer natural rubber; maximum loading 415 kPa.

**2.3 SPRINGS**

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

**2.4 HANGERS**

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

**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 vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- .2 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.
- .3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
  - .1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.
  - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .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.

**3.3 CLEANING**

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

**3.4 VIBRATION ISOLATION SCHEDULE:**

ISOLATED EQUIPMENT		BASE		ISOLATOR		
Description	Unit No.	Type	Thickness mm	Type	Static Deflection mm	Remarks
Horizontal Inline Pumps		EP-1	20 mm	H2	25 mm	On housekeeping pad
Boilers		EP-2	20 mm			On housekeeping pad
Return Fan	RF-AHU1			H2	25 mm	

**END OF SECTION**



**Part 1 General**

**1.1 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.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 QUALITY ASSURANCE**

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .2 Dispose of unused paint or coating material at official hazardous material collections site
  - .3 Do not dispose of unused paint or 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      Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2      Lettering and numbers raised or recessed.
- .3      Information to include, as appropriate:
  - .1          Equipment: manufacturer's name, model, size, serial number, capacity.
  - .2          Motor: voltage, Hz, phase, power factor, duty, frame size.

**2.2                EXISTING IDENTIFICATION SYSTEMS**

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

**2.3                PIPING SYSTEMS GOVERNED BY CODES**

- .1      Identification:
  - .1          Natural gas: to CSA/CGA B149.1.

**2.4                IDENTIFICATION OF PIPING SYSTEMS**

- .1      Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2      Pictograms:
  - .1          Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3      Legend:
  - .1          Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4      Arrows showing direction of flow:
  - .1          Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
  - .2          Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
  - .3          Use double-headed arrows where flow is reversible.
- .5      Extent of background colour marking:
  - .1          To full circumference of pipe or insulation.
  - .2          Length to accommodate pictogram, full length of legend and arrows.
- .6      Materials for background colour marking, legend, arrows:

- .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
- .2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
  - .1 Where not listed, obtain direction from Departmental Representative.
  - .2 Colours for legends, arrows: to following table:

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

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

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Domestic cold water supply	Green	DOM. CWS
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Make-up water	Yellow	MAKE-UP WTR
Natural gas	to Codes	
Gas regulator vents	to Codes	

## 2.5 IDENTIFICATION DUCTWORK SYSTEMS

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

## 2.6 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.

## 2.7 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.

## 2.8 LANGUAGE

- .1 Identification in English.

**Part 3            Execution**

**3.1                MANUFACTURER'S INSTRUCTIONS**

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

**3.2                TIMING**

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

**3.3                INSTALLATION**

- .1        Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2        Identify systems, equipment to conform to PWGSC PMSS.

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

### **3.7 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 QUALIFICATIONS OF TAB PERSONNEL**

- .1 Submit names of personnel to perform TAB to Departmental Representative within 90 days of award of contract.
- .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 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
- .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.

**1.2 PURPOSE OF TAB**

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

**1.3 EXCEPTIONS**

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

**1.4 CO-ORDINATION**

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

**1.5 PRE-TAB REVIEW**

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

**1.6 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.

**1.7 OPERATION OF SYSTEMS DURING TAB**

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

**1.8 START OF TAB**

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 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 Liquid systems:
    - .1 Flushed, filled, vented.
    - .2 Correct pump rotation.
    - .3 Strainers in place, baskets clean.
    - .4 Isolating and balancing valves installed, open.
    - .5 Calibrated balancing valves installed, at factory settings.
    - .6 Chemical treatment systems complete, operational.

**1.9 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
  - .1 Hydronic systems: plus or minus 10 %.

**1.10 ACCURACY TOLERANCES**

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

**1.11 INSTRUMENTS**

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

**1.12 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.13 PRELIMINARY TAB REPORT**

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

**1.14 TAB REPORT**

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
  - .1 Project record drawings.
  - .2 System schematics.
- .3 Submit electronic copy in PDF format of TAB Report to Departmental Representative for verification and approval, in English complete with PDF bookmarks.

**1.15 VERIFICATION**

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



- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

#### **1.16 SETTINGS**

- .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

#### **1.17 COMPLETION OF TAB**

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

#### **1.18 AIR SYSTEMS**

- .1 Standard: TAB to most stringent of TAB standards of AABC or NEBB.
- .2 Do TAB of following systems, equipment, components, controls:
  - .1 Air System Refurbished Supply Fans (Total of 5)
  - .2 Air System New Return Fan (Total of 5)
- .3 Qualifications: personnel performing TAB current member in good standing of AABC NEBB qualified to standards of AABC NEBB.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC or NEBB.
- .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, dewpoint), 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, humidifier, fan, other equipment causing changes in conditions.
  - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include main ducts only.
  - .1 TAB procedures:
    - .1 Perform air balance measurements of existing systems prior to commencing demolition or refurbishment of the air systems. This will establish a base operating case.
    - .2 Perform air balancing and measurements again after work is complete and the system is operating.

#### **1.19 MECHANICAL SYSTEMS**

- .1 Standard: TAB to most stringent of this section or TAB standards of NEBB.
- .2 Do TAB of systems, equipment, components, controls specified Division 23

- .3 Qualifications: personnel performing TAB are current members in good standing of NEBB
- .4 Quality assurance: perform TAB under direction of supervisor qualified by NEBB.
- .5 Measurements to include: flow rates, pressure drop (or loss), temperatures, RPM, electrical power, voltage, noise, vibration.
  - .1 At equipment.

## **Part 2 Products**

### **2.1 INSTRUMENTS**

- .1 Instruments: For testing and balancing of air and hydronic systems; all instruments shall have been calibrated within a period of six months and verified for accuracy prior to start of work.
- .2 Submit a list of equipment which will be used for the balancing of systems and the accuracy of test certification.
- .3 Measuring devices specified within Divisions 20 – 23, inclusive work such as water control devices and meters may be used providing the manufacturer submits documentation proving suitable calibration.

## **Part 3 Execution**

### **3.1 BALANCING SCHEDULE**

- .1 Equipment to be balanced - typical for five (5) units:
  - .1 Boiler B1, B2
  - .2 Boiler Pumps P-B1, P-B2
  - .3 Heating Distribution Pumps P-1, P-2
  - .4 Expansion Tank TK-1
  - .5 Venturi Flow measuring station.

### **3.2 GENERAL PROCEDURE**

- .1 Permanently mark settings on valves, splitters, dampers and other adjustment devices.
- .2 Take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- .3 At the completion during balancing procedures, allow for a minimum of two days for the Departmental Representative to witness test procedures and conduct tests.
- .4 When building is occupied prior to completion of balancing work, continue execution of such work outside of occupied hours.

### **3.3 SITE VISITS**

- .1 Schedule a total of 5 site visits to correspond with site meetings held by the Contractor. After each site visit submit a written report to the Contractor and Departmental

Representative. Site visits shall commence after the start of air distribution work and be spread over the construction period to the start of the balancing work.

- .2 A review of the installation shall be made at the scheduled visit and any additional dampers or valves required for proper balance shall be reviewed with the Departmental Representative and the Contractors.
- .3 Allow for 2 visits to the site to adjust systems for seasonal changes during warranty.

### **3.4 ACCEPTANCE**

- .1 Mechanical systems shall not be considered ready for final inspection until balancing results acceptable to the Departmental Representative are obtained.
- .2 If it is found that the specified air flows cannot be achieved on portions of the system, the actual conditions shall be reported to the Departmental Representative for consideration of corrective action before continuing the balancing procedure.
- .3 If measured flow at final inspection shows deviation of 10% or more or mean sound level deviation of 10 db or more from the certified report listings, by more than 10% of selected areas, the report shall be rejected.
- .4 If report is rejected, systems shall be re-balanced and a new certified report submitted at no extra cost.

