

1. GENERAL**1.1 Payment Procedures for Testing Laboratory Services**

- .1 Engage and pay for services of independent testing laboratory in accordance with Section 01 29 83 - Payment Procedures for Testing Laboratory Services.

1.2 Application

- .1 The air duct cleaning requirement are required for;
 - .1 New facility where air duct are used during construction
 - .2 New facility where air duct were not adequately protected during construction
 - .3 The procedures described herein will be applied if the use of HVAC systems during construction is approved by the Departmental Representative and under Section 23 05 01 – Use of HVAC Systems During Construction requirements.

1.3 References

- .1 Definitions:
 - .1 HVAC System: complete air duct system from outside air intake louvers to furthest air supply terminal unit and including:
 - .1 Rigid supply and return ductwork;
 - .2 Flexible ductwork;
 - .3 Mixing plenum boxes;
 - .4 Return air plenums including ceiling plenums;
 - .5 Cooling and heating coils and compartments;
 - .6 Condensate drain pans, eliminator blades and humidifiers;
 - .7 Fans, fan blades and fan housing;
 - .8 Filter housing and frames;
 - .9 Acoustically insulated duct linings;
 - .10 Diffusers, registers and terminal units;
 - .11 Dampers and controls;
- .2 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.

1.4 Administrative Requirements

- .1 Site Evaluation: conduct site visit 2 weeks before start of work to establish specific co-ordinated video survey and cleaning plan to establish how areas of facility and HVAC systems will be protected during cleaning operations.
 - .1 Organize and lay out plan for video survey and identify camera and cleaning apparatus insertion points.
 - .2 Ensure plan identifies sequence and schedule of survey and cleaning operations for each individual HVAC system and for complete facility.
 - .1 Take account of elbows, bends, turning vanes, dampers, transitions, take-offs, and other internal features.
 - .3 Departmental Representative to review video survey and cleaning plan 1 week minimum prior to start of work.
 - .1 Proceed with survey and cleaning work only after receiving written approval from Departmental Representative.
- .2 Scheduling: When working in an occupied building: complete work during non-business hours as follows:
 - .1 Monday to Thursday between 18:00 hours and 07:00 hours.
 - .2 Friday from 18:00 hours to Monday at 07:00 hours.
 - .3 Work may be carried out during statutory holidays.
 - .4 Hours of operation are subject to change with 12 hours notice.
- .3 Project Co-ordination: assign Project Co-ordinator to oversee air duct cleaning processes.
 - .1 Provide Departmental Representative with contact information of Project Co-ordinator including: name, telephone number, cell phone number.

1.5 Action and Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit video survey and cleaning plan developed during site evaluation.
 - .1 Ensure plan includes sequence of operation, identification of camera and cleaning apparatus insertion points and schedule for work.
- .3 Product Data:
 - .1 Submit manufacturer's printed product literature and data sheets for antimicrobial agents and include product characteristics, performance criteria and limitations.
 - .2 Provide two copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures for antimicrobial agents or coatings.
- .4 Testing Laboratory Services: submit name and address of laboratory engaged for work of this Section.
 - .1 Submit laboratory analysis report of particulate collection indicating:
 - .1 Location of collection;
 - .2 Particulate grade;
 - .3 Particulate size;
 - .4 Percentage concentration of individual particulates in each sample.

- .5 US EPA Registration: submit verification of EPA Registration of antimicrobial agent.
- .6 Submit verification of delivery of hazardous or toxic waste materials to contaminated waste facility, as described in PART 3 - CLEANING - Waste Management.

1.6 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 Identification of points where samples were collected and type of analysis used for each collection;
 - .6 Identification of each sample collected;
 - .7 Comments complete with photographs of each sampling location and other observed system features;
 - .8 Identify systems tested, observations, actions taken and recommendations for future maintenance.
- .3 Record post cleaning video survey: submit 2 copies of video survey DVD, USB Drive, SD, ED or Compact Flash memory card media, and include on video survey following:
 - .1 Areas tested for particulate analysis or microbial growth evaluation;
 - .2 Areas of special interest and location;
 - .3 Special internal features;
 - .4 Problems such as broken or damaged controls or components;
 - .5 Ensure system tested, locations, observations, actions taken and recommendations are clearly identified in English on video using text or voice over.
- .4 Extra Materials
- .5 Extra Stock Materials:
 - .1 Supply 4 extra filters for each HVAC System cleaned.
 - .2 Ensure filters are correct match, size, type and configuration of existing HVAC Systems.

1.7 Quality Assurance

- .1 Contractor: verification of membership in NADCA, with 5 years minimum experience in work similar to or exceeding work of this Section.
- .2 Project Co-ordinator: Air System Cleaning Specialist (ASCS) certified by NADCA on full time basis with 5 years minimum experience in work similar to or exceeding work of this Section.

2. PRODUCTS

2.1 Antimicrobial Agent

- .1 Use antimicrobial agents registered with US EPA-40 CFR.

2.2 System Filters

- .1 Supply and install new filters for each HVAC System cleaned.

2.3 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, polypropylene or other non-metallic material bristles.
 - .1 Ensure motor has capacity to continue to push brush after bristles are distorted.
 - .2 Replace worn and ineffective brushes when required.

2.4 Multi-Functional Robotic Cleaning System

- .1 Self-propelled remote controlled, wheeled drive equipped with: camera, halogen lights : rotating reciprocating brushes, air supply nozzle, vacuum and spraying system attachment.
 - .1 Ensure brushes are specifically manufactured and shaped to fit individual, equipment and components of HVAC system.
 - .2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces.
 - .3 Replace worn and ineffective brushes when required.
- .2 Camera: fully rotational remote control focus and dustproof video digital with 480 lines of resolution, capable of storing 4 hours of recorded media.
 - .1 Camera Light: 2 x 20 watt Halogen with dimmer

2.5 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.

2.6 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.

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 or instructed by Departmental Representative 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 or instructed by Departmental Representative 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.
- .7 Remove and reinstall ceiling tiles or panels to gain access to HVAC system as required.
 - .1 Replace ceiling tiles and panels damaged or soiled by air duct cleaning procedures.

3.2 Examination / Pre-Cleaning Inspection

- .1 Verification of Conditions:
 - .1 Make visual inspection of interior of HVAC system using remote controlled robotic camera.
 - .2 Insert camera at pre-established strategic locations to evaluate condition and cleanliness of HVAC systems and components.
- .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 Particulate Collection

- .1 Before starting duct cleaning, identify locations for sample collection and collect particulate samples.
- .2 Take samples from interior surfaces of HVAC system using sterile wipes for submission to independent testing laboratory.
- .3 For each HVAC system collect 4 samples from each HVAC unit as follows:
 - .1 Sample 1: collect from inside ventilation unit downstream of air filters but before fan discharge;
 - .2 Sample 2: collect downstream of fan discharge and 1 meter maximum downstream in first horizontal branch;
 - .3 Sample 3: collect at junction of last horizontal branch and start of low-pressure duct;
 - .4 Sample 4: collect at junction each air terminal unit and supply duct.

3.4 Laboratory Analysis

- .1 Ensure independent testing laboratory has demonstrated experience in work associated with air duct cleaning.
- .2 Ensure Super Electron Microscope (SEM) is used for analyzing and determining components of particulate collection samples:
 - .1 Identify components by grade and size;
 - .2 Report findings including percentage concentration of components to Departmental Representative.
- .3 Proceed with HVAC System Cleaning only after laboratory analysis test results have been received.
- .4 Ensure cleaning technicians have safety equipment appropriate for toxic or hazardous conditions identified by laboratory analysis before proceeding with cleaning operations.

3.5 Duct Cleaning

- .1 Do duct cleaning in accordance with NADCA ACR Standard.
- .2 Isolate and clean sections in zones to ensure that dirt deposits and debris from zone being cleaned does not pass through another zone which has already been cleaned.
 - .1 Isolate zone of duct using closed-cell polyurethane foam or air inflated zone bag before cleaning.
- .3 Ensure vacuum units and evacuation fans are securely in place before starting cleaning operation of isolated section of HVAC air duct system.
- .4 Install HEPA filter evacuation fan at one end of zone section and insert full contact brushes at other end.
- .5 Clean HVAC supply air duct system and components where particulate sample collected from surfaces is greater than 75 mg of particulate per 0.01 square metres.
- .6 Clean exhaust, return, transfer ductwork and plenums, equipment and components where particulate sample collected from surfaces is greater than 75 mg of particulate per 0.01 square meters.
- .7 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.
- .8 Clean equipment, components and other features in isolated zone before moving to next zone of HVAC air duct system.
- .9 Clean diffusers, registers, louvers, grilles and other terminal units.
- .10 Remove perforated supply diffusers from suspended tee-bar ceiling.
 - .1 Dismantle and clean perforated plates and supply diffuser duct collars.
 - .2 Re-assemble perforated plate diffusers and reconnect to HVAC system using supply diffuser duct collar after cleaning.
- .11 Advise Departmental Representative 72 hours minimum before deactivation of fire alarm and smoke detectors duct cleaning operations.
 - .1 Departmental Representative will pay for costs of deactivation of fire alarm and smoke detector system.

3.6 Acoustically Lined Ductwork Cleaning

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

3.7 Components and Equipment Cleaning

- .1 Brush and vacuum coils, humidifiers, air handling unit enclosures and heat exchanger surfaces to achieve required cleanliness.
- .2 When cleaning equipment and components by brushing and vacuuming is inappropriate or insufficient, dismantle and remove equipment or component and move to area designated by Departmental Representative for cleaning.
 - .1 Pressure wash with water and cleaning solution until required cleanliness is achieved.
 - .2 Clean equipment and components in place only if there is no hazard to adjacent materials.
- .3 Proceed to next section in cleaning sequence only after written approval from Departmental Representative.
- .4 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;

3.8 Anti Microbial Application

- .1 Apply antimicrobial agents when fungal growth is suspected and where unacceptable levels of fungal contamination have been verified through [visual inspection [testing.
- .2 Apply antimicrobial agents after removal of surface deposits and debris.
 - .1 Verify air duct interiors are free from deposits and debris by visual inspection .
 - .2 Report findings to Departmental Representative.
 - .3 Proceed with application of antimicrobial agents after written approval from Departmental Representative.
- .3 Apply antimicrobial agents in accordance with manufacturer's written instructions and US EPA 40 CFR registration and listing.
- .4 Manual or Robotic spray antimicrobial agents directly onto interior surfaces of HVAC air duct system.
 - .1 Do not use fog mist for downstream surfaces.

3.9 Field Quality Control/Final Inspections

- .1 Post Cleaning Inspection: carry out final inspection using robotic camera and other visual inspection methods after final cleaning has been completed.
 - .1 Carry out video survey as directed by Departmental Representative.
 - .2 Include in final survey areas inspected by Departmental Representative prior to cleaning.
 - .3 Identify on HVAC system record drawings access points used for inspection and cleaning.

- .4 Re-collect and analyze particulates collected at same locations where original samples were collected before cleaning.
- .5 Reset components including dampers and sensors, which have been disturbed during cleaning operations.

3.10 System Startup

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

3.11 Cleaning

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

End of Section

1. GENERAL**1.1 Action and Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for all products and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Territory of Nunavut, Canada, where specified.
 - .2 Indicate on drawings:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 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 SNC-Lavalin's "Shop Drawing Submittal Title Sheet". Identify section and paragraph number. Each drawing is to be submitted individually, in electronic (portable document file) format, with the Shop Drawing Submittal Title Sheet included in the electronic document. Refer to Appendix A for Submittal Identification Sheet.
- .4 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.2 Closeout Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for all mechanical equipment for incorporation into manual.
 - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before training begins.
 - .2 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.

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- .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .3 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.
 - .4 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.
 - .5 Approvals:
 - .1 Submit 2 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.
 - .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
 - .7 Site records:
 - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings in electronic (pdf) format. 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.
 - .8 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.
 - .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.3 Maintenance Material Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish spare parts as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket set for each heat exchanger.
 - .4 One glass for each gauge glass.
 - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .4 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 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 equipment 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.

2. PRODUCTS**2.1 Not used****3. EXECUTION****3.1 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for equipment 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 Painting Repairs and Restoration

- .1 Do painting in accordance with Section 09 91 00 - Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.3 System Cleaning

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

3.4 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 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .1 Refer to Section 01 91 13 – General Commissioning Requirements and Section 01 91 31 – Commissioning Plan and execute tests as described in all relevant technical sections.
- .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 - ACTION AND INFORMATIONAL 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.

3.5 Demonstration

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
 - .1 As defined by the Departmental Representative.
- .3 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.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Departmental Representative will record these demonstrations on video tape for future reference.

3.6 Commissioning requirements

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41, 01 91 51.
- .2 Contractor must provide a Commissioning schedule to include verification of component(s) and system(s) specific to static and dynamic functional performance. Include also period for tests of integrated system(s).
- .3 In addition, for start-up and operational verifications, refer to technical sections and manufacturers' specifications
- .4 In addition, provide a supplementary 5 days support during testing of integrated systems.
- .5 Coordinate with Contractor Commissioning Agent to determine schedule for test of integrated systems according with other disciplines.

3.7 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 recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management.

3.8 Protection


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

End of Section

APPENDIX A

SUBMITTAL IDENTIFICATION SHEET

SUBMITTALS IDENTIFICATION SHEET

PROJECT: New Daycare, Iqaluit, Nunavut	DEPT. REP.: PWGSC
	Construction Manager: EllisDon
	O/REF.: R.082769.001 Package:
CONTRACTOR:	ARCHITECT: EVOQ Architecture
Project Manager:	
Telephone:	ENGINEER: SNC-LAVALIN Inc.
E-mail:	Project no: 648139
SUBCONTRACTOR:	DISCIPLINE:
Address:	
	PRODUCT SUBMITTED:
Person responsible:	<input type="checkbox"/> As Specified
Telephone: () E-mail:	<input type="checkbox"/> Alternate
SUPPLIER or MANUFACTURER:	REVIEW AND COMMENTS (for use by Consultants):
Address:	<div style="text-align: center;">  <p>SNC • LAVALIN</p> <p>Verification of conformity</p> <p><u>Nature and scope of the examination</u></p> <p>Verification of conformity according to the specifications and drawings.</p> <hr/> <p>This verification is by no way a complete and detailed audit of the design.</p> <p><input type="checkbox"/> No correction noted</p> <p><input type="checkbox"/> Perform indicated corrections</p> <p><input type="checkbox"/> Correct and resubmit</p> <p><input type="checkbox"/> Refused</p> <div style="display: flex; justify-content: space-between; margin-top: 20px;"> <div> <p>Signature <input type="checkbox"/> Engineer <input type="checkbox"/> Other</p> <p>Name _____</p> </div> <div> <p>Date _____</p> <p>Member No. _____</p> </div> </div> <p>The review of this paper is limited to the nature and scope indicated. The person or company who prepared it cannot be relieved of their obligations in any cases, of any nature whatsoever.</p> </div>
Person responsible:	
Telephone: () E-mail:	
DESCRIPTION OF SUBMITTAL:	
# of pages:	
Reference to drawings:	
Reference to specs:	
Division: _____ Section: _____	
Article: _____ Page: _____	
Product abbreviation: _____	
REMARKS:	
Review of this submission is for compliance with general intent of the contract. This review does not relieve the Sub-Contractor, Supplier or Manufacturer of responsibility for error or omissions in the submission or the responsibility of meeting all requirements of the contract documents. Any deviation from the contract documents initiated by the Sub-Contractor, Supplier or Manufacturer shall be at their sole risk. QUANTITIES AND DETAIL DIMENSIONS ARE THE SUB-CONTRACTORS OR SUPPLIERS RESPONSIBILITY. VERIFY DATA WITH FIELD DIMENSIONS.	
SUBMITTAL TRACKING No.:	Date: Rev.:

1. GENERAL

1.1 Summary

- .1 Section Includes:
 - .1 Use of mechanical systems during construction.

1.2 Use of Systems

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

2. PRODUCTS

2.1 Not Used

- .1 Not Used.

3. EXECUTION

3.1 **Not Used**

.1 Not Used.

End of Section

1. GENERAL

1.1 References

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B139-04, Installation Code for Oil Burning Equipment.
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.
- .4 National Fire Code of Canada (NFCC 2015)
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
 - .2 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 Quality Assurance

- .1 Sustainability Standards Certification:
 - .1 Low-Emitting Materials: provide listing of sealants, coatings used in building, comply with VOC and chemical component limits or restriction requirements.

1.4 Delivery, Storage and Handling

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

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 Sealants: in accordance with Section 07 92 00 - Joint Sealing.
- .3 Fire Stopping: in accordance with Section 07 80 00 - Fire and Smoke Protection.

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 CSA B139.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer, CSA B139 or as indicated without interrupting operation of other system, equipment, and components.

3.4 Drains

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 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 air vents to CSA B139 at all 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 Install pipework to CSA B139.
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, and conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use gate, ball or butterfly valves at branch take-offs for isolating purposes except where specified.
 - .7 Install butterfly valves on chilled water and related condenser water systems only.
 - .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .9 Install ball valves for glycol service.
 - .10 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .16 Check Valves:
 - .1 Install silent check valves on discharge of pumps in vertical pipes with downward flow and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.8 Sleeves

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .1 Provide space for firestopping.
 - .2 Maintain fire rating integrity.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 Escutcheons

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

3.10 Preparation for Fire Stopping

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 80 00 - Fire and Smoke Protection.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 Flushing Out of Piping Systems

- .1 Flush system in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 Pressure Testing of Equipment and Piping

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Piping: 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.

3.13 Cleaning

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

End of Section

1. GENERAL

1.1 Summary

.1 Section Includes:

- .1 Electrical motors, drives and guards for mechanical equipment and systems.
- .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
- .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

1.2 References

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-01, 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).

1.3 Action and Informational Submittals

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control and 01 91 13 – General Commissioning Requirements
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

- .4 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 **Quality Assurance**

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, applicable Provincial /Territorial regulations.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 **Delivery, Storage, and Handling**

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

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 (1/2 HP) : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W (1/2 HP) 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.

2.4 **Belt Drives**

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW (10 HP) : standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW (10 HP) and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 Drive Guards

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives:
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
- .5 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.

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 Site Tests: conduct tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 – SUBMITTALS and with Section 01 91 13 – General Commissioning Requirements.
- .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 Cleaning

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

End of Section

1. GENERAL

1.1 References

- .1 ASTM International Inc.
 - .1 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A105/A105M-05, Standard Specification for Carbon Steel Forgings, for Piping 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 and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Manufacturer, model number, line contents, pressure and temperature rating.
 - .2 Movement handled, axial, lateral, angular and the amounts of each.
 - .3 Nominal size and dimensions including details of construction and assembly.

1.3 Closeout Submittals

- .1 Provide maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Data to include:
 - .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

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 and return by manufacturer of pallets crates padding packaging materials.

2. PRODUCTS

2.1 Slip Type Expansion Joints

- .1 Application: for axial pipe movement, as required.
- .2 Repacking: under full line pressure.
- .3 Body and packing housings: Class 150 carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe with ends to match pipe.

- .4 Slip or traverse sleeves: carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.
- .5 Anchor base: construction steel, welded to body.
- .6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.
- .7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.
- .8 Packing rings: 6 minimum, PTFE impregnated non-asbestos.
- .9 Thermal plastic packing: PTFE graphite impregnated non-asbestos slug supplied loose.
- .10 Lubricating fittings: pet cocks with grease nipple.
- .11 Plunger body and plunger:
 - .1 Plunger body: heavy wall carbon steel welded to body.
 - .2 Plunger: carbon steel with hex head for use with socket wrench.
- .12 Lubricant: to manufacturer's recommendations.
- .13 Lubricant gun: complete with hose assembly.
- .14 Drip connection: 20 MPa forged steel to ASTM A105/A105M. Include half coupling with drain plug.

2.2 Flexible Connection

- .1 Application: to suit motion as required.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset as indicated.
- .3 Inner hose: Stainless steel corrugated.
- .4 Braided wire mesh stainless steel outer jacket.
- .5 Diameter and type of end connection: as indicated.
- .6 Operating conditions:
 - .1 Minimum working pressure: 1034 kPa or to match system requirements
 - .2 Minimum working temperature: 80 degrees C or to match system requirements
- .7 Three flexible grooved couplings placed in close proximity to vibration source for vibration attenuation and stress relief.

2.3 Anchors and Guides

- .1 Anchors:
 - .1 Provide as required.
 - .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete 03 05 10 - Cast-in-Place - Short Form.

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- .3 Reinforcement: to Section 03 20 00 - Concrete Reinforcing.
 - .2 Alignment guides:
 - .1 Provide as required by conduit manufacturer.
 - .2 To accommodate specified thickness of insulation.
 - .3 Vapour barriers, jackets to remain uninterrupted.
 - 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 expansion joints with cold setting, as indicated or as instructed by Departmental Representative. Make record of cold settings.
 - .2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
 - .3 Install pipe anchors and guides as indicated. Anchors to withstand 150 % of axial thrust.
 - .4 Do welding in accordance with section 23 05 17 - Pipe Welding.
 - 3.3 **Pipe Cleaning and Start-Up**
 - .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
 - 3.4 **Performance Verification**
 - .1 In accordance with Section 23 08 01 - Performance Verification: Mechanical Piping Systems.
 - 3.5 **Cleaning**
 - .1 Clean in accordance with Section 01 74 11 - Cleaning.

End of Section

1. GENERAL

1.1 References

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2007, Power Piping.
 - .2 ANSI/ASME B31.3-2006, Process Piping.
 - .3 ANSI/ASME Boiler and Pressure Vessel Code-2007:
 - .1 Section I: Power Boilers.
 - .2 Section V: Non-destructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-03, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1-2006, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-2005, Safety Welding, Cutting and Allied Process.
 - .3 AWS W1-2000, Welding Inspection Handbook.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA W47.2-2008, Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA B51-2007, Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CSA-W117.2-06, Safety in Welding, Cutting and Allied Processes.
 - .5 CSA W178.1-2008, Certification of Welding Inspection Organizations.
 - .6 CSA W178.2-2008, Certification of Welding Inspectors.

1.2 Submittals

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

1.3 Qualifications

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

1.4 Quality Assurance

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

1.5 Delivery, Storage and Handling

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

2. PRODUCTS**2.1 Electrodes**

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

3. EXECUTION**3.1 Application**

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

3.2 Quality of Work

- .1 Welding: in accordance with ANSI/ASME B31.1, B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and applicable requirements of local 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 the Departmental Representative before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with the 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 in accordance with CSA W178.1 and CSA W178.2 and approved by the Departmental Representative.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - .3 Inspect and test 10% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests.
- .2 Hydrostatically test welds to requirements of ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
 - .1 Upon failure of welds by visual examination, perform additional testing as directed by the Departmental Representative of total of up to 10% of welds, selected at random by the Departmental Representative by particle tests.
- .5 Magnetic particle tests for compressed air service piping systems, heating hot water network, chilled water network and cooling tower.

3.6 Defects Causing Rejection

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessel Code.
- .2 In addition, hot water network :
 - .1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.
 - .2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.
 - .3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.
 - .4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8 mm.
 - .5 Repair cracks and defects in excess of 0.8 mm in depth.
 - .6 Repair defects whose depth cannot be determined accurately on basis of visual examination or particle tests.

3.7 Repair of Welds Which Failed Tests

- .1 Re-inspect and re-test repaired or re-worked welds without additional remuneration.

3.8 Cleaning

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

End of Section

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.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.
- .3 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP)
 - .1 IPMVP 2007 Version.
- .4 Green Seal Environmental Standards (GS)
 - .1 GS-11-11, Standard for Paints and Coatings.
 - .2 GS-36-11, Standard for Commercial Adhesives.

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 Shop Drawings:
 - .1 Submit drawings for review and approval.
- .4 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 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 with manufacturer's written instructions.

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- .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.
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, 125 mm scale length: to CAN/CGSB-14.4 ASME B40.200.
 - .1 Resistance to shock and vibration.
- 2.3 Remote Reading Thermometers
- .1 100 mm diameter mercury-free liquid filled vapour activated dial type: to CAN/CGSB-14.5 ASME B40.200, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass case for wall mounting.
- 2.4 Thermometer Wells
- .1 Copper pipe: copper or bronze.
 - .2 Steel pipe: stainless steel
- 2.5 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 Snubber for pulsating operation.
 - .2 Diaphragm assembly for corrosive service.
 - .3 Gasketed pressure relief back with solid front.
 - .4 Bronze stop cock.
 - .5 Oil filled for high vibration applications.

3. EXECUTION

3.1 Examination

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

3.2 General

- .1 Install thermometers and gauges so they can be easily read from floor or platform.
 - .1 If this cannot be accomplished, install remote reading units.
- .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 Heat exchangers.
 - .2 Water heating coils.
 - .3 Water boilers.
 - .4 On risers in mechanical rooms, on supply and return pipes.
 - .5 DHW tanks.
- .3 Install wells as indicated.
- .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 Upstream and downstream of control valves.
 - .4 Inlet and outlet of coils.
 - .5 Inlet and outlet of liquid side of heat exchangers.
 - .6 Outlet of boilers
 - .7 On risers in mechanical rooms, on supply and return pipes.
 - .8 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 lamicoid 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.

3.7 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

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-80-2008, Bronze Gate Globe, Angle and Check Valves.
 - .3 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 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 and return by manufacturer of pallets, crates, padding, packaging materials.

2. PRODUCTS

2.1 Materials

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: solder ends grooved ends to ANSI/ASME B16.18.
- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- .4 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: non-asbestos.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.
 - .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: handwheel.

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- .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: handwheel lockshield.
 - .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: handwheel.
 - .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed union bonnet.
 - .2 Operator: handwheel.
 - .5 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel.
 - .3 NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: handwheel.
 - .4 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: handwheel.
 - .5 Angle valve, NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
 - .3 Operator: handwheel.
 - .6 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.

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- .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .3 NPS 2 and under, swing type, bronze disc:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
 - .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE no. 6 composition rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
 - .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
 - .7 Silent Check Valves:
 - .1 NPS 2 and under:
 - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
 - .4 Disc and seat: renewable rotating disc.
 - .5 Stainless steel spring, heavy duty.
 - .6 Seat: regrindable.
 - .8 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125 2760-kPa CWP 4140-kPa CWP, 860 kPa steam.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders solder ends to ANSI.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel hard chrome solid ball and Teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.
 - .9 Butterfly Valves:
 - .1 NPS 2 1/2 through NPS 6, 2068 kPa with grooved ends.
 - .1 Body: cast bronze, with copper-tube dimensioned grooved ends.
 - .2 Disc: elastomer coated ductile iron with integrally cast stem.
 - .3 Operator: lever handwheel.

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 **Commissioning**

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

3.3 **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 recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management.

End of Section

1. GENERAL

1.1 References

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.1-05, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 ASTM International Inc.
 - .1 ASTM A49-01(2006), Standard Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A126-04, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM A536-84(2004)e1, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM B85/B85M-08, Standard Specification for Aluminum-Alloy Die Castings.
 - .7 ASTM B209-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-61-03, Pressure Testing of Steel Valves.
 - .2 MSS SP-70-06, Grey Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS SP-71-05, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS SP-82-1992, Valve Pressure Testing Methods.
 - .5 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded 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, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide drawings and submit data for valves specified in this Section..

1.3 Closeout Submittals

- .1 Submit 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 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 and return by manufacturer of pallets crates padding packaging materials.

1.5 Maintenance Material Submittals

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

2. PRODUCTS

2.1 Material

- .1 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
- .2 Standard specifications:
 - .1 Gate valves: MSS SP-70.
 - .2 Globe valves: MSS SP-85.
 - .3 Check valves: MSS SP-71.
- .3 Requirements common to valves, unless specified otherwise:
 - .1 Body, bonnet: cast iron to ASTM B209 Class B ductile iron to ASTM A536 Grade 65-45-12.
 - .2 Connections: flanged ends plain face with 2 mm raised face with serrated finish grooved ends to ANSI B16.1.
 - .3 Inspection and pressure testing: to MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Handwheel: die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
 - .9 Identification tag: with catalogue number, size, other pertinent data.

- .4 All products to have CRN registration numbers.

2.2 Gate Valves

- .1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze iron trim, solid wedge disc:
- .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62.
 - .3 Seat rings: renewable bronze to ASTM B62, screwed into body.
 - .4 Stem: bronze to ASTM B62.
 - .5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
 - .6 Seat: integral with body.
 - .7 Stem: wrought steel.
 - .8 Operator: handwheel or as indicated
 - .9 Bypass: complete with union and NPS gate globe valve as Section 23 05 23.01 - Valves – Bronze.
- .2 NPS 10 - 24, non rising stem, inside crew, bronze iron trim, solid wedge disc:
- .1 Body and multiple-bolted bonnet: cast iron to ASTM A126 Class B for sizes up to NPS 14, Class C for sizes NPS 16 and over, with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, body tie ribs between bonnet and end flanges.
 - .2 Pressure ratings: Class 125.
 - .3 Disc: solid offset taper wedge, with bronze rings to ASTM B62 rolled into cast iron disc, secured to stem.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .5 Stem: bronze to ASTM B62.
 - .6 Disc: solid offset taper wedge, cast iron secured to stem.
 - .7 Seat: integral with body up to NPS 14, renewable nodular iron on other sizes.
 - .8 Stem: wrought steel.
 - .9 Operator: handwheel or as indicated
 - .10 Bypass: complete with union and NPS gate globe valve as Section 23 05 05 - Installation of Pipework.
- .3 NPS 2 1/2-8, outside screw and yoke (OS Y), bronze iron trim, solid wedge disc:
- .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
 - .3 Seat rings: renewable bronze screwed into body.
 - .4 Stem: nickel-plated steel manganese-bronze.
 - .5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
 - .6 Seat rings: integral with body.
 - .7 Stem: nickel-plated steel.
 - .8 Pressure-lubricated operating mechanism.

- .9 Operator: handwheel or as indicated
- .10 Bypass: complete with union and NPS gate globe valve as Section 23 05 05 - Installation of Pipework.
- .4 NPS 10 - 24, outside screw and yoke (OS Y), bronze iron trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: NPS 10 - 14: cast iron to ASTM A126 Class B. With bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, body tie ribs between bonnet and end flanges, yoke, yoke hub, yoke sleeve and nut.
 - .2 Pressure ratings: Class 125.
 - .1 NPS 10-12: WP = 1.4 Mpa CWP.
 - .2 NPS 14-24: WP = 1.03 Mpa CWP.
 - .3 Disc: solid offset taper wedge, bronze disc rings to ASTM B62 rolled into cast iron disc, secured to stem through integral forged T-head disc-stem connection.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .5 Stem: nickel-plated steel manganese-bronze.
 - .6 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
 - .7 Seat: integral with body up to NPS 14, renewable nodular iron on other sizes.
 - .8 Stem: nickel-plated steel.
 - .9 Pressure-lubricated operating mechanism.
 - .10 Operator: handwheel or as indicated
 - .11 Bypass: complete with union and NPS gate globe valve as Section 23 05 23.01 - Valves - Bronze.

2.3 Underwriters Approved Gate Valve

- .1 NPS 2 1/2 - 14, OS Y:
 - .1 Approvals: UL and FM approved for fire service.
 - .2 UL and FM Label: on valve yoke.
 - .3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B) ductile iron to ASTM A536 Grade 65-45-12.
 - .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
 - .5 Packing gland: bronze.
 - .6 Stem: manganese bronze. Diameter to ULC C-262 (B). Brass, ASTM B16.
 - .7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
 - .8 Bosses for bypass valve, drain: on NPS 4 and over.
 - .9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: EPDM coated cast iron with bronze disc rings.
 - .10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
 - .11 Pressure rating:
 - .1 NPS 2-1/2 - 12: 1.7 Mpa CWP.
 - .2 NPS 14-1.2: 1.2 MPa CWP.
 - .12 Operator: handwheel.
 - .13 Bypass: complete with union and NPS gate globe valve as Section 23 05 23.01 - Valves - Bronze.

2.4 Globe Valves

- .1 NPS 2 1/2 - 10, OSY:
 - .1 Body: with multiple-bolted bonnet.
 - .2 WP: 860 kPa steam, 1.4 MPa CWP.
 - .3 Bonnet-yoke gasket: non-asbestos.
 - .4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
 - .5 Seat ring: renewable, regrindable, screwed into body.
 - .6 Stem: bronze to ASTM B62.
 - .7 Operator: handwheel or as indicated
 - .8 Bypass: complete with union and NPS gate globe valve as Section 23 05 23.01 - Valves - Bronze.

2.5 Bypasses for Gate and Globe Valves

- .1 Locations: on valves as indicated.
- .2 Size of bypass valve:
 - .1 Main valve up to NPS 8: NPS 3/4.
 - .2 Main valve NPS 10 and over: NPS 1.
- .3 Type of bypass valves:
 - .1 On gate valve: globe, with composition bronze disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.
 - .2 On globe valve: globe, with composition bronze disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.

2.6 Valve Operators

- .1 Install valve operators as follows:
 - .1 Handwheel: on valves except as specified.
 - .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in boiler rooms and mechanical equipment rooms.
 - .3 Motors:
 - .1 Application: As indicated.

2.7 Check Valves

- .1 Swing check valves, Class 125:
 - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Grooved or flanged ends: plain faced with smooth finish.
 - .1 Up to NPS 16: cast iron to ASTM A126 Class B, ductile iron ASTM A536 Grade 65-45-12.
 - .2 NPS 18 and over: cast iron to ASTM A126 Class C.
 - .2 Ratings:
 - .1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.
 - .2 NPS 14 - 16: 860 kPa steam; 1.03 MPa CWP.
 - .3 NPS 18 and over: 1.03 MPa CWP.

- .3 Disc: rotating for extended life.
 - .1 Up to NPS 6: bronze to ASTM B62 stainless steel type 316.
 - .2 NPS 8 and over: bronze-faced cast iron.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .5 Hinge pin, bushings: renewable bronze to ASTM B62 stainless steel.
 - .6 Disc: A126 Class B, secured to stem, rotating for extended life.
 - .7 Seat: cast iron, integral with body.
 - .8 Hinge pin: exelloy; bushings: malleable iron.
 - .9 Identification tag: fastened to cover.
 - .10 Hinge: galvanized malleable iron stainless steel.
- .2 Swing check valves, NPS 2 1/2 - 8 Class 250:
- .1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.
 - .2 Flanged ends: 2 mm raised face with serrated finish.
 - .3 Rating: 250 psi steam; 500 psi CWP.
 - .4 Disc: rotating for extended life.
 - .1 Up to NPS 3: bronze to ASTM B61.
 - .2 NPS 4 - 8: iron faced with ASTM B61 bronze.
 - .5 Seat rings: renewable bronze to ASTM B61, screwed into body.
 - .6 Hinge pin, bushings: renewable, bronze to ASTM B61.
 - .7 Hinge: galvanized malleable iron.
 - .8 Identification tag: fastened to cover.

2.8 Silent Check Valves

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

3. EXECUTION

3.1 Installation

- .1 Install rising stem valves in upright position with stem above horizontal.

3.2 Commissioning

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

3.3 Cleaning

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

- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management.

End of Section

1. GENERAL

1.1 References

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ASME B16, Fittings and Valves Package.
 - .2 ASME B16.5-2009, Pipe Flanges and Flanged Fittings: NPS through NPS 24 Metric/Inch Standard.
 - .3 ANSI/ASME B16.10-2009, Face-to-Face and End-to-End Dimensions Valves.
 - .4 ANSI/ASME B16.25-2007, Buttwelding Ends.
 - .5 ANSI/ASME B16.34- 2009, Valves Flanged, Threaded and Welding End. Includes Supplement (2010).
- .2 American Petroleum Institute (API)
 - .1 API STD 598-2009, Valve Inspection and Testing.
- .3 ASTM International
 - .1 ASTM A49-12, Standard Specification for Heat-Treated Carbon Steel Joint Bars, Micro Alloyed Joint Bars, and Forged Carbon Steel Comprise Joint Bars.
 - .2 ASTM A182/A182M-11a, Standard Specification for Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valve Parts for High Temperature Service.
 - .3 ASTM A193/A193M-12, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications.
 - .4 ASTM A194/A194M-2011, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both.
 - .5 ASTM A216/A216M-08, Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
 - .6 ASTM B85/B85M-10, Standard Specification for Aluminum-Alloy Die Castings.
- .4 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP)
 - .1 IPMVP 2007 Version.
- .5 Green Seal Environmental Standards (GS)
 - .1 GS-11-11, Standard for Paints and Coatings.
 - .2 GS-36-11, Standard for Commercial Adhesives.
- .6 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
 - .1 MSS SP-25-2008, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-61-2009, Pressure Testing of Valves.

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 each valve and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings and data.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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 valves for incorporation into manual.

1.4 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect valves 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.

1.5 Maintenance Material Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Extra Stock Materials:
- .3 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. PRODUCTS

2.1 Material

- .1 Valves:
 - .1 To be of single manufacturer.
 - .2 Test valves individually.
- .2 Requirements common to valves, unless specified otherwise:
 - .1 Pressure-temperature ratings: to ANSI B16.34.
 - .2 Inspections and tests: to API 598.
 - .3 Pressure testing: to MSS SP-61.
 - .4 Flanged valves:
 - .1 Face-to-face dimensions: to ANSI B16.10.
 - .2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face.
 - .5 Butt-weld valves:
 - .1 End-to-end dimensions: to ANSI B16.10.
 - .2 End dimensions: to ANSI B16.25 bored for standard pipe schedule.
 - .6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49.
 - .7 Markings: to MSS SP-25.
 - .8 Identification:
 - .1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.
 - .2 Body markings: manufacturer, size, primary service rating, material symbol.
 - .9 CRN registration number required for all products.