### **3.5 BALANCING REPORT**

- .1 Provide reports in soft cover 3-ring binder manuals, complete with contents, page and indexing tabs and cover identification at front and side.
- .2 Include types, serial number and dates of calibration of instruments.
- .3 Record test data on a drawing made from the latest available revised set of mechanical drawings and submit a PDF and 3 copies upon completion of the balancing contract.
- .4 Install at each piece of mechanical equipment a "Data Register" showing significant operating temperatures, pressures, amperes, voltage, brake horsepower. "Data Register" to be enclosed in a laminated plastic securely attached to the equipment or to a wall in the adjacent area.
- .5 Submit with report, fan and pump curves with operating conditions plotted. Submit grille and diffuser shop drawings and diffusion factors.
- .6 Report shall be indexed as follows:
  - .1 Water
    - .1 Summary
    - .2 Procedure
    - .3 Instrumentation
    - .4 Drawings
    - .5 Pump Data
    - .6 Pump Curves
    - .7 Flow Stations
  - .2 Equipment Data

- .1 Element Data Summary and Schematics (per system)
- .2 Diagnostic
- .3 Summary
- .4 Procedure
- .5 Instrumentation
- .6 Drawings
- .7 Profile
- .8 Scale Readings

### 3.6 HYDRONIC SYSTEMS PROCEDURE

- .1 Preparation of System - Phase I: The hydronic system shall be prepared for balancing in the following manner:
  - .1 Open all valves to full position including coil stop valves: close bypass valves; and return line balancing cocks.
  - .2 Examine water in system to determine if it has been treated and is clean.
  - .3 Check pump rotation.
  - .4 Check expansion tanks to ensure they are not air bound and that the system is full of water.
  - .5 Check air vents at high points of water systems to ensure they are installed properly and are operating freely. Make certain air is removed from circulating system.
  - .6 Set temperature controls so that coils are calling for full flow. This should close all automatic bypass valves.
  - .7 Check operation of automatic bypass valves.
  - .8 Check and set operating temperature of boiler and chiller design requirements.
  - .9 Execute air balance before water balance is initiated.
- .2 Test and Balance Procedure – Phase II (Variable Speed Pump System)
  - .1 Turn pumps to 0% (off) and record differential pressure from the control system.
  - .2 Adjust differential pressure if required with a constant offset such that there is 0 differential pressures for 0 flow.
  - .3 Set and lock all control valves to 100% open, and bypass valves to 0% open.
  - .4 Set and lock pump VFD to 100%.
  - .5 Adjust pump flow rate using the triple duty valve to achieve design flow rate
  - .6 Check and record flow rates, pressure differentials, and temperature differentials across the coils.
  - .7 Position and mark all automatic valves, hand valves, and balancing cocks for design flow through all coils, connectors, and all items in system requiring circulation.
  - .8 Upon completion of flow readings and coil adjustments, mark settings and record data.
  - .9 Re-adjust pump flow rate using the triple duty valve to design flow rate.

- .10 Record pressure system differential pressure from control system developed under balanced conditions.
- .11 Revise differential pressure set point to value recorded.
- .12 Release control valves and Pump VFDs to automatic.
- .13 Open pump triple duty valve back to 100% open. Pump VFD will ramp down to maintain setpoint.
- .3 Test and Balance Procedure - Phase II (Constant Speed Pump Systems)
  - .1 Set pumps to deliver approximately 10% excess flow volume if possible.
  - .2 Adjust flow of water through boiler.
  - .3 Check and record leaving water temperatures and return water temperatures and pressure drop through boiler and chiller. Reset to design temperatures.
  - .4 Check and record water temperature at inlet side of coils. Note rise or drop of temperatures from source.
  - .5 Position and mark all automatic valves, hand valves and balancing cocks for design flow through all coils, connectors and all items in system requiring circulation of chilled water, hot water or glycol.
  - .6 Upon completion of flow readings and coil adjustments, mark settings and record data.
  - .7 Coordinate shaving of pump impeller to pump operating condition on pumps larger than 1.5 kW.
  - .8 Ensure all bypass valves are tightly closed.
- .2 Test and Balance Procedure - Phase III:
  - .1 After making adjustments to coils, re-check settings at pumps. Re- adjust if required.

### **3.7 BALANCING DATA**

- .1 Balance and equipment data shall be listed in SI metric units.
- .2 Pump Installation Data:
  - .1 Manufacturer and model
  - .2 Size
  - .3 Drive type
  - .4 Motor type, kW, r/min, voltage, phase, cycles and full load motor amps.
- .3 Pump Design Data:
  - .1 Water flow rate
  - .2 Pressure
  - .3 r/min
  - .4 kW.
- .4 Pump Recorded Data:
  - .1 Discharge and suction pressures (full flow and no flow)
  - .2 Operating pressure and total dynamic head

- .3 Operating water flow rate (from pump curves if metering not provided)
- .4 Motor operating amps.
- .5 Expansion Tank Installation Data:
  - .1 Manufacturer, size, capacity
  - .2 Pressure reducing valve setting
  - .3 Pressure relief valve setting.
- .6 Heating Equipment Design Data:
  - .1 Heat transfer rate
  - .2 Water flow rate
  - .3 Entering and leaving water temperature
  - .4 Water pressure drop.
- .7 Heating Equipment Recorded Data:
  - .1 Element type and identification (location and designation)
  - .2 Entering and leaving water temperatures
  - .3 Water pressure drop.
  - .4 Water flow rate.

**END OF SECTION**

## 1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE 90.1-04-SI Edition, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 ASTM International Inc.
  - .1 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .2 ASTM C449/C449M-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .3 ASTM C547-07, Standard Specification for Mineral Fiber Pipe Insulation.
  - .4 ASTM C553-02, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .5 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .6 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
  - .1 CGSB 51-GP-52MA-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .2 CAN/CGSB 51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .5 South Coast Air Quality Management District (SCAQMD), California State
  - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .6 Thermal Insulation Association of Canada (TIAC)
  - .1 National Insulation Standards 2005.
- .7 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102-07, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

## 1.2 DEFINITIONS

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

.2 CPF: Code Piping Finish.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements SPEC NOTE: Co-ordinate the following paragraph when Section
- .3 Manufacturer's Instructions:
  - .1 Include procedures to be used and installation standards to be achieved.
- .4 Qualifications:
  - .1 Installer to be specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, member of TIAC.

### **1.4 DELIVERY, STORAGE AND HANDLING**

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

## **Part 2 Products**

### **2.1 FIRE AND SMOKE RATING**

- .1 Fire and smoke ratings to CAN/ULC-S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

### **2.2 INSULATION**

- .1 Mineral fibre: includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.



- .1 Mineral fibre: ASTM C547.
- .2 Maximum "k" factor: ASTM C547.
- .4 TIAC Code A.6: flexible unicellular tubular elastomer.
  - .1 Insulation: with vapour retarder jacket.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor.
  - .4 Certified by manufacturer free of potential stress corrosion cracking corrosdents.

## **2.3 CEMENT**

- .1 Thermal insulating and finish
  - .1 To: ASTM C449/C449M.
  - .2 Hydraulic setting or Air drying on mineral wool, to ASTM C449.

## **2.4 JACKETS**

- .1 Polyvinyl Chloride (PVC):
  - .1 One-piece moulded type and sheet to CAN/CGSB 51.53 with pre-formed shapes as required.
  - .2 Colours: White
  - .3 Minimum service temperatures: -20 degrees C.
  - .4 Maximum service temperature: 65 degrees C.
  - .5 Moisture vapour transmission: 0.02 perm.
  - .6 Thickness: 0.5 mm.
  - .7 Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
  - .8 Special requirements:
  - .9 Covering adhesive: compatible with insulation.
    - .1 Maximum VOC limit to SCAQMD Rule 1168
- .2 Canvas:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
  - .2 Lagging adhesive: compatible with insulation.
    - .1 Maximum VOC limit to SCAQMD Rule 1168

## **2.5 INSULATION SECUREMENTS**

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
  - .1 Maximum VOC limit to SCAQMD Rule 1168
- .3 Canvas adhesive: washable.
  - .1 Maximum VOC limit to SCAQMD Rule 1168

- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.
- .6 Fasteners: 4 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

### **Part 3 Execution**

#### **3.1 APPLICATION**

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

#### **3.2 PRE- INSTALLATION REQUIREMENTS**

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

#### **3.3 EQUIPMENT INSULATION INSTALLATION**

- .1 Install in accordance with TIAC National Standards
  - .1 Hot equipment: To TIAC code 1503-H.
- .2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.
- .3 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.
- .4 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .5 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports outside vapour retarder jacket.
- .6 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

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

- .1 Application: At valves, primary flow measuring elements, flanges and unions at equipment.
- .2 Installation to permit periodic removal and replacement without damage to adjacent insulation.