2.2 Gate Valves

- .1 NPS 2 1/2 - 12, rising stem, OS Y, solid wedge disc, flanged or butt-weld ends, Class 150:
 - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB, with full length disc guides designed to ensure correct re-assembly.
 - .2 Body/bonnet joint: flat, male-female face with corrugated metallic gasket.
 - .3 Bonnet studs: to ASTM A193/A193M Type B7.
 - .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
 - .5 Stuffing box: including non-galling two-piece ball jointed packing gland, with swing-type eye bolts and nuts.
 - .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
 - .7 Yoke sleeve: Ni-Resist, minimum melting point above 954 degrees C.
 - .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
 - .9 Disc: with disc stem ring to connect to stem, guided throughout its travel.
 - .1 NPS 2 1/2 - 6: solid corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.
 - .2 NPS 8 and larger: carbon steel faced with corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.
 - .10 Seat ring: seamless carbon steel with hard-faced cobalt-chromium-tungsten alloy seating surface, slipped in, seal welded, ground to match disc.

- .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut, T-head disc-stem connection.
- .12 Operator: Handwheel unless otherwise specified.

2.3 Globe Valves

- .1 NPS 2 1/2 - 12, rising stem, OS Y, flanged or butt-weld ends, Class 150:
 - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB.
 - .2 Body/bonnet joint: flat, male-female face with corrugated metallic gasket.
 - .3 Bonnet studs: to ASTM A193/A193M Type B7.
 - .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
 - .5 Stuffing box: including non-galling two-piece ball-jointed packing gland, with swing-type eye bolts and nuts.
 - .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
 - .7 Yoke bushing: Ni-Resist, minimum melting point above 954 degrees C.
 - .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
 - .9 Disc: plug type with 15 degrees taper seat and bottom guide, ball type with 35 degrees taper seat.
 - .10 Seat rings: with 1.6 mm thick cobalt-chromium-tungsten alloy facings with minimum hardness of 375 HB (cold), slipped in, seal welded, ground to match disc.
 - .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with bonnet bushing, long engagement with yoke bushing for accurate seating, accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .12 Operator: Handwheel unless otherwise specified.

2.4 Valve Operators

- .1 Handwheel: on all valves.
- .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in boiler rooms and mechanical equipment rooms.
- .3 Motors:
 - .1 Application: Not used

2.5 Bypasses for Gate and Globe Valves

- .1 Locations: on valves as required.
- .2 Size of bypass valve:
 - .1 Main valve up to NPS 8: NPS 3/4.
 - .2 Main valve NPS 10 and over: NPS 1.
- .3 Type of bypass valves:
 - .1 On gate valve: globe, with bronze trim, to Section 23 05 23.01 - Valves - Bronze.
 - .2 On globe valve: globe, with bronze trim, to Section 23 05 23.01 - Valves - Bronze.

2.6 Check Valves

- .1 NPS 2 1/2 and over, flanged or butt-weld ends, Class150: 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.

2.7 Silent Check Valves

- .1 Construction:
 - .1 Body: cast steel with integral seat.
 - .2 Pressure rating: Class 125,.
 - .3 Connections: flanged 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 Stainless steel spring, heavy duty.
 - .6 Seat: regrindable.

3. EXECUTION

3.1 Examination

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

3.2 Installation

- .1 Install in accordance with manufacturer's recommendations in upright position with stem above horizontal.

3.3 Commissioning

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

3.4 **Cleaning**

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

3.5 **Protection**

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

End of Section

1. GENERAL

1.1 References

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
 - .2 ASME B16.1-05, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
 - .3 ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings: NPS through 24.
 - .4 ANSI/ASME B16.11-05, Forged Fittings, Socket-Welding and Threaded.
 - .5 ANSI/ASME B16.25-07, Buttwelding Ends.
 - .6 ANSI/ASME B16.34-04, Valves - Flanged, Threaded and Welding Ends.
- .2 American Petroleum Institute (API)
 - .1 API Std. 609-04, Butterfly Valves: Double Flanged, Lug- and Wafer-Type.
- .3 ASTM International Inc.
 - .1 ASTM A126-04), Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM A536-84(2004)e1, Standard Specification for Ductile Iron Castings.
 - .3 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate Metric.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-67-02a, Butterfly Valves.

1.2 Action and Informational Submittals

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

1.3 Closeout Submittals

- .1 Submit 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 with manufacturer's written instructions.

- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labeled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding packaging materials.

1.5 Maintenance Material Submittals

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

2. PRODUCTS

2.1 Material

2.2 Butterfly Valves - Resilient Seat - 1400 kPa

- .1 Except to specialty valves, to be of single manufacturer.
- .2 To be suitable for dead-end service.
- .3 CRN registration number required for products.
- .4 Sizes:
 - .1 Lug type: NPS 2 to 30.
- .5 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
 - .1 NPS 2 - 90: 1400 kPa.
 - .2 NPS 14 - 340: 1400 kPa.
- .6 Minimum seat temperature ratings to 135 degrees C.
- .7 Application: on-off operation.
- .8 Full lug body (threaded)

- .9 Operators:
 - .1 NPS 2 - 6: 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.
 - .2 NPS 8 - 30: manual enclosed gear operator or as specified elsewhere in this section.
- .10 Designed to comply with MSS SP-67 and API 609.
- .11 Compatible with ANSI Class 125/Class 150 flanges.
- .12 Construction:
 - .1 Body ductile.
 - .2 Disc: 316 SS.
 - .3 Seat: EPDM.
 - .4 Shaft: 316 stainless steel.
 - .5 Taper pin: 316 SS.
 - .6 Key: . stainless..
 - .7 O-Ring: EPDM.
 - .8 Bushings: luberized bronze.

2.3 Mounting Flanges

- .1 Class 125 cast iron to ANSI B16.1 or Class 150 steel to B16.5 pipe flanges.

2.4 Electric Actuators

- .1 Operation: designed to provide precise quarter turn electric operation.
 - .1 Torque range: up to 1.130 N-m and speed ranges from 10 seconds to 30 seconds to move from fully open to fully closed.
 - .2 Gear train within actuator to provide smooth continuous rotary power stroke for accurate automatic valve positioning. Factory-set, field adjustable cam-actuated travel limit switches to provide precise control of shaft rotation.
- .2 Construction:
 - .1 Castings: heavy duty industrial grade for rugged use.
 - .2 Actuators: continuous duty with high efficiency single phase reversing capacitor motor with thermal overload protection.
 - .3 Gears and pinions constructed from hardened steel.
 - .4 Gear train to be permanently lubricated.
 - .5 Mechanical brake to ensure that gear is locked in precise position.
- .3 Electrical:
 - .1 Standard voltage: 120 VAC. 60 Hz.
 - .2 Control options: 4-20 Ma DC or 0-10 V DC.
 - .3 CSA approved.
 - .4 Electrical rating: NEMA IV.

3. EXECUTION

3.1 Preparation

- .1 Valve and mating flange preparation.
 - .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
 - .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
 - .3 Install butterfly valves with disc in almost closed position.
 - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 Installation of Valves

- .1 Install in accordance with manufacturer's instructions.
- .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .3 Verify suitability of valve for application by inspection of identification tag.
- .4 Mount actuator on to valve prior to installation.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- .7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 Actuator Installation

- .1 Air hoses or electrical connections to be made by actuator manufacturer.
- .2 Cycle valve operation from fully closed to fully open then back to fully closed.
- .3 At same time, check travel stop settings for proper disc alignment.

3.4 Cleaning

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management.

End of Section

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 drawings stamped and signed by professional engineer registered or licensed in the Territory of Nunavut, Canada.
 - .2 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 Departmental Representative will make available 1 copy of systems supplier'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 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 and return by manufacturer of pallets, crates, padding, packaging materials.

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 Performance Requirements:
 - .1 Design supports, platforms, catwalks, hangers to withstand seismic events as specified Section 23 05 49.01

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: galvanized painted with zinc-rich paint after manufacture.
 - .2 Use electro-plating galvanizing process hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are 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, 13 mm FM approved.
 - .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 FM approved to MSS-SP58 MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved to MSS SP69.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed FM approved.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved to MSS SP69.
- .5 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22 mm rod.
- .6 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel.
 - .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 FM approved, 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: epoxy coated, with formed portion plastic coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 Riser Clamps

- .1 Steel or cast iron pipe: black carbon steel to MSS SP58, type 42, UL listed FM approved.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.5 Insulation Protection Shields

.1 Insulated cold piping:

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

.2 Insulated hot piping:

.1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.6 Constant Support Spring Hangers

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 Variable Support Spring Hangers

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.8 Equipment Supports

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

2.9 Equipment Anchor Bolts and Templates

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

2.10 Platforms and Catwalks

- .1 To Section 05 50 00 - Metal Fabrications.

2.11 House-Keeping Pads

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.
- .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

2.12 Other Equipment Supports

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings .
- .2 Submit structural calculations with shop drawings.

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 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.
- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 Hanger Spacing

- .1 Plumbing piping: to Canadian Plumbing Code and authority having jurisdiction.
- .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	N/A
6	4.3 m	N/A
8	4.3 m	N/A
10	4.9 m	N/A
12	4.9 m	N/A

- .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 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 - ACTION AND INFORMATIONAL 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 - ACTION AND INFORMATIONAL 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.

3.8 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 recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management.

End of Section

1. GENERAL

1.1 References

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 13-2013, Standard for the Installation of Sprinkler Systems.
- .3 National Building Code of Canada 2015 (NBC)

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.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Territory of Nunavut, Canada.
 - .2 Provide separate shop drawings for each isolated system complete with performance and product data.
 - .3 Provide detailed drawings of seismic control measures for equipment and piping.
- .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.
 - .3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.3 Quality Assurance

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

1.4 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. PRODUCTS

2.1 General

- .1 Size and shape of bases type and performance of vibration isolation as indicated.
- .2 Isolated equipment shall be mounted directly on vibration isolation devices, on steel rail, on inertial base, etc. as indicated.
- .3 All vibration isolators shall be selected to achieve the required static deflection when supporting the load of the isolated equipment as indicated on the drawings. The vibration isolators shall also provide sufficient horizontal and vertical stability and seismic control/restraints per Code requirement. Follow manufacturer's instructions for installation.

2.2 Inertial bases

- .1 Isolated equipment installed on inertial bases mounted on spring/neoprene isolators providing the required static deflection under load for that equipment. Follow manufacturer's instructions for installation.
- .2 Thickness, weight and clearance
 - .1 For isolated equipment installed on an inertial base, the thickness of the base shall be greater than one-tenth the largest dimension in the plane between the isolators and respect the following rules:
 - .1 Pumps less than 40 HP: minimum thickness 150 mm.
 - .2 Pumps 40 to 99 HP: minimum thickness 200 mm.
 - .3 Pumps greater than 100 HP: minimum thickness 300 mm.
 - .2 The weight of the inertial base shall be one to two times the weight of the isolated equipment (considering the dead and dynamic load of the equipment, including the piping and the weight of fluid). Sufficient weight shall be provided to lower the center of gravity of the equipment/inertial base to or below the isolators' support plane.
 - .3 Maintain a clearance of at least 50 mm (2") between the inertial bases and the structure on which they are based.

2.3 Neoprene isolation pad and isolation mounts (Type A, B, E)

- .1 Neoprene waffle or ribbed, made of bridge bearing neoprene, maximum hardness of Duro 60. Use a combination of neoprene cushions and steel plates/shims (neoprene/steel/neoprene) to obtain the required static deflection under load.
- .2 Bridge bearing quality double deflection neoprene. All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top.

2.4 Spring – general (Type C, D, F)

- .1 Springs must be color coded based on stiffness and/or expected static deflection under load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs shall have a ratio of diameter to compressed height between 0.8 and 1.0. Springs must also have horizontal stiffness equal or higher than 0.9 the vertical stiffness.

2.5 Spring mount isolators (Type C, D, F)

- .1 Spring mount isolators shall be fitted with a neoprene pad between the housing and supporting structure, or with a neoprene spring cup which receives the spring. Pad or cup shall be made of bridge bearing quality neoprene and sized for a static deflection under load of at least 5 mm for this component of the isolators.

2.6 Spring and neoprene hangers (Type E, F)

- .1 Spring hanger isolators shall be fitted with a neoprene insert that links the upper hanger rod to the housing, or with a neoprene cup which receives the spring. The insert or cup shall be made of bridge bearing quality neoprene and sized so that this component of the isolators have a static deflection under load of at least 5 mm.
- .2 Spring and neoprene hanger isolators shall have a sufficient spring diameter and a housing box lower hole size allowing the lower hanger rod to swing 15 degrees relative to the axis of suspension without contact with the isolator housing. During installation leave at least a 6 mm gap between the isolator housing and the structure from which the upper support rod is hung.

2.7 Isolators with seismic, horizontal and/or vertical restraints or vertical limit stops (Type D)

- .1 For isolators with seismic, horizontal and/or vertical restraints, check that they do not short-circuit the isolator after installation and commissioning. Verify that there exists a 6 to 9 mm clearance between the equipment frame, isolator's top plate or any non-insulated component and the restraints. Isolators shall be capable of withstanding the design seismic loads and any other movement in all directions with no metal-to-metal contact.
- .2 All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 20 mm larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 12 mm to avoid bumping and interfering with the spring action. Vertical limit stops shall be out of contact during normal operation.

2.8 Horizontal thrust restraints (general)

- .1 Horizontal thrust restraints shall be installed when excessive horizontal thrust from isolated equipment is expected (> 10% of isolated equipment weight). Horizontal thrust restraints shall be built the same way as for spring/neoprene hangers and installed symmetrically on each side of isolated equipment in the same axis and central line of the generated thrust. Restraint springs shall have the same deflection as the isolators supporting or suspending the isolated equipment. Movement from stop to maximum thrust shall be limited to 6 mm.

2.9 Flexible piping connections

- .1 Double sphere connectors
 - .1 Made of reinforced neoprene without a reinforcing ring (molded-in or not).
 - .2 Selected connectors must conform to operating temperature, pressure, etc.
 - .3 If required, control rods are allowed if installed with oversized washers and rubber bushings in order to avoid shorting the vibration isolation.
 - .4 Follow manufacturer's instructions for installation.
- .2 Flexible hoses
 - .1 Braided-steel hoses or flexible couplings.

2.10 Acoustic Barriers for Anchors and Guides

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

2.11 Seismic Control Measures

- .1 General:
 - .1 Following systems and/or equipment to remain operational during and after earthquakes:
 - .1 Boilers.
 - .2 Heating network.
 - .2 Seismic control systems to work in every direction.
 - .3 Fasteners and attachment points to resist same maximum load as seismic restraint.
 - .4 Drilled or power driven anchors and fasteners not permitted.
 - .5 No equipment, equipment supports or mounts to fail before failure of structure.
 - .6 Supports of cast iron or threaded pipe not permitted.
 - .7 Seismic control measures not to interfere with integrity of firestopping.
- .2 Static equipment:
 - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
 - .2 Suspended equipment:
 - .1 Use one or more of following methods depending upon site conditions as indicated:
 - .1 Install tight to structure.
 - .2 Cross brace in every direction.
 - .3 Brace back to structure.
 - .4 Cable restraint system.
 - .3 Seismic restraints:
 - .1 Cushioning action gentle and steady.
 - .2 Never reach metal-like stiffness.
- .3 Vibration isolated equipment:
 - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
 - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.

-
- .3 As indicated.
 - .4 Piping systems:
 - .1 Fire protection systems: to NFPA 13.
 - .2 Piping systems: hangers longer than 300 mm; brace at each hanger.
 - .3 Compatible with requirements for anchoring and guiding of piping systems.
 - .5 Bracing methods:
 - .1 Approved by Departmental Representative.
 - .2 Structural angles or channels.
 - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.
 - .6 Service and utilities entrance into building: City water.
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 Seismic control measures to meet requirements of NBC.
 - .2 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
 - .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
 - .4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - .1 Up to 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.
 - .5 Where isolation is bolted to floor use vibration isolation rubber washers.
 - .6 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.
 - .7 Isolated equipment shall be connected to piping via flexible couplings.
 - .8 See drawings for the specific type of flexible piping connections.

- .9 No rigid connections between equipment and building structure shall be made as it degrades the noise and vibration isolation provided by the isolation devices.
- .10 All isolated equipment shall be supplied with flexible electrical connections that allow free motion of isolated equipment. Provide a sufficient length of cable to make a semi-circular loop (in the form of a “U”) between the isolated equipment and its electrical panel or the cable’s first fixation point to building.
- .11 All isolated fans shall be connected to ventilation ducts using a flexible canvas. In cases where isolated fans are inside a housing cabinet, the flexible canvas shall be installed between the fan and the discharge and/or return plenum to which it is connected. If excessive horizontal thrust from isolated equipment is expected (> 10% of isolated equipment weight) provision for horizontal thrust restraint shall be made.
- .12 Where indicated, piping connected to isolated equipment shall be made with flexible connections. Additionally, unless indicated otherwise, piping connected to isolated equipment shall be isolated with spring/neoprene hangers (or spring mount isolators) for all piping in mechanical/equipment rooms with a minimum of three fixation points and up to 15 m away from isolated equipments and pressure reduction valves. All piping isolators must have a static deflection under load of at least 25 mm. The isolator at the first three points of support must have a static deflection under load equal to the isolated equipment, but not exceeding 50 mm. The resulting static deflection of the first two piping isolators must be due to the load from the piping only (including fluid weight), with no contribution of isolated equipment weight/load. If required use a pre-compressed isolator type.

3.3 Field Quality Control

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After preparatory work is complete but before installation commences.
 - .2 Twice during the installation, at 25% and 60% completion stages.
 - .3 Upon completion of installation.
 - .3 Submit manufacturer's reports to Departmental Representative within 5 days of manufacturer representative's review.
 - .4 Make adjustments and corrections in accordance with written report.
- .2 Inspection and Certification:
 - .1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .2 Take vibration measurements for equipment as indicated listed below.
 - .1 Air Handling Units.
 - .2 Heat Pumps.
 - .3 Fan Coils.
 - .4 Exhaust Fans.
 - .5 Heating and Cooling Pumps
 - .6 Compressors.

- .7 Condensing Units.
- .3 Provide Departmental Representative with notice 72 h in advance of commencement of tests.
- .4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
- .5 Submit complete report of test results including sound curves.

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.
- .3 During the execution and on completion of the installation, before commissioning the isolated equipments, all debris, waste material, etc. shall be cleared from areas surrounding and beneath all isolated equipments. Isolated equipments shall be free of debris, etc. that could restrict the movement of the equipments on the vibration isolation devices.

End of Section

1. GENERAL

1.1 References

- .1 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.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 13-2013, Standard for the Installation of Sprinkler Systems.

1.2 Action and Informational Submittals

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data to include paint colour chips, other products specified in this section.
- .3 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.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

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 Dispose of unused paint and coating material at official hazardous material collections site approved by Departmental Representative.

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 System Nameplates

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

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

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
 - .1 Terminal cabinets, control panels: use size # 5.
 - .2 Equipment in Mechanical Rooms: use size # 9.
- .5 Identification for PWGSC Preventive Maintenance Support System (PMSS):
 - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
 - .2 Equipment in Mechanical Room:
 - .1 Main identifier: size #9.
 - .2 Source and Destination identifiers: size #6.
 - .3 Terminal cabinets, control panels: size #5.
 - .3 Equipment elsewhere: sizes as appropriate.

2.3 Piping Systems Governed by Codes

- .1 Identification:
 - .1 Fuel Oil: to CSA B139-09 or authority having jurisdiction.
 - .2 Sprinklers: to NFPA 13.

- .3 Hazardous materials: as per their respective code.

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 plastic-coated cloth 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		
Sea water	Green	SEA WATER
City water	Green	CITY WATER

Contents	Background colour marking	Legend
Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Low temp Htg. supply	Yellow	LT HTG. SUPPLY++
Low temp HW Htg. return	Yellow	LT HTG. RETURN++
Make-up water	Yellow	MAKE-UP WTR
Boiler feed water	Yellow	BLR. FEED WTR
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Contaminated lab waste	Yellow	CONT. LAB WASTE
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
No. 2 fuel oil suction	Yellow	# 2 FUEL OIL
No. 2 fuel oil return	Yellow	#2 FUEL OIL
Engine exhaust	Yellow	ENGINE EXHAUST
Purified water	Green	PURE WATER
Chlorine	Yellow	CHLORINE
Compressed air CLEAN	Green	CLEAN COMP. AIR ____ kPa
Compressed air Workshop	Yellow	WS COMP. AIR ____ kPa
Vacuum	Green	VACUUM
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

2.5 Identification Ductwork Systems

- .1 50 mm high stenciled 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.

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 00 - Painting has been completed.

3.3 Installation

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC / CSA registration plates as required by respective agency.
- .3 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 by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

3.7 Cleaning

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

End of Section

1. GENERAL

1.1 Summary

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

1.2 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 and documented 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.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 Purpose of Tab

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

1.4 Exceptions

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

1.5 Coordination

- .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.

1.6 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.

1.7 Start-up

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

1.8 Operation of Systems during Tab

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

1.9 Start of Tab

- .1 Notify 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 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 Application Tolerances

- .1 Do TAB to following tolerances of design values:
 - .1 Laboratory HVAC systems: plus 10 %, minus 0 %.
 - .2 Other HVAC systems: plus 5 %, minus 5 %.
 - .3 Hydronic systems: plus or minus 10 %.
 - .4 Laboratory utilities: plus 5 %, minus 5 %.

1.11 Accuracy Tolerances

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

1.12 Instruments

- .1 Prior to TAB, submit to Departmental Representative list of instruments 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.

1.13 Action and Informational Submittals

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 Preliminary Tab Report

.1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.15 Tab Report

.1 Format in accordance with referenced standard

.2 Submit TAB report template for review and approval before starting work.

.3 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.4 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 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.

1.17 Settings

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

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

1.18 Completion of Tab

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

1.19 Air Systems

- .1 Standard: TAB to most stringent of this section TAB standards of AABC, NEBB, SMACNA, or ASHRAE.
- .2 Do TAB of systems, equipment, components and controls specified in Division 23.
- .3 Qualifications: personnel performing TAB qualified to standards of AABC or 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 as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 Other Tab Requirements

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.
- .2 Liquid systems
 - .1 Measurements: to include liquid velocity, static pressure, flow rate, pressure drop (or loss), temperatures (supply, return), RPM, electrical power, voltage.
 - .2 Measurements: to be realized for pumps (primary, secondary, recirculation), coils, terminal reheat coils, radiators, unit heater, heat exchangers, laboratory equipment.
 - .3 Reports: in addition to measured data, provide calculations for power output of coils, terminal reheat coils and heat exchangers.
- .3 Measurement of spatial noise vibration:
 - .1 Standard: ANSI/ASA S12.2-2008 Criteria for evaluating Room Noise.
 - .2 TAB procedures:
 - .1 Once TAB is completed, measure noise level (NC) in each offices and laboratory.

- .4 Fire Dampers
 - .1 Test fire dampers and submit testing report.
 - .2 Tag fire dampers following instructions provided by the Departmental representative.

1.21 **Post-Occupancy Tab**

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, NC levels, in occupied zone of following areas: Offices, classrooms and common spaces.
- .2 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period, in coordination with the Departmental Representative.
- .3 Adjust systems following systems checks during the Warranty Period to address issues identified by occupants or Departmental Representative.

2. **PRODUCTS**

2.1 **Not Used**

- .1 Not used.

3. **EXECUTION**

3.1 **Not Used**

- .1 Not used.

End of Section

1. GENERAL

1.1 References

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

1.2 Action and Informational Submittals

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:
 - .1 Submit proposed report form and test report format to Departmental Representative for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.
 - .2 Prepare report of results and submit to Departmental Representative within 72 hours of completion of tests. Include:
 - .1 Schematic of entire system.
 - .2 Schematic of section under test showing test site.
 - .3 Required and achieved static pressures.
 - .4 Orifice differential pressure at test sites.
 - .5 Permissible and actual leakage flow rate (L/s) for test sites.
 - .6 Witnessed certification of results.
 - .3 Include test reports in final TAB report.
 - .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Instructions: submit manufacturer's installation instructions.

1.3 Quality Assurance

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section in accordance with Section 01 32 16.06 - Construction Progress Schedule - Critical Path Method (CPM)
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
 - .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

2. PRODUCTS

2.1 Test Instruments

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

3. EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Test Procedures

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

3.3 Site Tolerances and Tests Requirements

- .1 System leakage tolerances specified are stated as leakage classes, as described in SMACNA HVAC Air Duct Leakage Test Manual. A leakage class expresses an amount of acceptable air leakage through a given surface of duct.

- .2 Leakage tests on following systems not to exceed specified leakage classes (rectangular ducts/round ducts).
 - .1 Small duct systems up to 250 Pa: no testing required.
 - .2 VAV box and duct on downstream side of VAV box: no testing required.
 - .3 Large low pressure duct systems up to 500 Pa: no testing required
 - .4 High pressure duct systems up to 1000 Pa pressure classification, including upstream side of VAV boxes: leakage class 6 (rectangular) or 3 (round).
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 Testing

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

3.5 Field Quality Control

- .1 Performance Verification:
 - .1 Departmental Representative to witness tests and to verify reported results.
 - .2 To be certified by same TAB agency approved by Departmental Representative to undertake TAB on this project.

3.6 Cleaning

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

End of Section

1. GENERAL

1.1 References

.1 Definitions:

.1 For purposes of this section:

- .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces. On this project, the crawlspace of the MRB is considered a "CONCEALED" space.
- .2 "EXPOSED" - means "not concealed" as previously defined.
- .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:

- .1 CRD: Code Round Ductwork,
- .2 CRF: Code Rectangular Finish.

.2 Reference Standards:

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 ASTM International Inc.
 - .1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .9 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.
- .4 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-00, Commercial Adhesives.
- .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): National Insulation Standards (2005).

- .7 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

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 duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.
- .3 Shop Drawings:
 - .1 Provide drawings for review and approval.
- .4 Samples:
 - .1 Submit, for approval, a drawing for each type of proposed insulation system.
 - .2 If required by the Departmental Representative, submit for approval a complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
 - .3 Mount sample on 12 mm plywood board.
 - .4 Affix typewritten label beneath sample indicating service.
- .5 Manufacturers' Instructions:
 - .1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, cleaning procedures.

1.3 Quality Assurance

- .1 Qualifications:
 - .1 Installer: 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 and ULC markings.

2. PRODUCTS

2.1 Fire and Smoke Rating

- .1 To CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.
- .2 Fire resistant blanket is to meet NFPA-96 requirements and to meet ULC/FRD-3 and ULC/FRD-5.

2.2 Insulation

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("K" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code CER/2 and cER/3: Rigid mineral fibre board to ASTM C612, with or without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
 - .1 Maximum "K" factor: 0.58.
- .4 TIAC Code CEF/2: Mineral fibre blanket to ASTM C553 faced with or without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: 0.58.
- .5 Fire Resistant Duct Wrap: flexible wrap made of calcium-magnesium-silicate wool technology. The blanket is to be chosen for the applicable usage of the duct it protects and to be installed in accordance with the required fire resistance .
 - .1 Acceptable product: 3M FireMaster Duct Wrap or approved equivalent.

2.3 Jackets

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

2.4 Accessories

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.

- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921 untreated.
- .5 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .6 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
- .7 Contact adhesive: quick-setting
- .8 Canvas adhesive: washable.
- .9 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .10 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

3. EXECUTION

3.1 Application

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

3.2 Pre-Installation Requirements

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

3.3 Installation

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 Ductwork Insulation Schedule

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

TIAC Code	Type	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	CER/2	yes	50
Round cold and dual temperature supply air ducts	CEF/2	yes	50
Rectangular warm air ducts	CER/2	no	50
Round warm air ducts	CEF/2	no	50
Supply, return and exhaust ducts exposed in space being served	None	---	---
Outside air ducts to mixing plenum	CER/3	yes	100
Mixing plenums	CER/3	yes	100
Exhaust duct between dampers and louvers	CER/3	no	100
Acoustically lined ducts	None	---	---

- .2 Insulating blankets are an acceptable alternative to rigid insulation board for rectangular ducts, except in the mechanical rooms.
- .3 In the Main Research Station mechanical room, all ductwork from the ERV-01 to HUM-01 and from MUA-01 to HUM-01 are to be considered "Outside Air Duct" as described in article 3.4.1.
- .4 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:
- .1 Use TIAC code CER/2 insulation, scored to suit diameter of duct.
- .5 Finishes: conform to following table:

TIAC Code		
	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/1
Indoor, exposed elsewhere	CRF/2	CRD/2

3.5 Cleaning

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

End of Section

1. GENERAL

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 C533-07, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - .4 ASTM C547-07, Standard Specification for Mineral Fiber Pipe Insulation.
 - .5 ASTM C553-02, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .6 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 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 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 two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures.
- .3 Samples:
 - .1 Submit, for approval, a drawing for each type of proposed insulation system.
 - .2 If required by the Departmental Representative, submit for approval a complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
 - .1 Mount sample on 12 mm plywood board.
 - .2 Affix typewritten label beneath sample indicating service.
- .4 Manufacturer's Instructions:
 - .1 Include procedures to be used and installation standards to be achieved.
- .5 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.

1.3 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, labeled with manufacturer's name, address.
- .3 Store at temperatures and conditions recommended by manufacturer.

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-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52MA.
 - .3 Maximum "k" factor: ASTM C547.
- .5 TIAC Code C-1: rigid mineral fibre board, unfaced.
 - .1 Mineral fibre: ASTM C612.
 - .2 Maximum "k" factor: ASTM C612.
- .6 TIAC Code C-4: rigid mineral fibre board faced with factory applied vapour retarder jacket.
 - .1 Mineral fibre: ASTM C612.
 - .2 Jacket: to CGSB 51-GP-52MA.
 - .3 Maximum "k" factor: ASTM C612.
- .7 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52MA.
 - .3 Maximum "k" factor: ASTM C553.
- .8 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 corrodents.
- .9 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
 - .1 Insulation: ASTM C533.
 - .2 Maximum "k" factor: ASTM C533.
 - .3 Design to permit periodic removal and re-installation.

2.3 Cement

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

2.4 Jackets

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CSG 51.53 with pre-formed shapes as required.
 - .2 Colours: selected by Departmental Representative.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 0.8mm.

- .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
- .8 Special requirements:
 - .1 Outdoor: UV rated material at least 0.5 mm thick.
- .9 Covering adhesive: compatible with insulation.
- .2 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.

2.5 Insulation Securements

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.
- .6 Fasteners: 4 mm diameter pins with 35 mm diameter or square clips. Length of pin to suit thickness of insulation.

2.6 Vapour Retarder Lap Adhesive

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

2.7 Indoor Vapour Retarder Finish

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

2.8 Outdoor Vapour Retarder Mastic

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².

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 Installation

- .1 Install in accordance with TIAC National Standards
 - .1 Hot equipment: To TIAC code 1503-H.
 - .2 Cold equipment: to TIAC code 1503-C.
- .2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.
- .3 Provide vapour retarder as recommended by manufacturer.
- .4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.
- .5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports outside vapour retarder jacket.
- .7 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 expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- .2 Installation to permit movement of expansion joint, to permit periodic removal and replacement without damage to adjacent insulation.

3.5 Equipment Insulation Schedules

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 Hot Equipment:
 - .1 TIAC code A-1 with mechanical fastenings and 13 mm cement reinforced with one layer of reinforcing mesh.
 - .2 TIAC code C-2 unfaced with bands and 13 mm cement preceded by one layer of reinforcing mesh.

.3 Thicknesses:

Domestic hot water storage tanks 50 mm
Heat exchangers 50 mm
Hydraulic separator 50mm
Expansion tanks 50 mm

.3 Breechings, engine exhausts and mufflers:

- .1 TIAC code A-2 with 25 mm air gap, mechanical fastenings and 13 mm cement reinforced with one layer of reinforcing mesh.

.4 Cold equipment:

- .1 TIAC A-3, with mechanical fastenings bands and 13 mm cement reinforced with one layer of reinforcing mesh.
- .2 TIAC C-2 faced with vapor retardant jacket and with bands and 13 mm cement preceded by one layer of reinforcing mesh.
- .3 TIAC C-4 with mechanical fastenings.
- .4 Thicknesses: chillers (except factory insulated) and pumps: 50 mm.

.5 Finishes:

- .1 Engine exhaust piping and muffler: To TIAC code CRF-4.
- .2 Equipment in mechanical rooms: TIAC code CEF/1 with aluminum jacket.
- .3 Equipment elsewhere: TIAC code CEF/2 with 13 mm cement jacket.

3.6 **Cleaning**

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

End of Section

1. GENERAL

1.1 References

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-2003, Mineral Fiber Pipe Insulation.
 - .7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 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 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings

- .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

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. On this project, the crawlspace of the MRB is considered a "CONCEALED" space.
 - .2 "EXPOSED" - will mean "not concealed" as specified.
- .2 TIAC :
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.3 Action and Informational Submittals

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Territory of Nunavut, Canada.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.
- .5 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.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.4 Quality Assurance

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

1.5 Delivery, Storage and Handling

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.
- .3 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Place excess or unused insulation and insulation accessory materials in designated containers.
 - .3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
 - .4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

2. PRODUCTS

2.1 Fire and Smoke Rating

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

2.2 Insulation

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702, ASTM C547.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702, ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702, ASTM C547.
- .5 TIAC Code C-2: mineral fibre blanket faced with or without factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/ULC-S702, ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702, ASTM C547.
- .6 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: to CAN/ULC-S702, ASTM C547.
 - .4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

2.3 Insulation Securement

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

2.4 Cement

- .1 Thermal insulating and finishing cement:
 - .1 Air drying on mineral wool, to ASTM C449/C449M.

2.5 Vapour Retarder Lap Adhesive

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

2.6 Indoor Vapour Retarder Finish

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

2.7 Outdoor Vapour Retarder Finish

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

- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.8 **Jackets**

- .1 Canvas:
 - .1 220 and 120 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.
- .2 Aluminum:
 - .1 Application: for outdoor use.
 - .2 To ASTM B209.
 - .3 Thickness: 0.50 mm sheet.
 - .4 Finish: stucco embossed.
 - .5 Joining: longitudinal and circumferential slip joints with 50 mm laps.
 - .6 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .7 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

2.9 **Weatherproof Caulking for Jackets Installed Outdoors**

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

3. **EXECUTION**

3.1 **Manufacturer's Instructions**

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

3.2 **Pre-installation Requirement**

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

3.3 **Installation**

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

- .5 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 expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: aluminum.

3.5 Installation of Elastomeric Insulation

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

3.6 Piping Insulation Schedules

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: 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: SS bands at 300 mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 TIAC Code: A-6.
 - .1 Insulation securements: Tape.
 - .2 Seals: lap seal adhesive, lagging adhesive.
- .5 TIAC Code: C-2 with or without vapour retarder jacket.
 - .1 Insulation securements: SS bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-CA.
- .6 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 3700 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

- .7 Thickness of insulation as listed in following table.
- .1 Run-outs to individual units and equipment not exceeding 3700 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)				
			To 1	1¼ to 2	2½ to 4	5 to 6	8
Run out	up to 175	A-1	25	38	38	38	38
Boiler Feed Water	---	A-1	25	25	25	25	25
Glycol Heating (GHS/GHR)	60 - 94	A-1	25	38	38	38	38
Glycol Heating (HRR/HRS)	up to 59	A-1	25	25	38	38	38
Domestic Hot Water (DHW, DHWR)	---	A-1	25	25	38	38	38
Emergency Hot Water (EHW, EHWR)	---	A-1	25	25	38	38	38
Kitchen Hot Water (KHW, KHWR)	---	A-1	25	25	38	38	38
Domestic Cold Water (DCW, DCWR)	---	A-3	25	25	25	25	25
Drainage vents (3000 mm from outside wall or roof)	---	A-1	65	65	75	90	90
Fire protection	---	A-3	25	38	38	38	38
Fuel oil supply/return	---	A-3	50	50	50	50	50

- .8 Finishes:
- .1 Exposed indoors: canvas.
 - .2 Exposed in mechanical rooms: canvas.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
 - .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
 - .5 Outdoors: water-proof aluminum jacket.
 - .6 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.
 - .7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 Field Quality Control

- .1 Verification requirements in accordance with Section 01 91 13 – Commissioning General requirements including:
 - .1 Low-emitting materials.

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

1. GENERAL

1.1 Summary

- .1 Section Includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.

1.2 References

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-00, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 Action and Informational Submittals

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

1.4 Quality Assurance

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

1.5 Delivery, Storage, and Handling

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

2. 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.

3. EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Cleaning Hydronic and Steam Systems

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, 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 82 degrees C minimum. 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).
- .8 Glycol Systems:
 - .1 In addition to procedures specified above perform specified procedures.
 - .2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.3 Start-up of Hydronic Systems

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .5 Clean out strainers repeatedly until system is clean.
 - .6 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 over a 48 hour period.
 - .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 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
 - .15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
 - .16 Check operation of drain valves.
 - .17 Adjust valve stem packings as systems settle down.
 - .18 Fully open balancing valves (except those that are factory-set).
 - .19 Check operation of over-temperature protection devices on circulating pumps.
 - .20 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

1. GENERAL

1.1 References

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME-B16.3-2006, Malleable-Iron Threaded Fittings: Classes 150 and 300.
 - .2 ASME-B16.9-2007, Factory-Made Wrought Steel Buttwelding Fittings.
- .2 ASTM International
 - .1 ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .4 ASTM B75M-99(2005), Standard Specification for Seamless Copper Tube Metric.
- .3 Canadian Environmental Protection Act (CEPA)
 - .1 CCME PN 1326-2008, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems for Petroleum Products and Allied Petroleum Products.
- .4 CSA International
 - .1 CSA-B139-15, Installation Code for Oil Burning Equipment.
 - .2 CSA-B140.0-03, Oil Burning Equipment: General Requirements.
 - .3 CSA-C282-05, Emergency Electrical Power Supply for Buildings.
- .5 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-11-2008, 2nd Edition, Paints and Coatings.
- .6 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .7 Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
 - .1 MSS-SP-80-08, Bronze Gate, Globe, Angle and Check Valves.
- .8 National Association of Corrosion Engineers (NACE)
 - .1 NACE SP0169-2007, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
- .9 National Fire Code of Canada (NFCC 2005)
- .10 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
- .11 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC S603.1-03, External Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids.
 - .2 ULC ORD-C107.12-1992, Line Leak Detection Devices for Flammable Liquid Piping.