#### **3.5 PIPING INSULATION SCHEDULES**

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

- .2 TIAC Code: A-1.
  - .1 Securements: Tape or SS bands at 300 mm on centre.
  - .2 Seals: lap seal adhesive, lagging adhesive.
  - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
  - .1 Securements: Tape or SS bands at 300 mm on centre.
  - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
  - .3 Installation: TIAC Code: 1501-C.
- .4 Thickness of insulation as listed in following table.

Application	Temp deg C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6
Hot Water Heating	60 94	A-1	25	38	38	38	38
Hot Water Heating	up to 59	A-1	25	25	25	25	38
Domestic CWS		A-3	25	25	25	25	25

- .5 Finishes:
  - .1 Exposed in mechanical rooms: canvas or PVC jacket.
  - .2 Installation: to appropriate TIAC code CRF/1 through CPF/5.

### 3.6 CLEANING

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

**END OF SECTION**

**Part 1 General****1.1 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS**

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

**1.2 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 circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
    - .1 Pump operation.
    - .2 Boiler operation.
    - .3 Maximum heating demand.
    - .4 Boiler failure.
    - .5 Outdoor reset. Re-check boiler output supply temperature at 100% and 50% reset, maximum water temperature.

**1.3 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 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 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)
- .2 Test procedures:
  - .1 Open fully heating coil and radiation control valves.
  - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
  - .3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

#### **1.4 GASEOUS FUEL SYSTEMS**

- .1 Operation tests:
  - .1 Measure gas pressure at gas meter outlet and at burner manifold.
  - .2 Verify details of temperature and pressure compensation at meter.
  - .3 Verify settings, operation, venting of high and low pressure cut-outs, alarms.
  - .4 Check terminals of vents for gas pressure regulators.

#### **1.5 REPORTS**

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, supplemented as specified herein.

#### **1.6 TRAINING**

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel.

### **Part 2 Products**

#### **2.1 NOT USED**

- .1 Not Used.

### **Part 3 Execution**

#### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
  - .1 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 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 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 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
  - .1 Fill system with water, 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 degrees 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 degrees 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 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment Systems.
  - .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
  - .8 Repeat with water at design temperature.
  - .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
  - .10 Bring system up to design temperature and pressure slowly.
  - .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
  - .12 Adjust pipe supports, hangers, springs as necessary.
  - .13 Check operation of drain valves.
  - .14 Adjust valve stem packings as systems settle down.
  - .15 Fully open balancing valves (except those that are factory-set).
  - .16 Check operation of over-temperature protection devices on circulating pumps.
  - .17 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

### **3.4 CLEANING**

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

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1 ANSI/AWWA C111/A21.11-06, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .2 American Society of Mechanical Engineers (ASME)
  - .1 ASME B16.3-06, Malleable Iron Threaded Fittings: Classes 150 and 300.
  - .2 ASME B16.5-09, Pipe Flanges and Flanged Fittings: NPS through NPS 24 Metric/Inch Standard.
  - .3 ASME B16.9-07, Factory-Made Wrought Buttwelding Fittings.
  - .4 ASME/ANSI B16.18-1984(R1994) - Cast Copper Alloy Solder Joint Pressure Fittings
  - .5 ASME B16.22-2012 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
  - .6 ASME/ANSI B16.39-86(R1998) - Malleable Iron Threaded Pipe Unions
- .3 ASTM International
  - .1 ASTM A183 - 03(2009) Standard Specification for Carbon Steel Track Bolts and Nuts
  - .2 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
  - .3 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
  - .4 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.
  - .5 ASTM B32 - 08 Standard Specification for Solder Metal
  - .6 ASTM B88-09, Standard Specification for Seamless Copper Water Tube

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate on drawings:
    - .1 Components and accessories.

**1.3 CLOSEOUT SUBMITTALS**

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

- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.
  - .1 Include special servicing requirements.

#### **1.4 EXTRA STOCK MATERIALS**

- .1 Supply spare parts as follows:
  - .1 Gaskets for flanges: 1 minimum for every ten flanges.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

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

### **Part 2 Products**

#### **2.1 PRODUCT SELECTION**

- .1 Pipe and pipe fittings are specified by system.
- .2 Within each system one or more materials may be specified. Unless otherwise specified, any of the specified pipe, fitting and joint materials may be used in construction of the system.

#### **2.2 HYDRONIC HEATING SYSTEMS (UP TO 110°C, UP TO 1035 KPA)**

- .1 Ferrous
  - .1 Pipe:
    - .1 Black Steel Pipe: electric resistance welded, schedule 40 to ASTM A53, Grade B.
  - .2 Fittings:
    - .1 Malleable Iron Threaded Fittings: to ANSI B16.3.
    - .2 Wrought Steel Butt Welding Fittings: factory made to ANSI B16.9.
    - .3 Malleable Iron Cast Fittings: to ASTM A47.
    - .4 Ductile Iron Cast Fittings: to ASTM A536.

- .3 Joints:
  - .1 Steel Flanges and Fittings: to ANSI B16.5.
  - .2 Unions: to ANSI B16.9.
- .4 Grooved Piping System:
  - .1 Couplings: Victaulic style 07 couplings to ASTM A-47
    - Style 750 on reducing couplings
    - Style 741 or 743 on all flanged component connections
    - Style 77, 75 flexible couplings on connections to mechanical equipment
    - Style 72 outlet couplings on pipe headers
  - .2 Fittings: Victaulic full flow malleable iron or ductile iron fittings with grooved or shouldered ends to ASTM A536 (Ductile iron); ASTM A53 or A120 (Fabricated Steel).
  - .3 Gaskets: Pressure responsive type where pressure increases ability to seal; EPDM Grade E with green colour code identification to ASTM D-2000, suitable for -35°C to +110°C operating temperature range.
  - .4 Bolts and Nuts: Heat treated carbon steel to ASTM A183.
  - .5 Flanges: Victaulic Style 741 ANSI Class 125/150 ductile iron flanges to ASTM A183, suitable for opening, engaging grooves and securing in position with a tight fitting lock bolt.
  - .6 Pipe: Roll or cut grooved pipe in accordance with Victaulic coupling manufacturer's specifications. Use only specially designed tools available from Victaulic for grooving pipe on site.
  - .7 Approved alternate manufacturers: Grinnell.
- .2 Copper
  - .1 Pipe:
    - .1 Copper Tube: Type L to ASTM B88.
  - .2 Fittings:
    - .1 Wrought Copper, Solder Joint: to ANSI B16.22.
    - .2 Cast Copper, Solder Joint: to ANSI B16.18.
  - .3 Joints:
    - .1 Solder: to ASTM B32.

## **2.3 EQUIPMENT DRAINS AND OVERFLOW SYSTEMS**

- .1 Ferrous
  - .1 Pipe:
    - .1 Galvanized Steel: electric resistance welded, schedule 40 to ASTM A53 Grade B.
  - .2 Fittings:
    - .1 Galvanized Malleable Iron Threaded Fittings: 1034 kPa banded to ANSI B16.3.