1.2 Administrative Requirements

- .1 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section in accordance with Section 01 32 16.06 - Construction Progress Schedule.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.3 Action and Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheets for piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Indicate on manufacturer's catalogue literature the following: valves.
 - .2 Provide two copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and Section 01 35 43 - Environmental Procedures.
- .3 Indicate VOC's for adhesive and solvents during application and curing.
- .4 Test Reports:
 - .1 Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Manufacturers' Instructions: provide manufacturer's installation instructions.

1.4 Closeout Submittals

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

1.5 Quality Assurance

- .1 Sustainability Standards Certification:
 - .1 Low-Emitting Materials: provide listing of adhesives and sealants paints and coatings used in building, comply with VOC and chemical component limits or restriction requirements.
- .2 Ensure piping is installed by company authorized by authority having jurisdiction.

1.6 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.

2. PRODUCTS**2.1 Fill Vent and Carrier Pipe**

- .1 Materials as per CSA-B139, CEPA SOR/2008-197, NFCC.
- .2 Steel: to ASTM A53/A53M, Schedule 40, continuous weld or electric resistance welded, screwed.
- .3 Copper: type K, soft copper tubing, to ASTM B75M, in long lengths.

2.2 Flexible Pipe

- .1 Stainless steel wire braided hose. ULC certified.

2.3 Steel Pipe Coating

- .1 Paint
 - .1 Interior – Mechanical room:
 - .1 Apply two (2) coats of paint, 75 to 125 microns per coat.
 - .2 Surface preparation: manual cleaning, SSPC-SP-2 method (see manufacturer's instructions).
 - .3 Colours: as chosen by Departmental Representative.
 - .4 Acceptable product: Carbogard 690 from Carboline.
 - .2 Exterior:
 - .1 Apply two (2) coats of paint, 75 to 125 microns per coat (primer coat).
 - .2 Apply two (2) coats of finish paint, 50 to 100 microns.
 - .3 Surface preparation: manual cleaning, SSPC-SP2 method (see manufacturer's instructions).
 - .4 Colours: as chosen by Departmental Representative.
 - .5 Acceptable products:
 - .1 Primer: Carbogard 690 from Carboline.
 - .2 Finish paint: Carbothane 133HB, satin finish from Carboline.

2.4 Jointing Material

- .1 Screwed fittings: Teflon tape
- .2 Brazed fittings: 85/15.

2.5 Fittings

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

2.6 Gate Valves

- .1 NPS 2 and under, screwed bonnet: rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, solid wedge disc as specified under Section 23 05 23.01 - Valves - Bronze.

2.7 Globe Valves

- .1 NPS 2 and under, screwed: to MSS-SP-80, Class 125, 860 kPa, bronze body, screwed over bonnet, renewable bronze disc or composition disc suitable for oil service as specified under Section 23 05 23.01 - Valves - Bronze.
 - .1 Lockshield handles: as indicated.

2.8 Ball Valves

- .1 NPS 2 and under: bronze body, screwed ends, TFE seal, hard chrome ball, 4 MPa, WOG as specified under Section 23 05 23.01 - Valves - Bronze.

2.9 Swing Check Valves

- .1 NPS 2 and under, screwed: to MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, renewable composition disc suitable for oil service, screw in cap, regrindable seat as specified under Section 23 05 23.01 - Valves - Bronze.

2.10 Fusible Valve

- .1 NPS 1/2 and under, bronze body, fusible element melting temperature: 74°C.
- .2 NPS 1 and over, bronze body, quick closing, spring loaded, fusible element melting temperature: 74°C

2.11 Oil Safety Valve

- .1 ULC listed for No. 2 fuel oil at 414 kPa maximum inlet pressure.

2.12 Emergency Shut-off Valve

- .1 Full port/floating ball, 3-piece body with blowout-proof stem, encapsulated bolt design, adjustable packing nut, 1725 kPa steam rated fire-safe certified to API 607, antistatic design, positive lock-out device.

2.13 Lubricated Plug Cocks

- .1 NPS 2 and under, screwed: to ASTM B61, Class 150, 1 MPa, bronze body.

2.14 Fuel Oil Transfer Pumps

- .1 Two positive (duplex) displacement self-priming, direct driven from TEFC motor, mounted on common base. Complete with mechanical seal, permanently sealed ball bearings, relief valve, compound gauge on inlet, pressure gauge on discharge.
- .2 Suction pipe size: NPS 1.
- .3 Discharge pipe size: NPS 1/2.
- .4 Control panel
 - .1 NEMA/CSA 1 enclosure
 - .2 Two (2) circuit breakers single pole, located on the door of the control panel and fuse control circuit (120V-1ph).
 - .3 Two (2) magnetic starters.
 - .4 Two (2) Manual / Off / Auto selectors.
 - .5 Two (2) "powered" warning lights.
 - .6 Two (2) "on" indicator lights.
 - .7 Four (4) terminals for level switches.
 - .8 Fuse for control circuit.
 - .9 Pump selector P1 / AUTO / P2.
 - .10 Indicator light for pump fault, manual reset and start the standby pump.
 - .11 Standby pump start signal on low flow, timer, LED and pushbutton for reset.
 - .12 Indicator light and alarm contact for daily tank low level.
 - .13 Indicator light and alarm contact for daily tank high level.
 - .14 Terminal for connection of solenoid.
 - .15 Indicator light and alarm contact for leak detection in the drip pan.
- .5 Capacity:
 - .1 Pumped fluid: number 2 fuel oil.
 - .2 Flow rate: as indicated.
 - .3 Motor: As indicated.

2.15 Oil Filter

- .1 Duplex type replaceable cartridge type as recommended by oil burner manufacturer.
- .2 Furnish spare filter cartridge.

2.16 Oil Meters

- .1 Accuracy: tested and certified by manufacturer for accuracy within plus or minus 0.2% between 20% and 100% rated capacity.
- .2 Capacity: As indicated.

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 Piping

- .1 Install piping in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified.
- .2 Install oil piping system in accordance with NFCC, CSA-B139, CSA-B140.0.
- .3 Slope piping down in direction of storage tank unless otherwise indicated.
- .4 Underground piping to be protected in conformance with CAN/ULC-S603.1.
- .5 Above ground piping to be protected from physical impact due to impact.
- .6 Piping inside building:
 - .1 Ensure piping in solid flooring is installed to CSA-B139 and to authority having justification.
 - .2 Use approved fitting to CSA-B139 for steel piping.
 - .3 Install filter, gate valve, and fire valve at burners.
 - .4 Install piping insulation in accordance with Section 23 07 15 0 Thermal Insulation for Piping.
- .7 Fill, vent, suction and return piping outside building:
 - .1 Steel piping welded throughout except at tanks where electrically isolating fittings are used.
 - .2 Grading: slope piping at 1% minimum back to tanks.
- .8 Install buried piping in double-wall piping to CSA-B139 and to authority having jurisdiction.
- .9 Piping at tanks:
 - .1 Suction: terminate 150 mm from bottom of tank with foot valve and strainer.
 - .2 Return: terminate 150 mm from bottom of tank with return bend.
 - .3 Comply with CSA-B139 and to authority having jurisdiction for piping for venting at tanks including venting whistle venting alarm.
 - .4 Fill pipes: install to comply with CSA-B139.
 - .1 Include vapour/ liquid tight tamperproof cover.

- .2 Equip fill pipes on tanks with capacity greater than 5000 L with liquid and vapour tight connections.
- .5 Dipstick: extend tube to within 150 mm from bottom of tank. Terminate at grade with lockable cap and chain, and watertight cover.
- .10 Interconnections between multiple tanks:
 - .1 Interconnect vent, suction, return to ensure equal level in tanks.
 - .2 Valve to permit isolation of tanks without interfering with use of other tanks.
 - .3 Mount tanks on common foundation
 - .4 Align tank tops at same elevation.
 - .5 Connect inlet fill pipe to one tank only, unless indicated.
 - .6 Install vent whistle to tank with vent pipe connected.
 - .7 Ensure connecting pipe between tank bottoms is at least equal to size of inlet pipe.
 - .8 Vent each tank separately from top.
 - .9 Terminate vent pipe to exterior location.
 - .10 Join separate vents to common vent pipe cross-connected to tops of each tank using vent manifold pipe located above highest liquid level in tanks.
 - .11 Size common vent and manifold pipes to CSA-B139.
- .11 Clearly label piping runs in legible form indicating;
 - .1 Piping product content.
 - .2 Direction of flow.
 - .3 Identify transfer points in piping systems to CPPI Colour-Symbol System to Mark Equipment and Vehicles for Product Identification

3.3 Valves

- .1 Install valves with stems upright or horizontal unless approved otherwise by Departmental Representative.
- .2 Install gate valves at branch take-offs, to isolate pieces of equipment and as indicated.
- .3 Install globe valves for balancing and in by-pass around control valves.
- .4 Install swing check valves on discharge of pumps and as indicated.
- .5 Install plug cocks as indicated.

3.4 Oil Transfer Pumps

- .1 Equip pumps with check valve installed below suction pump to permit contents of pipe to drain back to storage tank if suction is broken.
- .2 Install as indicated.
- .3 Install gate -valves on inlet and discharge connections.
- .4 Install pressure gauge at pump discharge, compound gauge on pump inlet connection.
- .5 Install relief valve in pump discharge piping with relief valve discharge pipe as indicated.

3.5 Oil Filters

- .1 Install ULC approved as indicated in supply line.
- .2 At time of acceptance, replace filter cartridge with new.

3.6 Overfill and Spill Protection

- .1 To CSA-B139.

3.7 Leak Detection

- .1 Install line leak detector to ULC ORD C107.12.
- .2 Install secondary containment systems that will allow leaks to accumulate in containment sump available for visual inspection.

3.8 Field Quality Control

- .1 Site Tests/Inspection:
 - .1 Test system to CSA-B139 and CSA-B140.0 and authorities having jurisdiction.
 - .2 Isolate tanks from piping pressure tests.
 - .3 Maintain test pressure during backfilling.
- .2 Performance Verification:
 - .1 Refer to Section 23 08 01 - Performance Verification Mechanical Piping System.

3.9 Start-Up and Commissioning

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41 and 01 91 51.
- .2 Have manufacturer certify installation.
- .3 Have manufacturer present [during start-up] [tests and start up units] and certify performance.
- .4 Submit written start-up and commissioning reports to Departmental Representative.

3.10 Cleaning

- .1 Clean in accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems and to manufacturer's written recommendations, supplemented as follows:
 - .1 Flush after pressure test with number 2 fuel oil for a minimum of two hours. Clean strainers and filters.
 - .2 Dispose of fuel oil used for flushing out in accordance with requirements of authority having jurisdiction.
 - .3 Ensure vents from regulators, control valves are terminated in approved location and are protected against blockage and damage.
 - .4 Ensure entire installation is approved by authority having jurisdiction.

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

End of Section

1. GENERAL

1.1 References

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI/AWS A5.8/A5.8M-11, AMD1 Specification Filler Metals for Brazing and Braze Welding.
- .2 ASME
 - .1 ANSI/ASME B16.4-06, Gray-Iron Threaded Fittings Classes 125 and 250.
 - .2 ANSI/ASME B16.15-11, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
 - .3 ANSI B16.18-12, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.22-12, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 ASTM International
 - .1 ASTM B32-08, Standard Specification for Solder Metal.
 - .2 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .3 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B88M-05(2011), Standard Specification for Seamless Copper Water Tube Metric.
 - .5 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturers Standardization Society (MSS)
 - .1 MSS SP67-2011, Butterfly Valves.
 - .2 MSS SP70-2011, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS SP71-2011, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS SP80-2008, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS SP85-2011, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

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.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and to Section 01 35 43 - Environmental Procedures.
- .3 Shop Drawings:
 - .1 Submit drawings for review.
 - .2 Indicate on manufacturers catalogue literature the following: valves.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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.
- .3 Submit 3 copies of operation and maintenance manual.

1.4 Maintenance Materials Submittals

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

1.5 Quality Assurance

- .1 Regulatory Requirements: ensure Work is performed in compliance with CEPA, CEAA, TDGA, applicable Provincial /Territorial regulations.

1.6 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 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.

2. PRODUCTS**2.1 Tubing**

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

2.2 Fittings

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

2.3 Flanges

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

2.4 Joints

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

2.5 Valves

- .1 Connections:
 - .1 NPS 2 and smaller: ends for soldering.
 - .2 NPS 2 1/2 and larger: flanged
- .2 Gate Valves: application: isolating equipment, control valves, pipelines:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: Class 125, rising stem split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Mechanical Rooms: rising stem, split wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators: handwheel
 - .2 Elsewhere: Non- rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators: handwheel
- .3 Butterfly valves: application: isolating each cell or section of multiple component equipment (i.e. multi-section coils, multi-cell cooling towers):
 - .1 NPS 2 1/2 and over: lug type: as specified Section 23 05 17 - Pipe Welding.

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- .4 Globe valves: application: throttling, flow control, emergency bypass:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 With composition, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .2 Operators: handwheel
 - .5 Balancing, for TAB:
 - .1 Sizes: calibrated balancing valves, as specified.
 - .2 NPS 2 and under:
 - .1 Mechanical rooms: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .3 Pressure meter connections with positive shutoff valves.
 - .6 Drain valves: gate, Class 125 as specified 23 05 23.01 - Valves - Bronze.
 - .7 Bypass valves on valves NPS 8 and larger: NPS 3/4, globe, with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .8 Swing check valves:
 - .1 NPS 2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Flanged: as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .9 Silent check valves:
 - .1 NPS 2 and under:
 - .1 As specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Flanged: as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .10 Ball valves:
 - .1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.
 - .11 Lubricated Plug Valves:
 - .1 NPS 2 and under: N/A.
 - .2 NPS 2 1/2 and over: as specified Section 23 05 23.02 - Valves - Cast Iron.

3. EXECUTION

3.1 Examination

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

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

3.4 Valve Installation

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

- .7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.

- .8 Install ball valves for glycol service.

3.5 Circuit Balancing Valves

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.6 Flushing and Cleaning

- .1 Flush and clean in presence of Departmental Representative.
- .2 Flush after pressure test for a minimum of 4 hours.
- .3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hours.
- .4 Refill system with clean water. Circulate for at least 4 hours. Clean out strainer screens/baskets regularly. Then drain.
- .5 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.
- .6 Drainage to include drain valves, dirt pockets, strainers, low points in system.
- .7 Re-install strainer screens/baskets only after obtaining Departmental Representative's approval.

3.7 Filling of System

- .1 Refill system with clean water adding water treatment as specified glycol.

3.8 Field Quality Control

- .1 Testing:
 - .1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.
 - .2 For glycol systems, retest with propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.
- .2 Balancing:
 - .1 Balance water systems to within plus or minus 5% of design output.
- .3 Glycol Charging:
 - .1 Provide mixing tank and positive displacement pump for glycol charging.
 - .2 Retest for concentration to ASTM E202 after cleaning.

- .3 Provide report to Departmental Representative.

3.9 **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

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 B16.1-10, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - .2 ASME B16.3-06, Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .3 ASME B16.5-09, Pipe Flanges and Flanged Fittings: NPS through NPS 24 Metric/Inch Standard.
 - .4 ASME B16.9-07, Factory-Made Wrought Butt welding Fittings.
 - .5 ASME B18.2.1-10, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).
 - .6 ASME B18.2.2-10, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
 - .7 ASME B31.1-2012, Power piping.
- .3 ASTM International
 - .1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202-10, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .4 CSA International
 - .1 CSA B242-05(R2011), Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)
 - .1 MSS-SP-67-2002a, Butterfly Valves.
 - .2 MSS-SP-70-06, Gray Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-05, Gray Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80-08, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85-02, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.

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 Submit drawings stamped and signed by professional engineer registered or licensed in Territory of Nunavut Canada.
 - .2 Submit drawings for review and approval.
 - .3 Indicate on drawings:
 - .1 Components and accessories.
- .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 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.

1.3 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 Valve seats: 1 minimum for every ten valves, each size. Minimum one.
 - .2 Discs: 1 minimum for every ten valves, each size. Minimum one.
 - .3 Stem packing: 1 minimum for every ten valves, each size. Minimum one.
 - .4 Valve handles: 2 minimum of each size.
 - .5 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 Develop Construction Waste Management Plan related to Work of this Section.

2. PRODUCTS

2.1 Pipe

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 To NPS 6: Schedule 40.
 - .2 NPS 8 and over, 10.
- .2 Supply and install the underground heating piping and fittings between the FMB and the MRB as specified hereafter.
 - .1 Buried heating water piping network
 - .1 General :
 - .1 All components of the piping system by the same manufacturer.
 - .2 All straight sections, fitting, anchors and accessories to be factory fabricated, insulated and jacketed.
 - .3 Field insulation of fitting is not allowed.
 - .4 Piping system layout to be analyzed by the piping system manufacturer to determine the stresses and displacement of the service pipe.
 - .5 Piping system system and manufacture to be in strict conformance with ASME B31.1
 - .6 Piping system to include two (2) empty conduits network for the installation of heat tracing element.
 - .7 Perform piping installation in accordance with manufacturer's instruction.
 - .2 Service pipe :
 - .1 Standard weight ASTM A53 Gr. B, ERW carbon steel.
 - .2 Joints : butt welded.
 - .3 Supply straight section in 12 meters length with piping exposed at each end for field joint fabrication.
- .3 Service pipe coating
 - .1 Exterior steel pipe surface : abrasive blast-cleaned to a minimum of a near white surface, SSPC-SP10-63T. Profile must be a minimum of 1.5 mil peak to valley range. Any areas of rust bloom or oil to be wiped or reblasted.
 - .2 Coat the steel service pipe with Zinc.
 - .3 Zinc coating :
 - .1 High solids inorganic zinc rich coating that protects the steel galvanically, thus eliminating sub-film corrosion.
 - .2 Two part sprayable coating consisting of a liquid base portion and a dry powdered metal. The two components, when mixed together can be spray applied.
 - .3 Dry film thickness in a range of 0.05 to 0.1 mm.

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- .4 Insulation
 - .1 Polyurethane foam insulation
 - .1 32 kg/m³ minimum density.
 - .2 90% minimum closed cell content.
 - .3 Maximum initial thermal conductivity : 0.026 W/m-°C.
 - .4 Insulation to fill completely the annular space between the service pipe and jacket and to be bonded to both.
 - .5 Insulation minimum thickness : 75 mm.
 - .5 Insulation jacket
 - .1 Outer protective insulation jacket
 - .1 Seamless high density polyethylene (HDPE) in accordance with ASTM D3350 minimum cell classification PE 345444 C.
 - .2 Minimum thickness : 2.54 mm.
 - .2 Accessories
 - .1 Elbows, tees, reducers, anchors, field joints and end seals
 - .2 Factory fabricated to prevent the ingress of moisture into the system
 - .3 Fittings
 - .1 Factory prefabricated and pre-insulated.
 - .2 Straight tangent lengths to be added to all ends so that all filed joints are at straight sections of pipe.
 - .3 Elbows insulation jackets
 - .1 Molded HDPE.
 - .4 Gluing, taping or hot air welding of the insulation jackets is not allowed.
 - .4 Field joints insulation
 - .1 Poured in-place into the field joint area.
 - .2 Applied only in straight sections of pipe.
 - .3 Field joint insulation of fittings is not acceptable.
 - .4 Field joints to be sealed with a heat shrinkable adhesive backed sleeve
 - .5 Backfilling is not allowed until the heat shrink sleeve has cooled.
 - .6 Conduit for heat tracing element
 - .1 Quantity: 2
 - .2 Size: 20 mm
 - .3 Conduits to be embedded in the insulation
 - .4 Conduit to be continuous on the overall length of the network and c/w a polypropylene fish cord.
 - .7 Warning tape
 - .1 Polyethylene tape: 150 mm wide by 0.15 mm thick as approved by Departmental Representative.
 - .2 Tape for heating pipes: red in colour with factory applied markings at one metre intervals, i.e. "Caution Buried Heating Line".
 - .8 Buried warning identification tape
 - .1 Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification or buried piping.
 - .2 Tape: detectable by electronic detection instrument.
 - .3 Provide tape in rolls, 75 mm width, colour for utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length.

- .4 Warning and identification: read “CAUTION BURIED PREINSULATED PIPING BELOW” or similar wording.
- .5 Use permanent code and letter colouring unaffected by moisture and other substances contained in trench backfill material.
- .9 Operating design criteria
 - .1 Temperature: 85°C.
 - .2 Pressure: 1035 kPa.
 - .3 Heating media: Polypropylene glycol 50%.

2.2 Pipe Joints

- .1 NPS 2 and under: screwed fittings with PTFE tape
- .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.
- .3 Flanges: plain or raised face, slip-on or weld neck to ANSI/AWWA C111/ A21.11.
- .4 Orifice flanges: slip-on raised face, 2100 kPa.
- .5 Flange gaskets: to ANSI/AWWA C111/ A21.11.
- .6 Pipe thread: taper.
- .7 Bolts and nuts: to ASME B18.2.1, ASME B18.2.2.

2.3 Fittings

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ASME B16.1, Class 125.
 - .2 Steel: to ASME B16.5.
- .3 Butt-welding fittings: steel, to ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47/A47M ASME B16.3.

2.4 Valves

- .1 Connections:
 - .1 NPS 2 and smaller: screwed ends.
 - .2 NPS 2-1/2 and larger: flanged ends.
- .2 Gate valves: to MSS-SP-70 to MSS-SP-80 application: isolating equipment, control valves, pipelines and as indicated:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms : Class 125, rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

- .2 NPS 2-1/2 and over:
 - .1 Mechanical Rooms: rising stem, split wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators: manual .
 - .2 Elsewhere: non- rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators: Handwheel.
- .3 Butterfly valves: to MSS-SP-67, application: isolating cells or section of multiple component equipment (i.e. multi-section coils, multi-cell cooling towers)and as indicated:
 - .1 NPS 2-1/2 and over: lug type: as specified Section 23 05 17 - Pipe Welding.
- .4 Globe valves: application: throttling, flow control, emergency bypass or as indicated to MSS-SP-80:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2-1/2 and over:
 - .1 With composition disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .2 Operators: Handwheel.
- .5 Balancing, for TAB:
 - .1 Sizes: calibrated balancing valves, as specified this section.
 - .2 NPS 2 and under:
 - .1 Mechanical Rooms: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
- .6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
- .7 Bypass valves on gate valves NPS 8 and larger: NPS 3/4, Globe, with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.
- .8 Swing check valves: to MSS-SP-71.
 - .1 NPS 2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2-1/2 and over:
 - .1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron.
- .9 Silent check valves:
 - .1 NPS 2 and under:
 - .1 As specified Section 23 05 23.01 - Valves - Bronze.

- .2 NPS 2-1/2 and over:
 - .1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron.
- .10 Ball valves:
 - .1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.
- .11 Lubricated Plug Valves
 - .1 NPS 2 and under: N/A
 - .2 NPS 2-1/2 and over:
 - .1 As specified Section 23 05 23.02 - Valves - Cast Iron.
- 3. EXECUTION
 - 3.1 Examination
 - .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic systems installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied 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.
 - .2 Slope piping in direction of drainage and for positive venting.
 - 3.3 Circuit Balancing Valves
 - .1 Install flow measuring stations and flow balancing valves as indicated.
 - .2 Remove handwheel after installation and when TAB is complete.
 - .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.
 - 3.4 Cleaning, Flushing and Start-Up
 - .1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.
 - 3.5 Testing
 - .1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.
 - .2 For glycol systems, retest with propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.6 Balancing

- .1 Balance water systems to within plus or minus 5 % of design output.
- .2 In accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.7 Glycol Charging

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

3.8 Performance Verification

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

3.9 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.

3.10 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

1. GENERAL**1.1 References**

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .2 ASTM International
 - .1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278/A278M-01(2011), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .3 ASTM A516/A516M-10, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.
 - .5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 CSA Group
 - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.

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 expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings for review and approval.

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 specialties for incorporation into manual.
- .3 Submit 3 copies of operation and maintenance manual.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic specialties from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 Diaphragm Type Expansion Tank

- .1 Horizontal Vertical galvanized steel pressurized diaphragm type expansion tank.
- .2 Capacity: As indicated.
- .3 Size: as indicated
- .4 Diaphragm sealed in elastomer suitable for indicated operating temperature.
- .5 Working pressure: 860 kPa with ASME stamp and certification 520 kPa.
- .6 Air precharged to 200 kPa (initial fill pressure of system).
- .7 Saddles for horizontal installation or Base mount for vertical installation as indicated.
- .8 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems.
- .9 Renewable diaphragm.

2.2 Hydraulic Separator (HYS-1)

- .1 The low-loss header shall be constructed of mild carbon steel with NPS or ANSI fittings. The device must be designed and tested with various flow rates having predictable hydronic resistance charts available for the design purpose;
- .2 Capacity: As indicated;
- .3 Connections: 75mm ANSI;
- .4 The boiler manufacturer shall make approved drawings available, which contain piping and control diagrams with low-loss header configurations and sizing;
- .5 Size: as indicated;
- .6 The low-loss header shall be designed and tested with time-proven, standard control strategies allowing for optimum boiler efficiency, ease of installation and programming.

2.3 Automatic Air Vent

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 690 kPa working pressure.

.2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.

.3 Float: solid material suitable for 115 degrees C working temperature.

2.4 Combination Separators/Strainers

.1 Steel, tested and stamped in accordance with ASME BPVC, for 860 kPa operating pressure, with galvanized steel integral strainer with 5 mm perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube. Equipped with a manual bleeding valve at the bottom of the air separator.

2.5 Combination Low Pressure Relief and Reducing Valve

.1 Adjustable pressure setting: 206 kPa relief, 55 to 172 kPa reducing.

.2 Low inlet pressure check valve.

.3 Removable strainer.

2.6 Pipe Line Strainer

.1 NPS 1/2 to 2: bronze body to ASTM B62, solder end or screwed connections, Y pattern.

.2 NPS 2 1/2 to 12: cast steel body to ASTM A278/A278M, Class 30, cast iron body to ASTM A278/A278M, Class 30 flanged connections.

.3 Blowdown connection: NPS 1.

.4 Screen: stainless steel with 1.19 mm perforations.

.5 Working pressure: 860 kPa.

2.7 Suction Diffuser

.1 Body: cast iron with flanged or screwed 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 tapings.

.6 Adjustable support leg.

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 specialties 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 Application

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

3.3 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 tappings for ancillaries and for equipment operating weights.

3.4 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 as indicated.

3.5 Air Vents

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

3.6 Expansion Tanks

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

3.7 **Pressure Safety Relief Valves**

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

3.8 **Suction Diffusers**

- .1 Install on inlet to pumps having suction size greater than 50, unless last elbow is located to a distance at least five (5) pipe diameter from the suction of the pump.

3.9 **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

1. GENERAL

1.1 References

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IES Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group
 - .1 CAN/CSA-B214-12, Installation Code for Hydronic Heating Systems.
- .3 Electrical Equipment Manufacturers Association of Canada (EEMAC)
- .4 National Electrical Manufacturers' Association (NEMA)
 - .1 NEMA MG 1-2011, Motors and Generators.

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 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 Shop Drawings:
 - .1 Submit drawings for review and approval.
 - .2 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 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.
- .3 Submit 3 copies of operation and maintenance manual.

1.4 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic pumps from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 Equipment

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

2.2 Primary Heating Pumps HP1-1 and HP1-2

- .1 Canned rotor type, pump and motor form an integral unit without shaft seal and with only two gaskets for sealing. The bearings are lubricated by the pumped liquid;
- .2 3 speed motor;
- .3 Ceramic radial bearings;
- .4 Carbon axial bearing;
- .5 Stainless steel rotor can, bearing plate and rotor cladding;
- .6 Aluminium alloy stator housing;
- .7 Cast iron pump housing;
- .8 Stator with built-in thermal switch.
- .9 Capacity and electrical data: see plans

2.3 Secondary Heating Pumps HP2-1 and HP2-2 (Integrated VFD, differential pressure and temperature sensor)

- .1 Canned rotor type, pump and motor form an integral unit without shaft seal and with only two gaskets for sealing. The bearings are lubricated by the pumped liquid;
- .2 Controller integrated in the control box
- .3 Control panel with TFT display on the control box
- .4 Control box prepared for optional CIM modules
- .5 Built-in differential-pressure and temperature sensor
- .6 Cast-iron pump housing (depending on model)
- .7 Carbon-fibre-reinforced composite rotor can
- .8 Stainless-steel bearing plate and rotor cladding
- .9 Aluminium alloy stator housing
- .10 Air-cooled power electronics
- .11 Automatic adaptation to the conditions
- .12 Flowrate adaptation and flow limit.
- .13 Proportional-pressure control.
- .14 Constant-pressure control.
- .15 Constant-temperature control.
- .16 Constant-curve duty.
- .17 Max. or min. curve duty.
- .18 Automatic Night Setback.
- .19 No external motor protection required.

- .20 Insulating shells supplied with single-head pumps for heating systems.
- .21 Large temperature range where the liquid temperature and the ambient temperature are independent of each other.
- .22 Capacity and electrical data: see plans

2.4 General requirements for heating pumps

- .1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.
- .2 Impeller: cast bronze or as indicated
- .3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 degrees C.
- .5 Coupling: flexible self-aligning.
- .6 Motor: to NEMA MG 1 resilient mounted, drip proof, TEFC, sleeve bearing, 1750 r/min, suitable for VFD operation, minimum efficiency in accordance to ASHRAE
- .7 Capacity: as indicated
- .8 Design pressure: 860 kPa.

2.5 Motors:

- .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
- .2 For use with variable speed controllers. Motor: to NEMA MG 1 resilient mounted, drip proof, TEFC, sleeve bearing, 1750 r/min, suitable for VFD operation, minimum efficiency in accordance to ASHRAE.
- .3 **For HP2-1 and HP2-2: 4 poles synchronous permanent magnet motor.**

2.6 Variable Frequency Drive (VFD)

- .1 All VFD must be from the same manufacturer.
- .2 VFD designed for use with NEMA B squirrel cage induction motors, with a 1.15 service factor.
 - .1 Ambient operating conditions: 0 to 40° continuously.
 - .2 Altitude: 0 to 1 000 m above sea level.
 - .3 Humidity: less than 95% without condensation.
 - .4 Voltage: 600 V, 3 phase.
 - .5 Overload capacity: 110% of normal running current for one (1) minute and every ten (10) minutes
 - .6 Overcurrent capacity: 130% of normal running current for two (2) minutes.
 - .7 Rated current at VFD entry: less than 3% of rated output current.

- .8 Integrated impedance of 5% to reduce harmonic current distortions of the supply current and to increase protection against transients.
 - .9 VFD is able to start from a stopped position, accelerate and decelerate without triggering the supply breaker or damaging components.
 - .10 VFD is able to automatically restart after an overvoltage, a current surge, an undervoltage or after a signal loss protection device is activated; the number of restart attempts, the length of the attempts and the time between the attempts must be programmable.
 - .11 VFD to detect a pressure loss and to signal the problem by displaying a message on the keypad, by transmitting a signal to a relay and/or a series communication bus.
 - .12 All drives to be protected against invalid I/O supply connections and display an alarm on the keypad.
- .3 **User Interface**
- .1 VFD equipped with removable keypad and digital screen.
 - .2 VFD protected by a password.
 - .3 Menu function keys included.
 - .4 Backlit LCD display.
 - .5 Entry of complete words for programming and trouble shooting.
 - .6 Alphanumerical codes not accepted.
 - .7 Assistants provided:
 - .1 Start-up.
 - .2 Parameter programming.
 - .3 Maintenance.
 - .4 Trouble shooting.
 - .8 Minimum of three (3) of the following operating data displayed at the same time in engineering values;
 - .1 Output frequency.
 - .2 Motor speed.
 - .3 Motor current.
 - .4 Calculated motor torque.
 - .5 Calculated motor strength, kW.
 - .6 DC bus voltage.
 - .7 Output voltage.
 - .9 «Programmable integrated clock with calendar, equipped with a ten (10) year battery life.
- .4 **Controls and Communication**
- .1 VFD equipped with PC software to permit copying, programming and supervision of operating parameters.
 - .2 VFD must use application programs specially designed to facilitate start-up; provide a minimum of ten (10) pre-programmed operating software.
 - .3 In case of loss of reference input (4-20 ma or 2-10 V), provide user with the following options;
 - .1 To stop and display a defect.
 - .2 To operate at a programmable pre-defined speed.
 - .3 To maintain speed based on the last reference data received.
 - .4 To issue a warning.
 - .4 VFD controls;
 - .1 Three (3) programmable frequency lock-in ranges.

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- .2 Two (2) standard PID set point controllers.
 - .3 Two (2) programmable analog inputs accepting voltage or current signals.
 - .4 Two (2) programmable analog outputs.
 - .5 Six (6) programmable digital inputs.
 - .6 Three (3) programmable digital outputs for form C relays.
 - .7 Seven (7) pre-defined programmable speeds.
 - .8 Two (2) independently adjustable acceleration/deceleration ranges with adjustable with adjustable throughputs of 1 to 1 800 seconds.
 - .5 VFD to include a motor power supply.
 - .6 VFD to include a carrier frequency control circuit.
 - .7 VFD to include a bypass input for fire services.
 - .5 **Serial Communications**
 - .1 VFD must be compatible with standard RS-485 access compatible with Modbus, bus Johnson Controls N2, Siemens Building Technologies FLN.
 - .2 Each VFD must be equipped with base certified protocols.
 - .3 Building Automation System (BAS) must be able to verify at least fifteen (15) operating parameters.
 - .4 All serial communication functions of each VFD must be compatible with the BAS.
 - .6 **Additional Features**
 - .1 All components installed within a single NEMA 1 enclosure.
 - .2 Input disconnect switch with interlocking device mounted on the enclosure door.
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 pump 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 **Application**
- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.
- 3.3 **Installation**
- .1 Install hydronic pumps to: CAN/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 Base mounted type: supply templates for anchor bolt placement.
 - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
 - .2 Align coupling in accordance with manufacturer's recommended tolerance.
 - .3 Check oil level and lubricate. After run-in, tighten glands.
- .4 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.
- .5 Pipe drain tapping to floor drain.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.

3.4 Start-Up

- .1 General:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements and Section 01 91 31 – Commissioning Plan; supplemented as specified herein.
 - .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
 - .1 Before starting pump, check that 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 Run-in pumps for 12 continuous hours minimum.
 - .5 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .6 Eliminate air from scroll casing.
 - .7 Adjust water flow rate through water-cooled bearings.
 - .8 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
 - .9 Adjust alignment of piping and conduit to ensure true flexibility.
 - .10 Eliminate cavitation, flashing and air entrainment.
 - .11 Adjust pump shaft seals, stuffing boxes, glands.
 - .12 Measure pressure drop across strainer when clean and with flow rates as finally set.
 - .13 Replace seals if pump used to degrease system or if pump used for temporary heat.
 - .14 Verify lubricating oil levels.

3.5 Performance Verification (PV)

- .1 General:
 - .1 Verify performance in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements and Section 01 91 31 – Commissioning Plan, supplemented as specified herein.

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- .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 procedures 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 31 - Commissioning (Cx) Plan: Requirements reports supplemented as specified herein. Reports to include:
 - .1 Record of points 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 31 - Commissioning (Cx) Plan : Report Forms and Schematics.
 - .3 Pump performance curves (family of curves).

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

1. GENERAL

1.1 References

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

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 water treatment systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Shop Drawings:
 - .1 Submit drawings for approval.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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 HVAC water treatment systems for incorporation into manual.
- .3 Include following:
 - .1 Log sheets as recommended by Departmental Representative.

1.4 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.

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- .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 HVAC water treatment systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Develop Construction Waste Management Plan related to Work of this Section.
 - .5 Packaging Waste Management: remove for reuse 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.
2. PRODUCTS
- 2.1 **Manufacturer**
- .1 Equipment, chemicals, and service provided by one supplier.
- 2.2 **Glycol Pressurization Unit**
- .1 Supply and install the glycol pressurization system for all glycol closed loop system. This system includes the following items:
 - .1 One (1) 208 litres tank made of high density polyethylene (HDPE) with a removable cover for the refilling;
 - .2 One (1) brass positive displacement pump;
 - .3 Power supply to the unit will be 115V/60Hz/1ph.
 - .4 Pumps, pressure switches, pressure gauge, check valve, low level switch, copper interconnection piping, leak detection and control panel are factory assembled on a polyethylene platform on top of the glycol storage tank. All electrical items are factory wired and tested before the shipping;
- 2.3 **Pot Feeder**
- .1 Welded steel, pressure rating 860 kPa. Temperature rating: 90 degrees C.
- 2.4 **Chemical Feed Piping**
- .1 Resistant to chemicals employed. Pressure rating: 860 kPa.
- 2.5 **Chemical Feed Pumps**
- .1 Top-mounted electronic metering diaphragm type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with pressure relief valve, check valve, foot valve, injection fitting.
 - .2 Piston type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with stainless steel piston, pressure relief valve, double ball and check valves.

2.6 Shipping/Feeding Chemical Containers

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

2.7 Conductivity Controller

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

2.8 Conductivity Probes

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

2.9 Water Treatment for Hydronic Systems

- .1 Glycol heating system: pot feeder, 25 L, operating pressure 860 kPa.
- .2 Glycol run-around system: pot feeder, 25 L, operating pressure 860 kPa.
- .3 Micron filter for each pot feeder:
 - .1 Capacity 2% of pump recirculating rate at operating pressure.
 - .2 Six (6) sets of filter cartridges for each type, size of micron filter.

2.10 Chemicals

- .1 Provide 1 years supply.
- .2 Obtain chemicals from manufacturer with existing valid contract with PWGSC.

2.11 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.

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 water treatment systems installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied 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 Install HVAC water treatment systems in accordance with ASME Boiler and Pressure 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.