- .3 Joints:
  - .1 Unions: to ANSI B16.39.
  - .2 Threaded Fittings: protected with galvanized pipe paste.
- .2 Copper
  - .1 Pipe:
    - .1 Copper tube, Type "L" to ASTM B88M.
  - .2 Fittings:
    - .1 Wrought Copper, Solder Joint: to ANSI B16.22.
  - .3 Joints:
    - .1 Solder: to ASTM B32.

## **2.4 DOMESTIC WATER SYSTEMS (ABOVE GRADE)**

- .1 Copper
  - .1 Pipe:
    - .1 Copper Tube: Type "L" to ASTM B88M for nominal pipe diameters up to and including 50 mm.
  - .2 Fittings:
    - .1 Wrought Copper: solder joint type to ANSI B16.22.
    - .2 Cast Copper: solder joint type to ANSI B16.8.
    - .3 Grooved Victaulic: mechanical coupling to ASTM B.75 with Grade E EDPM gasket to ASTM D-2000 (for sizes 75 mm to 150 mm), suitable for operating temperatures up to 110°C.
  - .3 Joints:
    - .1 Solder: 95/5 (95% tin; 5% other metals; lead free to ASTM B32).

## **2.5 NATURAL GAS SYSTEMS (INSIDE BUILDING)**

- .1 Ferrous
  - .1 Pipe:
    - .1 Black Steel Pipe: electric resistance welded, schedule 40 to ASTM A53, Grade B.
  - .2 Fittings:
    - .1 Malleable Iron Threaded Fittings: to ANSI B16.3 (for pipe diameters up to and including 50 mm).
    - .2 Wrought Steel Butt Welding Fittings: to factory made ANSI B16.9.
  - .3 Joints:
    - .1 Steel Flanges and Fittings: to ANSI B16.5.
    - .2 Unions: to ANSI B16.9.

**Part 3            Execution**

**3.1                EXAMINATION**

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

**3.2                PIPING INSTALLATION**

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

**3.3                CLEANING, FLUSHING AND START-UP**

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

**3.4                TESTING**

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

**3.5                BALANCING**

- .1      In accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

**3.6                GLYCOL CHARGING**

- .1      Include mixing tank and positive displacement pump for glycol charging.
- .2      Retest for concentration to ASTM E202 after cleaning.

**3.7                PERFORMANCE VERIFICATION**

- .1      In accordance with Section 23 08 01 - Performance Verification Mechanical Piping Systems.

**3.8                CLEANING**

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

- .2 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.9 PROTECTION**

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

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME-04(2007), Boiler and Pressure Vessel Code.
- .2 ASTM International Inc.
  - .1 ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A278/A278M-01(2006), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
  - .3 ASTM A516/A516M-06, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  - .4 ASTM A536-84(2004), Standard Specification for Ductile Iron Castings.
  - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International)
  - .1 CSA B51-03(R2003), Boiler, Pressure Vessel, and Pressure Piping Code.
  - .2 CSA B51-03(R2005), Boiler, Pressure Vessel, and Pressure Piping Code, Supplement #1.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3                CLOSEOUT SUBMITTALS**

- .1 Submit maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals.

**1.4                DELIVERY, STORAGE AND HANDLING**

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

**Part 2            Products**

**2.1                DIAPHRAGM TYPE EXPANSION TANK**

- .1      Vertical galvanized steel pressurized diaphragm type expansion tank.
- .2      Capacity: as indicated.
- .3      Size: as indicated.
- .4      Diaphragm sealed in EPDM suitable for 115 degrees C operating temperature.
- .5      Working pressure: 860 kPa with ASME stamp and certification.
- .6      Air precharged to 84 kPa (initial fill pressure of system).
- .7      Base mount for vertical installation.
- .8      Supports: provide supports with hold down bolts and installation templates.

**2.2                AUTOMATIC AIR VENT**

- .1      Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.
- .2      Float: solid material suitable for 115 degrees C working temperature.

**2.3                AIR SEPARATOR - IN-LINE**

- .1      Working pressure: 860 kPa.
- .2      Size: as indicated.

**2.4                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 steel body to ASTM A278/A278M, Class 30, flanged connections.
- .3      NPS 2 to 12: T type with ductile iron body to ASTM A536, grooved ends.
- .4      Blowdown connection: NPS 1.
- .5      Screen: stainless steel with 1.19 mm perforations.
- .6      Working pressure: 860 kPa.

**2.5                SUCTION DIFFUSER**

- .1      Body: cast iron with flanged connections.
- .2      Strainer: with built-in, disposable 1.19 mm mesh, low pressure drop screen and NPS 1 blowdown connection.
- .3      Permanent magnet particle trap.
- .4      Full length straightening vanes.
- .5      Pressure gauge tappings.
- .6      Adjustable support leg.



**2.1 TRIPLE DUTY VALVE**

- .1 Configuration: Straight
- .2 Construction: Per ANSI B1.20.1-38
- .3 Pressure rating: 862 kPa
- .4 Body: Cast Iron with Flanged connections
- .5 Seat: Bronze
- .6 Disk: Bronze with EPDM seat insert.
- .7 Stainless steel stem, and spring
- .8 Provide Cv rating at every 10% increment opening.
- .9 Pressure gauge tapings.

**Part 3 Execution**

**3.1 APPLICATION**

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

**3.2 GENERAL**

- .1 Run drain lines and blow off connections to terminate above nearest drain.
- .2 Maintain adequate clearance to permit service and maintenance.
- .3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .4 Check shop drawings for conformance of tapings for ancillaries and for equipment operating weights.

**3.3 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 larger than NPS 1 and radiation except at radiation and as indicated.

**3.4 AIR VENTS**

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

**3.5 EXPANSION TANKS**

- .1 Adjust expansion tank pressure to suit design criteria.

- .2 Install lockshield type valve at inlet to tank.

**3.6 PRESSURE SAFETY RELIEF VALVES**

- .1 Run discharge pipe to terminate above nearest drain.

**3.7 SUCTION DIFFUSERS**

- .1 Install on inlet to pumps as indicated.

**3.8 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers Advisory Council (EEMAC)
- .3 Canadian Standards Association (CSA International)
  - .1 CSA-B214-07, Installation Code for Hydronic Heating Systems.
- .4 National Electrical Manufacturers' Association (NEMA)
  - .1 NEMA MG 1-2006, Motors and Generators.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for pump, circulator, and equipment, and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.
- .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.

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 MAINTENANCE**

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

**1.5 DELIVERY, STORAGE AND HANDLING**

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

**Part 2            Products**

**2.1                SUSTAINABLE REQUIREMENTS**

**2.2                EQUIPMENT**

- .1            Size and select components to: CSA-B214.

**2.3                IN-LINE CIRCULATORS**

- .1            Construction: STD125
- .2            Connection: 1.5 in. Dia. 2-Bolt flanges, Companion Flange Cast Iron 1-1/2
- .3            Impeller: 30% Glass-filled Noryl
- .4            Bearings: Permanently lubricated SS
- .5            Seal Type: Bellows-style Silicon Carbide
- .6            Capacity: as indicated
- .7            Motor Enclosure: ODP

**2.4                VERTICAL IN-LINE CIRCULATORS**

- .1            Type: single stage, single suction, with pump characteristics which provide rising heads to shut off. Split-coupled type VIL units, with rigid spacer type coupling.
- .2            Pump Construction:
  - .1            Pump Casing: Cast Iron with 125 psig ANSI/PN16 flanges for working pressure below 175 psig (12 bar) at 150°F (65°C)
  - .2            Suction and discharge connections: flanged, same size, and drilled and tapped for seal flush and gauge connections.
- .3            Impeller: Bronze, fully enclosed type. Dynamically balanced. Two-plane balancing is required where installed impeller diameter is less than 6 times the impeller width.
- .4            Shaft: Stainless Steel.
- .5            Coupling: Rigid spacer type of high tensile aluminum alloy. Coupling designed to be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and to be replaced without disturbing the pump or motor.
- .6            Mechanical Seals: Stainless Steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat. Provide 316 stainless steel gland plate and factory installed flush line with manual vent.
- .7            Provide split coupled pumps with a lower seal chamber throttle bushing to ensure seals maintain positively cooling and lubrication.
- .8            Seal flush line accessories: Supply in the flush line to the mechanical seal a 50 micron cartridge filter and sight flow indicator, to suit the working pressure encountered.
- .9            Filters shall be changed, by the installing contractor, after system is flushed and on a regular basis until turned over to the Departmental Representative.
- .10          VIL circulators complete with sensorless pump controller for variable speed operation:

- .1 Squirrel cage induction type driving motor incorporating with an integrated (in standard terminal box position) variable frequency drive (VFD), vertical solid shaft with IP55 enclosure and shall be of physical dimensions such that the pump size envelope is no larger than the fixed speed equivalent.
- .2 The integrated VFD shall be of the VVC-PWM type providing near unity displacement power factor ( $\cos \phi$ ) without the need for external power factor correction capacitors at all loads and speeds. The VFD shall incorporate DC link chokes for the reduction of mains borne harmonic currents to aid in compliance with the Electricity Council's Engineering Recommendation G5/4 Stage 2 and to reduce the DC link ripple current thereby increasing the DC link capacitors lifetime. The product shall be CE marked showing compliance with both the EMC Directive 89/336/EEC and the Low Voltage Directive 72/23/EEC. RFI filters will be fitted as standard to ensure the VFD meets the emission and immunity requirements of EN61800-3.
- .3 VFD and motor protection includes: motor phase to phase fault, motor phase to earth fault, loss of supply phase, over voltage, under voltage, motor over temperature, inverter overload, over current.
- .4 Sensorless control software embedded in the integrated VFD to provide automatic speed control in variable volume systems without the need for pump mounted (internal/external) or remote differential pressure sensor. The default operating mode under sensorless control shall be 'quadratic pressure control' whereby head reduction with reducing flow will be according to a quadratic control curve, the head at minimum flow being 40% of the design duty head. Control mode setting and minimum / maximum head setpoints shall be user adjustable via an optional programming interface.
- .5 The VFD shall have the following additional features:
  - .1 Sensorless override for BMS
  - .2 Manual pump control or closed loop PID control
  - .3 Programmable skip frequencies and adjustable switching frequency for noise/vibration control
  - .4 Auto alarm reset
  - .5 Motor pre-heat function,
  - .6 Four programmable digital inputs
    - .1 Two analogue inputs
    - .2 One programmable analogue/digital output
    - .3 One volt-free contact
  - .7 One RS485 port for serial communications to building management systems

## **Part 3 Execution**

### **3.1 APPLICATION**

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

### **3.2 INSTALLATION**

- .1 Install hydronic pumps to: CSA-B214.
- .2 In line circulators: install as indicated by flow arrows.
  - .1 Support at inlet and outlet flanges or unions.
  - .2 Install with bearing lubrication points accessible.
- .3 Ensure that pump body does not support piping or equipment.
  - .1 Provide stanchions or hangers for this purpose.
  - .2 Refer to manufacturer's installation instructions for details.
- .4 Pipe drain tapping to floor drain.
- .5 Install volute venting pet cock in accessible location.
- .6 Check rotation prior to start-up.
- .7 Install pressure gauge test cocks.

### **3.3 START-UP**

- .1 General:
  - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: 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 minimum.
  - .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.
  - .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.

### **3.4 PERFORMANCE VERIFICATION (PV)**

- .1 General:
  - .1 Verify performance in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.
- .2 Verify that manufacturer's performance curves are accurate.
- .3 Ensure 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 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) 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 Use Report Forms specified in Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.
  - .3 Pump performance curves (family of curves).

### **3.5 OPERATION REQUIREMENTS**

- .1 Operational requirements in accordance with Section 01 47 19 - Sustainable Requirements: Operations, include:
  - .1 Repair and maintenance materials and instructions.

### **3.6 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 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).

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1 Submit copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Closeout Submittals:
  - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
  - .2 Include following:
    - .1 Log sheets as recommended by manufacturer.

**1.3 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
  - .1
  - .2 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.



**Part 2            Products**

**2.1                MANUFACTURER**

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

**2.2                POT FEEDER**

- .1        Welded steel, pressure rating 1200 kPa. Temperature rating: 90 degrees C.

**2.3                CHEMICAL FEED PIPING**

- .1        Resistant to chemicals employed. Pressure rating: 1200 kPa.

**2.4                SHIPPING/FEEDING CHEMICAL CONTAINERS**

- .1        High density moulded polyethylene, with liquid level graduations, cover.

**2.5                CONDUCTIVITY CONTROLLER**

- .1        Fully transistorized, suitable for wall or flush panel mounting, linear over full measuring range of 0-5000 micromhs.
- .2        Insensitive to phase angle shifts, capable of operating on 95-130 Volts without affecting accuracy, power, bleedoff status lights.

**2.6                CONDUCTIVITY PROBES**

- .1        Dual carbon elements in PVC holder, quick disconnect, self-locking connection.

**2.7                WATER TREATMENT FOR HYDRONIC SYSTEMS**

- .1        Hot water heating system: pot feeder, 19 L, operating pressure 150 kPa.
- .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.
- .3        CHEMICALS
  - .1            Provide 1 years supply.
  - .2            Obtain chemicals from manufacturer with existing valid contract with Departmental Representative.
- .4        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**

- .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.
- .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 CHEMICAL FEED PIPING
  - .1 Install crosses at changes in direction. Install plugs in unused connections.
- .4 CLEANING OF MECHANICAL SYSTEM
  - .1 Provide copy of recommended cleaning procedures and chemicals for approval by Departmental Representative.
  - .2 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.
  - .3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.
  - .4 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
  - .5 Disposal of cleaning solutions approved by authority having jurisdiction.
- .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 Provide necessary recording charts and log sheets for one year operation.
    - .5 Provide necessary laboratory and technical assistance.
    - .6 Provide clear, concise, written instructions and advice to operating staff.
- .6 FIELD QUALITY CONTROL
  - .1 Start-up:
    - .1 Start up water treatment systems in accordance with manufacturer's instructions.
  - .2 Commissioning:
    - .1 Commissioning Agency: to be installing water treatment sub-contractor.
    - .2 Timing:
      - .1 After start-up deficiencies rectified.

- .2 After start-up and before TAB of connected systems.
- .3 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.
- .4 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 in writing on matters regarding installed water treatment systems.
- .5 Commissioning procedures - Water Softeners:
  - .1 Demonstrate compliance with specifications by chemical analyses of raw water and treated water.
  - .2 Determine, demonstrate actual softening capacity between regenerations.
  - .3 Establish regeneration intervals and procedures.
  - .4 Train O M personnel in regeneration procedures.
- .6 Commissioning procedures - Water side of closed circuit coolers, Cooling Tower Systems:
  - .1 Verify operation of bleed-off system.
  - .2 Establish bleed-off flow rate.
  - .3 Establish rate of chemical feed - continual and periodic.
  - .4 Test system water for chlorides, TDS, suspended solids, algae, slime, inhibitor level, pH, alkalinity, hardness, other impurities and microbiological organisms.
  - .5 Compare with readings of total dissolved and suspended solids metre.
  - .6 Read make-up water metre, compare with chiller load summation (ton-hours).

- .7 Test make-up water for chlorides, hardness.
- .8 Compare test results with readings from TDS metre.
- .9 Record quantity of make-up water, compare with summation of chiller load (in ton-hours).
- .10 Record types, quantities of chemicals applied.
- .7 Commissioning procedures - Closed Circuit Hydronic Systems:
  - .1 Analyze water in system.
  - .2 Based upon an assumed rate of loss approved by Departmental Representative, establish rate of chemical feed.
  - .3 Record types, quantities of chemicals applied.
- .8 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.
- .9 Certificates:
  - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .10 Commissioning Reports:
  - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative.
- .11 Commissioning activities during Warranty Period:
  - .1 Check out water treatment systems on regular basis and submit written report to Departmental Representative.