3.4 **Chemical Feed Piping**

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

3.5 **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.

3.6 **Water Treatment Services**

- .1 Provide water treatment monitoring and consulting services for period of 1 year after system start-up. Service to include:
 - .1 Initial water analysis and treatment recommendations.
 - .2 System start-up assistance.
 - .3 Operating staff training.
 - .4 Visit plant on a regular basis during period of operation and as required until system stabilizes, and advise on treatment system performance.
 - .5 Provide necessary recording charts and log sheets for 1 year operation.
 - .6 Provide necessary laboratory and technical assistance.
 - .7 Provide clear, concise, written instructions and advice to operating staff.

3.7 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 water treatment supplier holder of service contract.
 - .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 raw 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 - 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.
 - .6 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.
 - .7 Certificates:
 - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
 - .8 Commissioning Reports:
 - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative.

- .9 Commissioning activities during Warranty Period:
 - .1 Check out water treatment systems on regular basis and submit written report to Departmental Representative.
- .10 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41 and 01 91 51.
- .11 Have manufacturer certify installation.
- .12 Have manufacturer present during start-up tests and start up units and certify performance.
- .13 Submit written start-up and commissioning reports to Departmental Representative.

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.

End of Section

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 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-12, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
 - .3 IAQ Guideline for Occupied Buildings Under Construction 2007.
- .6 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 Shop Drawings:
 - .1 Submit drawings for review and approval.

- .4 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.
- .5 Sustainable Design Submittals:
 - .1 Construction IAQ Management Plan:
 - .1 Submit Indoor Air Quality (IAQ) Plan for pre-occupancy phases of building.
 - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings Under Construction.

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 off ground, indoors 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.
- .4 Develop Construction Waste Management Plan related to Work of this Section.

2. PRODUCTS

2.1 Seal Classification

2.2 Ductwork (see pressure class on plan M401)

- .1 Material:
 - .1 Galvanized steel with Z90 designation zinc coating lock forming quality: to ASTM A653/A653M.
 - .2 Thickness: to SMACNA.
- .2 Construction: round and oval.
 - .1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.
 - .2 Transverse joints up to 900 mm: slip type with tape and sealants.
 - .3 Transverse joints over 900 mm: Vanstone.
 - .4 Fittings:
 - .1 Elbows: smooth radius 5 piece (for 90 degrees), 3 piece (for 45 degrees). Centreline radius: 1.5 x diameter.
 - .2 Branches: conical transition with conical branch at 45 degrees and 45 degrees elbow.

- .3 Construction: rectangular:
 - .1 Ducts: to SMACNA.
 - .2 Transverse joints: welded proprietary duct joints SMACNA seal Class A and B.
 - .3 Fittings:
 - .1 Elbows: smooth radius; centreline radius 1.5 x width of duct. No vanes.
 - .2 Branches: with conical branch at 45 degrees and 45 degrees elbow.
- .4 Fire stopping:
 - .1 50 x 50 x 3 mm retaining angles around duct, on both sides of fire separation.
 - .2 Fire stopping material must not distort duct.

- .5 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
750 & +	A
500	A
250	A
125	A

- .6 Seal classification:
 - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
 - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant, tape or combination thereof.

2.3 Sealant

- .1 Sustainability Characteristics:
 - .1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .2 Adhesives and sealants: VOC limit 30 g/L maximum to SCAQMD Rule 1168, GS-36.
- .2 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.4 Tape

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

2.5 Duct Leakage

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

2.6 Fittings

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
 - .1 Rectangular: standard radius or 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 thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with 45 degrees entry on branch
 - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with splitter damper.
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
 - .1 as indicated
- .7 Obstruction deflectors: maintain full cross-sectional area.
 - .1 Maximum included angles: as for transitions.

2.7 Fire Stopping

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

2.8 Galvanized Steel

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

2.9 Stainless Steel

- .1 To ASTM A480/A480M, Type 304.
- .2 Finish: number 4.
- .3 Thickness, fabrication and reinforcement: to SMACNA as indicated.
- .4 Joints: to SMACNA be continuous inert gas welded.

2.10 Kitchen Exhaust Systems (see 23 51 00.01 Grease ducts)

- .1 Construct in accordance with NFPA 96.

- .2 Material: Type 304 stainless steel sheet.
- .3 Thickness: as indicated.
- .4 Fabrication: as indicated.
- .5 Reinforcement: as indicated.
- .6 Drainage: as indicated.
- .7 Grease filters: to Section 23 38 13 - Commercial Kitchen Hoods.

2.11 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 SMACNA.
 - .3 Hangers: galvanized steel angle with black steel rods to 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 steel plate washer.
 - .3 For steel beams: manufactured beam clamps:

2.12 Painting

- .1 All apparent ducts shall be painted white. Follow the spiral duct manufacturer recommendations for painting of galvanized steel.

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

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, minimum spacing as follows:

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

3.4 Watertight Duct

- .1 Provide watertight duct for:
 - .1 Dishwasher exhaust.
 - .2 Fresh air intake up to AHU.
 - .3 Minimum 3000 mm from duct mounted humidifier in all directions.
 - .4 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Weld joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards hoods served.
 - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve and discharging to open funnel drain or as indicated.

3.5 Kitchen Exhaust Systems

- .1 Install to NFPA 96 and as indicated.

3.6 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.

3.7 Leakage Tests

- .1 No leakage tests are required for low pressure ducts, unless indicated in Section 23 05 94 - Pressure Testing of Ducted Air 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.

End of Section

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 acoustical air plenums and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit separate drawings for each piece of attenuation equipment/system shop drawings 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 off ground, in doors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect acoustical air plenums from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

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 Acoustic plenums: transmission loss and acoustical absorption.
 - .3 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 fiber, 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. Steel gage of silencers to be same gage as ducting to which they attach.
- .2 Outer casing and galvanized steel inner casing with clean cut circular perforations to enclose acoustic media. Inner casing to have half-splitter pods running full length of silencer where any cross sectional dimension exceeds 450 mm. Protect media from erosion with glass fiber cloth Tedlar/Mylar between media and perforated metal.
- .3 Silencers as follow:
 - .1 Dimensions: As indicated
 - .2 Capacity (L/s): As indicated
 - .3 Pressure drop: 70 Pa.
 - .4 Insertion loss per octave band between 125 Hz to 4 kHz inclusive: As indicated
 - .5 Self generated noise: as specified.
- .4 Performance: as indicated.

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 63 to 8000 Hz and taken:
 - .1 Upstream and downstream of each silencer and plenum.
 - .2 In areas adjacent to mechanical equipment rooms, duct and pipe shafts.
 - .3 At 1800 mm above floor adjacent to first air terminal.
 - .4 At following critical locations: Laboratories.
 - .3 Provide Departmental Representative with 24 hours notice 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.
- .2 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After preparatory work is complete but before installation commences.
 - .3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.

3.5 Adjusting

- .1 Make adjustments and corrections in accordance with written report.

- .2 Provide Departmental Representative with 24 hours notice 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, 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.

End of Section

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 Develop Construction Waste Management Plan related to Work of this Section
- .3 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 Turning vanes.
 - .4 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 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 air duct accessories from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Develop Construction Waste Management Plan related to Work of this Section

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 2 mm thick with fabric clenched by means of double locked seams.

- .2 Material:
 - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m².

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.
 - .6 300 x 300 mm glass viewing panels.

2.4 Turning Vanes

- .1 Factory or shop fabricated single thickness or double thickness with or without trailing edge, to recommendations of SMACNA and as indicated.

2.5 Instrument Test

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

2.6 Spin-In Collars

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

3. EXECUTION

3.1 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 Access Doors and Viewing Panels:
 - .1 Size:
 - .1 1000 x 1000 mm for person size entry.
 - .2 600 x 600 mm for servicing entry.
 - .3 300 x 300 mm for viewing.
 - .4 Or as indicated.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.

- .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 And as indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by Departmental Representative.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 And as indicated.
- .4 Turning Vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.

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

1. GENERAL

1.1 References

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-2013.

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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Construction IAQ Management Plan:
 - .1 Submit Indoor Air Quality (IAQ) Plan for construction pre-occupancy phases of building.
 - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings Under Construction.

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 dampers for incorporation into manual.

1.4 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 General

- .1 Manufacture to SMACNA standards.

2.2 Splitter Dampers

- .1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Single thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.
- .5 Pivot: piano hinge.
- .6 Folded leading edge.

2.3 Single Blade Dampers

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height as indicated .
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 Multi-Bladed Dampers

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: as indicated 100 mm.
- .4 Bearings: pin in bronze bushings or self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage : 2% at 500 Pa.

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper 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 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .2 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .3 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .4 Install where indicated.
- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.
- .7 Corrections and adjustments conducted by Departmental Representative.

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

1. GENERAL

1.1 References

- .1 ASTM International
 - .1 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 AMCA 500 – Test Methods for Louvers, Dampers and Shutters.

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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.

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 dampers for incorporation into manual.

1.4 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 Multi-Leaf Dampers

- .1 Opposed or parallel blade type as indicated.
- .2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel or extruded aluminum frame.

-
- .3 Pressure fit self-lubricated bronze bearings.
 - .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
 - .5 Operator: to Section 25 30 02 – EMCS: Field Control Devices.
 - .6 Performance:
 - .1 Leakage: in closed position less than 2% of rated air flow at 2500 Pa differential across damper calculated in accordance with AMCA 500.
 - .2 Pressure drop: at full open position less than 10 Pa differential across damper at 2.5 m/s.
 - .7 Insulated aluminum dampers:
 - .1 Frames: insulated with extruded polystyrene foam with same thermal resistance as the blades.
 - .2 Blades:
 - .1 Material: Minimum 0.075 inch (1.9 mm) 6063-T5 extruded aluminum.
 - .2 Width: Maximum 6 inches (152 mm).
 - .3 Style: Airfoil-shaped.
 - .4 Action: Opposed.
 - .5 Orientation: Horizontal.
 - .6 Foam Isolation: Injected with 2-part, high-density, CFC-free, polyurethane foam.
 - .7 Thermal Isolation Gap: Each blade underneath tooled blade edge seal pocket.
 - .8 Thermal Transfer:
 - .1 Both sides of blade shall be isolated from each other eliminating thermal transfer.
 - .2 Damper blade overlap and thermal break shall be oriented to eliminate thermal transfer from 1 side of blade skins to other.
 - .3 No downstream blade skin shall be exposed to upstream temperatures or conditions.
 - .9 Linkage: Concealed in equal flanged frame.
 - .10 Axles: Minimum 13 mm diameter plated steel, hex-shaped, mechanically locked internally into blade.
 - .11 Bearings: Pressure-molded low temperature Lexan bearings.
 - .12 Seals:
 - .1 Blade: Extruded silicon for service down to -57 degrees C, mechanically attached to blade edge.
 - .2 Jamb: Polycarbonate.
 - .13 Control Shaft: Removable, 13 mm diameter shaft extends 152 mm beyond frame.
 - .14 Temperature Rating: -57 to 93 degrees C.
 - .15 Finish: Mill aluminum.

2.2 Back Draft Dampers

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

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper 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 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with low temperature silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Ensure dampers are observable and 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

1. GENERAL

1.1 References

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S112-10, Standard Test Method of Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC-S112.2-07, Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies.
 - .3 ULC-S505-1974, Standard for Fusible Links for Fire Protection Service.

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 fire and smoke dampers and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Smoke dampers.
 - .3 Fire stop flaps.
 - .4 Operators.
 - .5 Fusible links.
 - .6 Design details of break-away joints.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Territory of Nunavut, Canada.
 - .2 Submit complete plans to Authority of Jurisdiction for review and approval before commencement of work.
- .4 Certificates of rating: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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 fire and smoke dampers for incorporation into manual.

1.4 Maintenance Material Submittals

- .1 Extra Materials:
 - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

- .2 Provide:
 - .1 6 fusible links of each type.

1.5 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect fire and smoke dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 Fire Dampers

- .1 Fire dampers: arrangement Type A, B, C, listed bear label of ULC UL , meet requirements of authorities having jurisdiction, local fire authority, Fire Commissioner of Canada (FCC) CFFM and NFPA 90A. Fire damper assemblies fire tested in accordance with CAN/ULC-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
 - .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.
 - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: offset single damper, round or square; multi-blade hinged interlocking type; roll door type; guillotine type; sized to maintain full duct cross section as indicated.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.

- .9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
- .10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.2 Smoke Dampers

- .1 Smoke Dampers: to be ULC listed and labeled.
- .2 Normally closed reverse action smoke vent (S/D-RASV): folding blade type, opening by gravity upon detection of smoke, and/or from remote alarm signalling device actuated by an electro thermal link or as indicated. Two flexible stainless steel blade edge seals to provide required constant sealing pressure.
- .3 Normally open smoke/seal (S/D-SSSD): folding blade type, closing when actuated by means of electro thermal link and/or from remote alarm signalling device. Blade edge seals of flexible stainless steel to provide required constant sealing pressure. Provide stainless steel negator springs with locking devices to ensure positive closure for units mounted horizontally in vertical ducts.
- .4 Motorized (S/D-M): folding blade type, normally open with power on. When power is interrupted damper shall close automatically. Both damper and damper operator shall be ULC listed and labelled.
- .5 Electro thermal link (S/D-ETL): dual responsive fusible link which melts when subjected to local heat of 74 degrees C and from external electrical impulse of low power and short duration; ULC or UL listed and labelled.

2.3 Combination Fire and Smoke Dampers

- .1 Damper: similar to smoke dampers specified above.
- .2 Combined actuator: electrical control system actuated from smoke sensor or smoke detection system and from fusible link.

2.4 Fire Stop Flaps

- .1 Fire smoke flaps: ULC listed and labelled and fire tested in accordance with CAN/ULC-S112.2.
- .2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.
- .3 Flaps held open with fusible link conforming to ULC-S505 and close at 74 degrees C or as indicated.

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for fire and smoke damper 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 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Co-ordinate with installer of fire stopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

3.3 Cleaning

- .1 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.

3.4 Start-Up and Commissioning

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41 and 01 91 51.

End of Section

1. GENERAL

1.1 References

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-12, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 2005.
- .4 Underwriters' Laboratories (UL)
 - .1 UL 181-2005, Standard for Factory-Made Air Ducts and Air Connectors.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S110-2007, Standard Methods of Tests for Air Ducts.

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 flexible ducts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .3 Test and Evaluation Reports:
 - .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 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 flexible ducts from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 General

- .1 Factory fabricated to CAN/ULC-S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 Metallic Acoustic Insulated – Low and Medium Pressure

- .1 Type 5: spiral wound, flexible perforated aluminum with factory applied 37 mm thick flexible mineral fibre thermal insulation and sleeved by aluminum foil/mylar laminate Type M vapour barrier, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Frequency (Hz)					
Duct Diam:	125	250	500	1000	2000
150	5.35	6.4	12	14.3	10.5

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for flexible ducts 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 Duct Installation

- .1 Install in accordance with: CAN/ULC-S110, UL 181, NFPA 90A, NFPA 90B and SMACNA.

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

1. GENERAL

1.1 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.

1.2 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 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, Power (kW) and efficiency.
 - .2 Sound rating data at point of operation.
 - .2 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
 - .2 Minimum performance achievable with variable speed controllers as appropriate.

1.3 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.

1.4 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect VAC fans from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

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, total static pressure, power (W), efficiency, revolutions per minute, power, 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, except for propeller fans smaller than 300 mm diameter.

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 For use with variable speed controllers. Motor: to NEMA MG 1 resilient mounted, drip proof, TEFC, sleeve bearing, 1750 r/min, suitable for VFD operation, minimum efficiency in accordance to ASHRAE.
 - .3 Sizes as indicated.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable motor bases, belt guards, coupling guards fan inlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment, inlet and outlet dampers and vanes and as indicated.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Scroll casing drains: as indicated.

- .5 Finish on fume hood exhaust fans: Protective coating
- .6 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .7 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .8 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.3 Centrifugal Fans

- .1 Fan wheels:
 - .1 Welded steel construction.
 - .2 Maximum operating speed of centrifugal fans not more than 40% of first critical speed.
 - .3 Air foil, forward curved or backward inclined blades, as indicated.
- .2 Bearings: heavy duty grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 hours.
- .3 Shaft seals on laboratory fume hood and biological safety cabinet exhaust fans:
 - .1 Air tight.
- .4 Housings:
 - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, cast iron, steel, aluminum, for smaller wheels, braced, and with welded supports.
 - .2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.
 - .3 Provide bolted latched airtight access doors with handles.
- .5 Variable volume control devices:
 - .1 Mounted by fan manufacturer.
 - .2 Variable speed drives: As indicated.

2.4 Cabinet Fans - General Purpose

- .1 Fan characteristics and construction: as centrifugal fans.
- .2 Cabinet hung single or multiple wheel with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, variable speed V-belt drive and guard inside or outside casing.
- .3 Fabricate casing of zinc coated or phosphate treated steel of thickness as indicated reinforced and braced for rigidity. Provide removable panels for access to interior. Paint uncoated, steel parts with corrosion resistant paint to MPI #18. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with 50 mm thick rigid acoustic insulation, pinned and cemented, complete with perforated metal liner.

2.5 Utility Sets

- .1 Characteristics and construction: for centrifugal fans.
- .2 Preassemble single width centrifugal fan with removable weatherproof protective hood with vents, and automatic spring loaded back draft dampers and 12 mm mesh bird screens.
- .3 Provide belt driven sets with adjustable motor bed plate and variable pitch driver sheave.

2.6 Axial Flow Fans (Tube-Axial or Vane-Axial)

- .1 Casings: welded steel with welded motor support, bolted access plates, streamlined inlet cone and discharge bell sections and external silencer.
- .2 Blade material: steel. Hub material: steel or aluminum.
- .3 Supports:
 - .1 Floor mounted units: reinforced legs.
 - .2 Ceiling suspended units: support brackets welded to side of casing. Extend grease lubrication facilities to outside of casing.
- .4 Bearings: ball or roller with extension tubes to outside of casing.
- .5 Direct drive:
 - .1 Fixed blade wheels: totally-enclosed, air over motors.
 - .2 Diameter of wheel hub: at least equal to that of motor frame.
 - .3 Adjustable blades for varying range of volume and pressure. Provide permanent pitch angle indication vernier scale on hub. Provide adjustment set at factory before shipment for automatic adjustment while in motion. Provide adjustment stops to avoid overloading motor.
- .6 Belt drive:
 - .1 Drive fixed adjustable blades by externally mounted motors through V-belt drive. Provide internal belt fairing, external belt guards and adjustable motor mounts.
 - .2 Adjust blades for varying range of volume and pressure. Hubs to facilitate indexing of blade angle. Provide manual automatic adjustment stops to avoid overloading motor.

2.7 In-Line Centrifugal Fans

- .1 Characteristics and construction: as for centrifugal fan wheels, with axial flow construction and direct drive.
- .2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

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 and Seismic 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 Anchor Bolts and Templates

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

3.4 Cleaning

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

3.5 Start-Up and Commissioning

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41 and 01 91 51.

End of Section

1. GENERAL**1.1 Action and Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.
- .3 Samples:
 - .1 Samples are required for following:
 - .1 Submit one samples of each type.