.7 CLEANING

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
  - .1 ASTM A480/A480M-12, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
  - .2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
  - .3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Green Seal Environmental Standards (GS)
  - .1 GS-36-11, Standard for Adhesives for Commercial Use.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
  - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
  - .3 IAQ Guideline for Occupied Buildings Under Construction 2007.
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
  - .1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Test and Evaluation Reports:
  - .1 Certification of Ratings:
    - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**1.3 DELIVERY, STORAGE AND HANDLING**

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

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect metal ducts from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

## **Part 2 Products**

### **2.1 SEAL CLASSIFICATION**

- .1 Classification as follows:

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

- .2 Seal classification:
  - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
  - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant tape or combination thereof.
  - .3 Class C: transverse joints and connections made air tight with gaskets sealant tape or combination thereof. Longitudinal seams unsealed.
  - .4 Unsealed seams and joints.

### **2.2 SEALANT**

- .1 Sustainability Characteristics:
  - .1 Adhesives and sealants: VOC limit to SCAQMD Rule 1168.
- .2 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

### **2.3 TAPE**

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

### **2.4 DUCT LEAKAGE**

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

### **2.5 FITTINGS**

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:

- .1 Rectangular: standard radius short radius with single thickness turning vanes centreline radius: 1.5 times width of duct.
- .2 Round: smooth radius five piece, centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm: with single double thickness turning vanes.
  - .2 Over 400 mm: with double thickness turning vanes.
- .4 Transitions:
  - .1 Diverging: 20 degrees maximum included angle.
  - .2 Converging: 30 degrees maximum included angle.
- .5 Offsets:
  - .1 Full radiused elbows.
- .6 Obstruction deflectors: maintain full cross-sectional area.
  - .1 Maximum included angles: as for transitions.

## 2.6 GALVANIZED STEEL

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

## 2.7 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
    - .1 Maximum size duct supported by strap hanger: 500.
  - .2 Hanger configuration: to ASHRAE SMACNA.
  - .3 Hangers: black galvanized steel angle with black galvanized steel rods to ASHRAE SMACNA following table:

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

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

**Part 3 Execution**

**3.1 EXAMINATION**

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

**3.2 GENERAL**

- .1 Do work in accordance with SMACNA.
- .2 Support risers in accordance with SMACNA.

**3.3 HANGERS**

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

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

**3.4 SEALING AND TAPING**

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

**3.5 LEAKAGE TESTS**

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

**3.6 CLEANING**

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

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- .2 ASTM International
  - .1 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - .2 ASTM C423-09a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
  - .3 ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
  - .4 ASTM E477-06a, Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- .3 National Building Code of Canada (NBC) 2011.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for silencers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit separate drawings for each piece of attenuation equipment complete with product data.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**1.3 DELIVERY, STORAGE AND HANDLING**

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

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

## **Part 2 Products**

### **2.1 PERFORMANCE REQUIREMENTS**

- .1 Rating Data:
  - .1 Provide performance rating data, certified by professional engineer or accredited test laboratory and supported by calculations and verified by test results in accordance with referenced standards as follows:
    - .1 Silencer: insertion loss, pressure drop at design conditions, generated noise level.
    - .2 Acoustical performance measurements in accordance with ASTM E477, ASTM E90 and ASTM C423, except where specified otherwise.

### **2.2 ABSORPTION AND INSULATING MEDIA**

- .1 Acoustic quality, glass fibre, bacteria and fungus resistant; free of corrosion causing or accelerating agents; packed to density to meet performance requirements; and meet NBC fire requirements or requirements of authority having jurisdiction for duct lining.

### **2.3 SILENCERS**

- .1 Factory manufactured of prime coated or galvanized steel, compatible with ductwork specified elsewhere and to ASHRAE and SMACNA standards.
- .2 Outer casing and galvanized steel inner casing with clean cut circular perforations to enclose acoustic media. Inner casing to have half-splitters pods running full length of silencer where any cross sectional dimension exceeds 450 mm. Protect media from erosion with Tedlar or Mylar between media and perforated metal.
- .3 Performance: as indicated.

## **Part 3 Execution**

### **3.1 EXAMINATION**

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

### **3.2 MANUFACTURER'S INSTRUCTIONS**

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

### **3.3 INSTALLATION**

- .1 Noise flanking: where indicated, install in wall sleeve with uniform clearance around to ensure no contact of silencer with wall sleeve. Pack with flexible, non hardening caulking on both sides of sleeves.
- .2 Instrument test ports: install at inlet and outlet to permit measurement of insertion loss and pressure loss.
- .3 Suspension: to manufacturer's instructions.

### **3.4 FIELD QUALITY CONTROL**

- .1 Testing:
  - .1 Experienced and competent sound and vibration testing professional engineer to take sound measurement after start up and testing, adjusting and balancing of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
  - .2 Sound measurements to extend over frequency range of 63Hz to 8 kHz and taken upstream and downstream of each silencer.
  - .3 Provide Departmental Representative 24 with notice hours in advance of commencement of tests.
  - .4 Establish adequacy of equipment isolation, acceptability of noise levels in occupied areas, other conditions affecting acoustics and, where appropriate, recommendation for remedial measures and costs.
  - .5 Submit complete report of test results including sound curves.

### **3.5 ADJUSTING**

- .1 Make adjustments and corrections in accordance with written report.
- .2 Provide Departmental Representative with notice 24 hours in advance of visit.

### **3.6 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

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

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect air duct accessories from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 GENERAL**

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

**2.2 FLEXIBLE CONNECTIONS**

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

## **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
- .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.

## **2.4 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.

## **Part 3 Execution**

### **3.1 EXAMINATION**

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

### **3.2 INSTALLATION**

- .1 Flexible Connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm.

- .3 Minimum distance between metal parts when system in operation: 75 mm.
- .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 Instrument Test Ports:
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
  - .2 Locate to permit easy manipulation of instruments.
  - .3 Install insulation port extensions as required.
  - .4 Locations:
    - .1 For traverse readings:
      - .1 Ducted inlets to roof and wall exhausters.
      - .2 Inlets and outlets of other fan systems.
      - .3 Main and sub-main ducts.
      - .4 And as indicated.
    - .2 For temperature readings:
      - .1 At outside air intakes.
      - .2 At inlet and outlet of coils.

### **3.3 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

**1.2 REFERENCES**

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
  - .1 ANSI/AMCA Standard 99-[2010], Standards Handbook.
  - .2 ANSI/AMCA Standard 210-[2007]/(ANSI/ASHRAE 51-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - .3 ANSI/AMCA Standard 300-[2008], Reverberant Room Method for Sound Testing of Fans.
  - .4 ANSI/AMCA Standard 301-[1990], Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 The Master Painters Institute (MPI)
  - .1 Architectural Painting Specification Manual - current edition.
    - .1 MPI #18, Primer, Zinc Rich, Organic.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
    - .1 Provide:
      - .1 Matched sets of belts.
      - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
        - .1 Bearings and seals.
        - .2 Addresses of suppliers.



- .3 List of specialized tools necessary for adjusting, repairing or replacing.

## **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect HVAC fans from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Waste Management and Disposal:
  - .1 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 Performance Requirements:
  - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
  - .2 Capacity: flow rate, static pressure, motor size (kW), bhp (kW), efficiency, revolutions per minute, model, size, sound power data and as indicated on schedule.
  - .3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA Standard 99.
  - .4 Sound ratings: comply with ANSI/AMCA Standard 301, tested to ANSI/AMCA Standard 300. Supply unit with ANSI/AMCA certified sound rating seal.
  - .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA Standard 210. Supply unit with ANSI/AMCA certified rating seal,

### **2.2 FANS GENERAL**

- .1 Motors:
  - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment, supplemented as specified herein.

- .2 Sizes as indicated on schedule.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet/outlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .5 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .6 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

### **2.3 MIXED FLOW FANS (TUBE-AXIAL)**

- .1 Casings: welded steel with welded motor support, bolted access plates, streamlined inlet cone and discharge bell sections and external intake silencer.
- .2 Blade material: steel.
- .3 Hub material: steel.
- .4 Supports:
  - .1 Ceiling suspended units: support brackets welded to side of casing. Extend grease lubrication facilities to outside of casing.
- .5 Bearings: L(10) ball or roller with extension tubes to outside of casing.
- .6 Belt drive:
  - .1 Drive adjustable blades by externally mounted motors through V-belt drive. Provide internal belt fairing, external belt guards and adjustable motor mounts.
- .7 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.
- .8 Matching inlet silencer

## **Part 3 Execution**

### **3.1 EXAMINATION**

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

**3.2 FAN INSTALLATION**

- .1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

**3.3 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standard Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE 52.2-12, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size (ANSI approved).
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-115.10-M90, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.
  - .2 CAN/CGSB-115.14-M91, High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems.
  - .3 CAN/CGSB-115.15-M91, High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
- .3 International Organization of Standardization (ISO)
  - .1 ISO 14644-1-99, Clean Rooms and Associated Controlled Environments - Part 1: Classification of Air Cleanliness.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC filters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**1.3 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
  - .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.
  - .3 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each.

**1.4 DELIVERY, STORAGE AND HANDLING**

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

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect HVAC filters from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Waste Management and Disposal:
  - .1 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Media: suitable for air at 100% RH and air temperatures between -40 and 50 degrees C.
- .2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated.
- .3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.

### **2.2 ACCESSORIES**

- .1 Holding frames: permanent "T" section or channel section construction of same material as casing, 1.6 mm thick, except where specified.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: through existing AHU access doors.

### **2.3 PANEL FILTERS**

- .1 Media: the air filter shall consist of a 3 ply panel filter element in a uniform non woven structure the filter shall be fabricated from variable denier Dacron fibres offering a graduated media with minimum loft of 40 mm and shall be progressively bonded with a fire retardant latex binder.
- .2 The filter shall contain a non migrating tackifier impregnated between the second and third ply to prevent unloading of the tackifier downstream.
- .3 Holding Frames: 1.214 mm core metal thickness minimum galvanized frame with expanded metal grid on leaving air side and steel rod grid on air entering side, hinged with pull and retaining handles.
- .4 The filter shall be Class II listed UL.

- .5 Filters containing asbestos, urea formaldehyde or fiberglass will not be accepted.
- .6 The filter shall have an average dust spot efficiency of 45% in accordance with ASHRAE 52 at 2.54 m/s maximum face velocity at a final resistance of 125 Pa.
- .7 MERV 13 rating.

## **2.4 PLEATED FILTERS**

- .1 Media: the filter shall be constructed of non-woven reinforced cotton-rayon. A diamond grid with 98% open area shall provide support for the media. The media shall be bonded to media support to ensure pleat stability. A rigid, moisture resistant heavy duty kraft board shall enclose the media. The filter pack shall be bonded to the inside periphery of the frame to eliminate air by pass.
- .2 The efficiency shall be 30% - 35% based on ASHRAE 52 up to 2.54 m/s 50 mm thick; and up to 3.05 m/s for 100 mm thick.
- .3 Filters containing asbestos, urea formaldehyde or fiberglass will not be accepted.
- .4 MERV 8 pre-filter.

## **2.5 FILTER GAUGES - DIAL TYPE**

- .1 Diaphragm actuated, direct reading.
- .2 Range: 0 to 250 Pa.

# **Part 3 Execution**

## **3.1 EXAMINATION**

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

## **3.2 INSTALLATION GENERAL**

- .1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

## **3.3 REPLACEMENT MEDIA**

- .1 Replace media with new upon acceptance.
- .2 Filter media new and clean, as indicated by pressure gauge, at time of acceptance.

**3.4 FILTER GAUGES**

- .1 Install type as indicated across each filter bank (pre-filter and final filter) in approved and easy readable location.
- .2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

**3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

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

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1 Submit copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Indicate following:
    - .1 Methods of sealing sections.
    - .2 Methods of expansion.
    - .3 Details of thimbles.
    - .4 Bases/Foundations.
    - .5 Supports.
    - .6 Guy details.
    - .7 Rain caps.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Closeout Submittals
  - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**1.3 QUALITY ASSURANCE**

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



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

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
  - .1 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 TYPE B GAS VENT**

- .1 ULC labelled, 288 degrees C rating maximum, atmospheric gas vent only.
- .2 Sectional, prefabricated, double wall with 13 mm air space. Aluminum inner wall. Galvanized steel outer wall. Mated fittings and couplings.

#### **2.2 ACCESSORIES**

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Barometric dampers: single acting, 70% of full size of breeching area. Acceptable Draft Ranges: 1.25Pa to 37.5 Pa.
- .3 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA).
- .4 Rain cap.
- .5 Expansion sleeves with heat resistant caulking, held in place as indicated.

### **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 - GENERAL**

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 Suspend breeching at 1.5 m centres and at each joint.
- .3 Support chimneys at bottom, roof and intermediate levels as indicated.

- .4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.
- .5 Install flashings on chimneys penetrating roofs, as indicated.
- .6 Install rain caps and cleanouts, as indicated.

**3.3 INSTALLATION - REFRACTORY LINED STEEL CHIMNEY**

- .1 Grind welds smooth to form appearance of single tube.
- .2 Seal insulating refractory at top of stack.
- .3 Pack annular space around breeching at entry tee with heat resistant caulking.
- .4 Run drain line from drain connection to nearest floor drain.
- .5 On completion, paint one coat of rust inhibitive primer and two coats of heat resisting paint of colour, make and quality approved by Departmental Representative.

**3.4 FIELD QUALITY CONTROL**

**3.5 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 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).

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1 Submit copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Indicate the following:
    - .1 General arrangement showing terminal points, instrumentation test connections.
    - .2 Plans, elevations, sections, details and attachments to other work
    - .3 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.

- .4 Foundations with loadings, anchor bolt arrangements.
- .5 Piping hook-ups.
- .6 Equipment electrical drawings.
- .7 Burners and controls.
- .8 All miscellaneous equipment.
- .9 Flame safety control system.
- .10 Breeching and stack configuration.
- .11 Wiring Diagrams for power, signal and control wiring
- .12 Source Quality Control Test Reports: Reports shall be included in submittals.
- .13 Field Quality Control Test Reports: Reports shall be included in submittals.
- .14 ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
- .3 Engineering data to include:
  - .1 Boiler efficiency at 25%, 50%, 75%, 100%, of design capacity.
  - .2 Radiant heat loss at 100% design capacity.
  - .3 Pressure Drop Curve: Submit pressure drop curve for flows.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals:
  - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

### **1.3 QUALITY ASSURANCE**

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial /Territorial regulations.
- .2 When the heating surface on the boiler is 2 square metres or larger, comply with the requirements of Alberta Regulation 49/2006 Safety Codes Act, Pressure Equipment Safety Regulation
- .3 Comply with Provincial Regulations and have CGA label. Construct CAN 1-3.1.
- .4 Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- .5 I=B=R Performance Compliance: boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within

- .6 prescribed tolerances.
- .7 .ASME Compliance: boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".
- .8 .ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- .9 .DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- .10 UL Compliance: Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- .11 NOx Emission Standards: When installed and operated in accordance with manufacturer's instructions, boilers shall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.1; and the Texas Commission on Environmental Quality (TCEQ), Title 30, Chapter 117, and Rule 117.465.

#### **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 Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
  - .1 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

#### **1.5 MAINTENANCE**

- .1 Extra materials:
  - .1 Special tools for burners, manholes, handholes and Operation and Maintenance.
  - .2 Spare parts for 1 year of operation.
  - .3 Spare gaskets.
  - .4 Spare gauge glass inserts.
  - .5 Probes and sealants for electronic indication.
  - .6 Spare burner tips.
  - .7 Spare burner gun.
  - .8 Safety valve test gauge.

**Part 2 Products**

**2.1 GENERAL**

- .1 The hydronic heating boiler shall be design certified by CSA international and shall meet the requirements of ANSI Z21.13, and CSA 4.9. The heating boiler shall be vented as a Category I or III.

**2.2 DIMENSIONS:**

- .1 Drawings indicate piping configuration for unit selected as basis of design.
- .2 Basis of Design Unit Dimensions: 1735mm Tall, 635mm Wide 685mm Deep
- .3 Ensure provided boiler works within available space constraints.

**2.3 PERFORMANCE OVERVIEW**

- .1 Efficiency: up to 85% thermal.
- .2 Four pass design Heat exchanger, cylindrical counter-flow water tube
- .3 Construction: 439 grade stainless steel construction and all welded design with integral 439 grade stainless heat transfer tubes and waterways.
- .4 Forced draft.
- .5 Furnace tube centrally located in boiler shell.
- .6 Tube bundle arranged to facilitate water circulation and prevent sludge accumulation.
- .7 Tubes rolled and beaded into tube sheets, accessible for cleaning and replacement.
- .8 Combustion chamber: refractory lined.
- .9 Access for cleaning water side: at least one manhole and adequate number of handholes.
- .10 Hinged or davitted gasketed front and rear heads with access to tube sheets without removal of any front end equipment.
- .11 3:1 gas input turn down ratio with sustained efficient combustion characteristics throughout entire modulating range.
- .12 Oxides of Nitrogen (NOx) of 9 ppm corrected to 3% oxygen.
- .13 Category I venting certification with Category III venting options.
- .14 Fully factory fire test boiler to obtain optimum combustion characteristics and to establish certified gas input rates.
- .15 System safety and operating devices and controls are fully configured, calibrated and factory tested.
- .16 Comply with the energy efficiency requirements of the ASHRAE 90.1-2007

**2.4 TRIM TO BE PROVIDED BY BOILER SUPPLIER**

- .1 ASME rated pressure relief valve.
- .2 Low water cut-off with automatic reset complete with electric test switch.

- .3 Provide inlet flow switch to automatically prevent burner operation when water flow fails.
- .4 Constant temperature controller complete with manual/auto switch.
- .5 High limit temperature controller with automatic reset shall control burner to prevent boiler water temperature from exceeding safe system temperature.
- .6 Blocked flue vacuum switch.
- .7 Indicating light package including: power on, operator, high limit, low water, low air, trial for ignition, main burner and flame failure.

## **2.5 FUEL BURNING SYSTEM**

- .1 Natural gas fired boiler shall have window view port for burner. Electronic intermittent pilot ignition and gas pressure regulator.
- .2 Provide flue gas collector and barometric damper when vented vertically.
- .3 The following venting options shall be utilized:
  - .1 Category I Venting - single vent or combined vent
- .4 The following category I vent material shall be utilized:
  - .1 'B' Type

## **2.6 ELECTRICAL POWER**

- .1 Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- .2 Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.
- .3 Electrical Characteristics: 115V/60Hz/1Ph

## **2.7 CONTROLS**

- .1 Provide pre-wired, factory assembled electric controls enclosed in cabinet.
- .2 Control string includes pilot safety and ignition transformer, 24-volt gas valve, manual main and pilot valves and junction box.
- .3 Provide terminal strip for control system interface, including terminals for flame failure.

## **2.8 SOURCE QUALITY CONTROL**

- .1 Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.
- .2 Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
  - .1 If boiler are not factory assembled and fire-tested, the local vendor is responsible for all field assembly and testing.

- .3 Allow Departmental Representative access to source quality-control testing of boilers. Notify Departmental Representative fourteen days in advance of testing.

### **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 using specified vibration isolation in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .5 Pipe hot water relief valves full size to nearest drain.
- .6 Pipe drain to floor drain.
- .7 Natural gas fired installations - in accordance with CAN/CSA-B149.1.

#### **3.3 MOUNTINGS 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.

#### **3.4 FIELD QUALITY CONTROL**

- .1 Perform tests and inspections and prepare test reports.
  - .1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- .2 Tests and Inspections:
  - .1 Perform installation and startup checks according to manufacturer's written instructions.
  - .2 Perform hydrostatic test. Repair leaks and retest until no leaks exist.



- .3 Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
- .4 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - .1 Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
  - .2 Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- .3 Remove and replace malfunctioning units and retest as specified above.
- .4 Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- .5 Performance Tests:
  - .1 The boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the boiler manufacturer to complete the following performance tests:
    - .1 Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
    - .2 Boiler shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
    - .3 Perform field performance tests to determine capacity and efficiency of boilers.
  - .2 Test for full capacity.
  - .3 Test for boiler efficiency at low fire, 20, 40, 60, 80, 100 percent of full capacity. Determine efficiency at each test point.
  - .4 Repeat tests until results comply with requirements indicated.
  - .5 Provide analysis equipment required to determine performance.
  - .6 Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
  - .7 Notify Departmental Representative in advance of test dates.
  - .8 Document test results in a report and submit to Departmental Representative.

### **3.5 CERTIFICATION**

- .1 Submit certification from boiler manufacturer that this equipment has been installed, connected and is ready to be put into operation in accordance with factory recommended procedure.

### **3.6 TRAINING**

- .1 Arrange for manufacturer's representative to attend training seminar and instruct Departmental Representative on routine maintenance procedures and operation.

**3.7 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
  - .1 ANSI/ARI 430-99(R2002), Central-Station Air-Handling Units.
- .2 American Society of Heating, Refrigeration and Air Condition Engineers (ASHRAE)
  - .1 ANSI/ASHRAE 90.1-2007, (I-P) Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - .2 ANSI/ASHRAE 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for insulation, filters, adhesives, and paints, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate following: Fan bearings, filters, dampers, coil;

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include following: fan bearings, motor, dampers, air volume, total heating, EDB, LDB, Water flow.

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide one spare set of filters.

**1.5 DELIVERY, STORAGE AND HANDLING**

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

- .3 Waste Management and Disposal:
  - .1 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

## **Part 2 Products**

### **2.1 GENERAL**

### **2.2 FILTER BOX**

- .1 Material to match casing. For Pleated and Panel type filter arrangement.
  - .1 Provide access to filter through existing hinged door with suitable hardware.
- .2 Provide blank-off plates and gaskets to prevent air bypass.
- .3 Filters: in accordance with Section 23 44 00 - HVAC Air Filtration.
  - .1 Immediately prior to occupancy, replace filtration media with new Pre-Filtration media with Minimum Efficiency Reporting Value (MERV) of 8, and with Final Filtration of MERV 13 in accordance with ASHRAE 52.2.

### **2.3 MIXING BOX**

- .1 Material to match casing and produce uniformly mixed air temperature within plus or minus 5 degreesC of design across face of outlet.
- .2 Dampers:
  - .1 Dampers for mixing boxes: in accordance with Section 253002 - EMCS Field Control Devices.

### **2.4 COILS**

- .1 Capacity: as indicated.
- .2 Ratings: ARI certified.
- .3 Construction:
  - .1 Casings: 1.5 mm thick galvanized sheet steel.
    - .1 Supports of galvanized steel channel.
    - .2 Blank-off plates. Insulated sandwich construction.
  - .2 Hot water coils: cleanable fins.
    - .1 Tubes: copper, brass or steel.
    - .2 Fins: copper or aluminum, plate or spiral wound.
    - .3 Headers: steel.
    - .4 Pressure tests: 1.7 MPa.

**Part 3            Execution**

**3.1                APPLICATION**

- .1      Refurbish existing Air Handling units with new components as indicated.
- .2      Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

**3.2                INSTALLATION**

- .1      Provide appropriate protection apparatus.
- .2      Install unit components in accordance with manufacturer's instructions and as indicated.
- .3      Ensure adequate clearance for servicing and maintenance.

**3.3                CLEANING**

- .1      Clean in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**