1.2 Maintenance Material Submittals

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect diffuser, registers and grilles from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

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.

2.2 General

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- .2 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames where set into plaster or gypsum board and as specified.
 - .3 Concealed fasteners.
- .3 Concealed manual volume control damper operators.
- .4 Colour: as directed by Departmental Representative.

2.3 Manufactured Units

- .1 Grilles, registers and diffusers of same generic type, products of one manufacturer
- .2 Extraction arms (Elephant trunks) can be from another manufacturer.

2.4 Diffusers and Grilles

- .1 General: with opposed blade dampers, where applicable.
- .2 General: Floor and sill grilles to be capable of supporting 90 kg point load weight between supports with negligible deflection.
- .3 General: volume control dampers with flow straightening devices [and blank-off quadrants] and gaskets
- .4 Type AA: See specifications on plans. Acceptable products: E.H. Price TLRD-LP-T, Titus, Nailor.
- .5 Type AB: See specifications on plans. Acceptable products: E.H. Price TLRD-LP-T, Titus, Nailor.
- .6 Type AC: See specifications on plans. Acceptable products: E.H. Price TLRD-LP-T, Titus, Nailor.
- .7 Type RA: See specifications on plans. Acceptable products: E.H. Price TLRD-LP-T, Titus, Nailor.
- .8 Type RB: See specifications on plans. Acceptable products: E.H. Price TLRD-LP-T, Titus, Nailor.
- .9 Type RC: See specifications on plans. Acceptable products: E.H. Price TLRD-LP-T, Titus, Nailor.

.10 Type DG: See specifications on plans. Acceptable products: E.H. Price TLRD-LP-T, Titus, Nailor.

.11 Type DG1: See specifications on plans. Acceptable products: E.H. Price TLRD-LP-T, Titus, Nailor.

3. EXECUTION

3.1 Examination

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for diffuser, register and grille 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 Install in accordance with manufacturers' instructions.

.2 Install with adequate screws in countersunk holes where fastenings are visible.

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

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-115.11-M85, Filters, Air, High Efficiency, Disposable, Bag Type.
 - .3 CAN/CGSB-115.12-M85, Filters, Air, Medium Efficiency, Disposable, Bag Type.
 - .4 CAN/CGSB-115.13-85, Filter Media, Automatic Roll.
 - .5 CAN/CGSB-115.14-M91, High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems.
 - .6 CAN/CGSB-115.15-M91, High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
 - .7 CAN/CGSB-115.16-M82, Activated Carbon for Odor Removal from Ventilating Systems.
 - .8 CAN/CGSB-115.18-M85, Filter, Air, Extended Area Panel Type, Medium Efficiency.
 - .9 CAN/CGSB-115.20-95, Polarized Media Air Filter.
- .3 International Organization of Standardization (ISO)
 - .1 ISO 14644-1-99, Clean Rooms and Associated Controlled Environments - Part 1: Classification of Air Cleanliness.
- .4 National Fire Protection Association (NFPA)
 - .1 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 ULC -S111-07, Standard Method of Fire Tests for Air Filter Units.
 - .2 ULC-S646-06, Exhaust Hoods and Related Controls for Commercial and Institutional Kitchens.
- .6 US Department of Defense - Test Method Standard
 - .1 MIL-STS-282-95, Filter Units, Protective Clothing, Gas-Mask Components and Related Products; Performance Test Methods.

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 Shop Drawings:
 - .1 Submit drawings for review and approval.
- .4 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 off ground indoors 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.

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 channel section construction of galvanized steel extruded aluminum same material as casing/hood, 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 doors/panels on each side and/or from upstream downstream face of filter bank.

2.3 Cartridge Type Pre-Filters (MERV 8)

- .1 Media: pleated panel filter.
- .2 Media support: welded wire grid.
- .3 Performance: MERV 8 to ANSI/ASHRAE 52.2.

2.4 Bag Type High Efficiency Filters (MERV 14)

- .1 Disposable media multi pocket bag type of ultrafine glass media.
- .2 Holding frame: molded plastic frame.
- .3 Media support: micro mesh media backing.
- .4 Performance: MERV 14 to ANSI/ASHRAE 52.2.

2.5 Filter Gauges - Dial Type

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

2.6 Filter Gauges - Manometer Type

- .1 Inclined acrylic tube.
- .2 Complete with levelling screws.
- .3 Range: 0 to 2 times initial pressure 0 to 250 Pa.

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.
 - .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.

3.6 Start-Up and Commissioning

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41 and 01 91 51.

End of Section

1.1 References

- .1 General requirements of installation:
 - .1 NFPA 211
 - .2 CSA-B139-15
- .2 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- .3 Underwriters' Laboratories of Canada (ULC)

1.2 Submittals

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures
 - .2 Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Territory of Nunavut, Canada, in accordance with Section 01 33 00 - Submittal Procedures
 - .2 Indicate following:
 - .1 Stack Calculations and sizing.
 - .2 Seismic and wind loads.
 - .3 Methods of sealing sections.
 - .4 Methods of expansion.
 - .5 Details of thimbles.
 - .6 Bases/Foundations.
 - .7 Supports.
 - .8 Guy details.
 - .9 Acceleration cones.

- .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, conform to ASTM, UL and ASHRAE
 - .2 Submit a complete engineering report certifying that all stacks, chimneys and breechings are installed in accordance to all seismic precaution and wind calculation due to wind loads.
- .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 Qualifications : All welders shall be certified by the Standard D9.1AWS, Specification for metal sheet welding.
- .2 Codes and Standards :
 - .1 NFPA : in conformity with NFPA 211 « Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances ».
 - .2 UL : in conformity with the applicable section of « UL Safety Standards », furnish all UL homologated products and have the seal of homologation.
 - .3 SMACNA : in conformity with « SMACNA Low Pressure Duct Standards for fabricated breeching and smoke pipe ».
 - .4 AWS : in conformity with « AWS Structural Welding code for welder's qualifications, welding details, and workmanship standards ».
 - .5 ASHRAE : in conformity with « ASHRAE Equipment Handbook for Chimney, Gas Vent, and Fireplace Systems, material requirements and design criteria ».

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

2. PRODUCTS

2.1 **Evacuation Chimney Double Lined**

- .1 Supply a double wall, factory-built chimney, listed in accordance with UL 103 and ULC/ORD-C959. All products shall bear the appropriate label.
- .2 The chimney shall withstand a continuous operating temperature of up to 540°C (1000°F) and must have been tested at 760°C (1400°F) for 1 hour and 927°C (1700°F) for 10 minutes.
- .3 The inner wall shall be made of 20 gauge, type 316 stainless steel with continuous plasma welds. Outer wall shall be made of 24 gauge, type 316 stainless steel. Two (2) inches of mineral fiber insulation between the inner and outer walls.
- .4 All inner pipe joints shall be inserted, held together and sealed using an assembly band and a low temperature sealant, for flue gas temperatures up to 315°C (600°F), or a high temperature sealant, for flue gas temperatures over 315°C (600°F), as supplied by the manufacturer.
- .5 All parts, such as appliance adapters, elbows, fittings, expansion joints, tees, supports, roof/wall penetrations and terminations required, shall be listed as the same chimney model and shall be provided by a single manufacturer.
- .6 The chimney manufacturer shall provide adapters for fittings, to permit the installation of any required equipment, such as barometric damper, induced fan and test ports.
- .7 All exposed galvanized and aluminized steel surfaces shall be at all times protected with a minimum of one base coat primer and one finish coat of heat and corrosion resistant paint (supplied and applied by contractor).
- .8 The product must be prefabricated in factory and shall conform to NFPA 211. The system shall be conceived and install to form a complete installation without any gas leaks. It must be tested and approved UL in conformity to UL103 to resist a positive pressure of 15 kPa and must be UL certified. The system shall be conceived for thermal expansion. The clearance to adjacent materials with respect to fire ignition criteria must be included in the detail of installation.
- .9 Joint assembly shall be of male / female type grooved, end to end joint with a V-band attachment. An internal sleeve shall serve as a fast alignment of components and for long term protection. All components that are not grooved will be refused.

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- .10 The materials and the construction of the sections shall all conform to UL homologation. Stacks and chimney shall be covered by a 10 years warranty from material, installation and manufacturing defects.
 - .11 The calculations, the shop drawings as well as the «As built» drawings of the project drawn to scale shall be furnished by the manufacturer. The shop drawings shall be sealed by the manufacturer's engineer. Those drawing must be representative of the current installation/construction.
 - .12 The inside diameter must be confirmed by the chimney supplier. The sizing calculation must be technically renowned and must follow the ASHRAE calculation methods and show the internal characteristics of the flow of the chimney.
 - .13 Accessories:
 - .1 Provide and install section of stainless steel 316 breeching from the boiler to the double walled chimney to allow the installation of the barometric damper and BVSO. All sections located less than 2 meters of the finished floor must be insulated as per section 23 07 14.
 - .2 Provide and install a drain at the bottom of the chimney. Pipe the drain back to a funnel floor drain.
 - .3 Terminate chimney with the necessary equipment to prevent rain from entering into the chimney stack. Top of the chimney at 1000 mm minimum from the top of the architectural curb.
 - .4 Provide galvanized metal flashing storm collar
 - .5 The chimney shall be self-supporting.

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.
- .2 The installation must be in accordance with the manufacturer's installation instructions and with the requirements of NFPA-211 and any other local code.

3.2 Installation - General

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.

3.3 Cleaning

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

End of Section

1. GENERAL

1.1 References

- .1 General requirements of installation:
 - .1 NFPA 96 "Standard for ventilation control and fire protection of commercial cooking operations"
- .2 Sheet Metal and Air Conditioning Contractors National Association (SMACNA) "low pressure duct standards for fabricated breeching and smoke pipe"
- .3 Underwriters' Laboratories of Canada (ULC)
 - .1 ULC1978 "Standard for grease duct"
 - .2 ULC2221 "Standard for tests of fire resistive grease duct enclosure assembly"
 - .3 CAN/ULC-S662

1.2 Submittals

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures
 - .2 Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Territory of Nunavut, Canada, in accordance with Section 01 33 00 - Submittal Procedures
 - .2 Indicate following:
 - .1 Stack Calculations and sizing.
 - .2 Seismic and wind loads.
 - .3 Methods of sealing sections.
 - .4 Methods of expansion.
 - .5 Details of thimbles.
 - .6 Bases/Foundations.
 - .7 Supports.
 - .8 Guy details.
 - .9 Acceleration cones.
- .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, conform to ASTM, UL and ASHRAE
 - .2 Submit a complete engineering report certifying that all stacks, chimneys and breechings are installed in accordance to all seismic precaution and wind calculation due to wind loads.

- .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 Qualifications : All welders shall be certified by the Standard D9.1AWS, Specification for metal sheet welding.
- .2 Codes and Standards :
 - .1 NFPA: in conformity with NFPA 96 « Standard for ventilation control and fire protection of commercial cooking operations», UL: in conformity with the applicable section of « UL Safety Standards », provide products which have been listed and labelled.
 - .2 SMACNA: in conformity with « SMACNA Low Pressure Duct Standards for fabricated breeching and smoke pipe ».
 - .3 AWS: in conformity with « AWS Structural Welding code for welder's qualifications, welding details, and workmanship standards ».
 - .4 ASHRAE: in conformity with « 2012 ASHRAE Handbook, HVAC System and Equipment for chapter 19 duct construction », and with « 2015 ASHRAE Handbook, HVAC Application chapter 33, Kitchen ventilation ».
 - .5 CAN/ULC-S662: « Standard for factory-built grease duct ».

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

2. PRODUCTS

2.1 Zero clearance grease duct

- .1 Supply a zero clearance factory-built grease duct, listed in accordance with ULc1978, ULc2221 and NFPA 96. All products shall bear the appropriate label.
- .2 The inner wall shall be made of 20 gauge, type 304 stainless steel with continuous plasma welds. Outer wall shall be made of 24 gauge, type 304 stainless steel 100 mm (4 inches) of high temperature of ceramic fiber insulation between the inner and outer walls. The materials and construction of the modular sections and accessories shall be as specified by the terms of the product's UL Listing.
- .3 This duct system shall be designed and installed to be gas tight. It shall be UL 1978 Listed for exhaust of grease laden vapour and shall bare the appropriate label. This duct system shall be designed to compensate for all flue gas induced thermal expansions.

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- .4 The joint assembly shall be a male/female slip-type jointing with flange to flange and V-band assembly. An internal sleeve serves for readily alignment as well as long term joint seal protection from condensate, water and flue gas temperature. Non-slip type joints are not acceptable.
 - .5 The entire grease duct system from the kitchen exhaust hood, including accessories, shall be from one manufacturer.
 - .6 The grease duct assembly shall be warranted against functional failure due to defects in material and manufacturer's workmanship for a period of 10 years from the date of delivery.
 - .7 Drawings showing the actual layout and drawn to scale shall be provided by the manufacturer. The system shall be installed as designed by the manufacturer and in accordance with the terms of the manufacturer's 10 year warranty and in conjunction with sound engineering practice.
 - .8 The inner diameter for breeching and stack shall be verified by the manufacturer's computations. The computation shall be technically sound, shall follow ASHRAE calculation methods and incorporate the specific flow characteristics of the inner pipe.
 - .9 Technical services supports. The factory built modular stack system shall be furnished by a vendor organization which assures design, installation and service coordination and provides in-warranty and post warranty unified responsibility for owner.
 - .10 All parts, such as appliance adapters, elbows, fittings, expansion joints, tees, supports, roof/wall penetrations and terminations required, shall be listed as the same grease duct model and shall be provided by a single manufacturer.
 - .11 The inside diameter must be confirmed by the grease duct supplier. The sizing calculation must be technically renowned and must follow the ASHRAE calculation methods and show the internal characteristics of the flow of the grease duct stack.
 - .12 Accessories:
 - .1 Provide and install the necessary equipment to prevent rain from entering into the grease duct and all the necessary equipment and accessories for a complete and operational installation. The top of the grease duct must be at 1000 mm minimum from the top of the architectural curb.
 - .2 Provide galvanized metal flashing storm collar
 - .3 The grease duct shall be self-supporting.

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.

- .2 The installation must be in accordance with the manufacturer's installation instructions and with the requirements of NFPA-96 and any other local code.

3.2 **Installation - General**

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 The joining of pipe sections must be made using the assembly band, the finishing band and the appropriate sealing material. Roof penetrations shall be suitable for a combustible roof and shall be according to the manufacturer's detail drawings and installation instructions.
- .3 When installed according to the manufacturer's installation instructions the stack and its supporting system shall resist side loads at least 1.5 times the weight per foot of piping.

3.3 **Cleaning**

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

End of Section

1. GENERAL

1.1 References

- .1 American Boiler Manufacturers Association (ABMA)
- .2 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .3 CSA Group
 - .1 CSA B51-15, Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CSA B139-15, Installation Code for Oil Burning Equipment.
 - .3 CSA B140.7-05, Oil Burning Equipment: Steam and Hot-Water Boilers.
- .4 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

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 heating boilers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Territory of Nunavut, Canada.
 - .2 Indicate on drawings:
 - .1 General arrangement showing terminal points, instrumentation test connections.
 - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
 - .3 Foundations with loadings, anchor bolt arrangements.
 - .4 Piping hook-ups.
 - .5 Equipment electrical drawings.
 - .6 Burners and controls.
 - .7 All miscellaneous equipment.
 - .8 Flame safety control system.
 - .9 Breeching and stack configuration.
 - .10 Stack emission continuous monitoring system to measure CO, O, NOx, SO, stack temperature and smoke density of flue gases.
 - .3 Engineering data to include:
 - .1 Boiler efficiency at 25%, 50%, 75% and 100% of design capacity.
 - .2 Radiant heat loss at 100% design capacity.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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 heating boilers for incorporation into manual.

1.4 Quality Assurance

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

1.5 Maintenance Material Submittals

- .1 Extra materials:
 - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Special tools for burners, access opening, 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.

1.6 Delivery, Storage and Handling

- .1 Deliver, store and handle materials in accordance 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 boiler and equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.

2. PRODUCTS**2.1 General**

- .1 Packaged boiler:
 - .1 Triple-pass cast iron heat transfer design;
 - .2 The water-side of the heat exchanger shall use a press-nipple design between sections to allow transportation of individual sections and reliable field assembly.

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- .3 The heat exchanger shall have a full-swing door, left- or right-hinge, to allow for easy inspection and cleaning.
 - .4 Complete with burner and necessary accessories and controls.
 - .5 Factory tested at rated capacity to CSA B140.7.
 - .6 Ready for attachment to piping, electrical power, controls, flue gases exhaust.
 - .7 Designed and constructed to ASME Boiler and Pressure vessel Code.
 - .8 CRN (Canadian Registration Number), to CSA B51.
 - .9 Boiler/burner package to bear ULC label.
 - .10 Complete with the boiler sequencing system
- .2 Performance:
- .1 In accordance with American Boiler Manufacturers Association (ABMA), or ANSI Z21.13/CSA 4.9 (gas burning) testing procedures.
 - .2 Hot water: 125 kW gross output. 82 degrees C supply. 66 degrees C return. 1,100 kPa maximum operating pressure.
 - .3 Firing rate: #2 oil;
 - .4 **Boiler efficiency: 87.2% minimum** at 30% to 100% firing rates.
 - .5 Flue gas temperature leaving boiler:
 - .1 Not to exceed 260 degrees C.
 - .2 Above dewpoint conditions at minimum firing rate.
- .3 Controls: factory wired. Enclosed in EEMAC 1 steel cabinet.
- .4 Thermal insulation:
- .1 The R-value of the insulation shall be equivalent to 4" (100 mm) fiberglass with nylon backing. Seal insulation at handholes, access opening, mudholes, piping connections with insulating cement or asphaltic paint. Finish with heat resisting paint.
 - .2 Heat losses less than 0.5% of rated input.
- .5 Jackets: heavy gauge metal, finished with heat resisting paint.
- .6 Mounting:
- .1 Structural steel base, lifting lugs.
- .7 Anchor bolts and templates:
- .1 Supply for installation by other Divisions. Anchor bolts to be sized to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .8 Start-up, instruction, on-site performance tests: 3 days per boiler.
- .9 Trial usage:
- .1 Departmental Representative may use boilers for test purposes prior to acceptance and commencement of warranty period.
 - .2 Supply labour, materials and instruments required for tests.
- .10 Temporary use by contractor:
- .1 Contractor may use boilers only after written approval from Departmental Representative.
 - .2 Monitor and record performance continuously. Keep log of maintenance activities carried out.
 - .3 Refurbish to as-new condition before final inspection and acceptance.

2.2 Firetube Boiler

- .1 Design:
 - .1 Forced draft.
 - .2 Furnace tube centrally located in boiler shell.
 - .3 Tube bundle arranged to facilitate water circulation and prevent sludge accumulation.
 - .4 Tubes rolled and beaded into tube sheets, accessible for cleaning and replacement.
 - .5 Combustion chamber: refractory lined.
 - .6 Access for cleaning water side: at least one access opening and adequate number of handholes.
 - .7 Hinged or davitted gasketed front and rear heads with access to tube sheets without removal of any front end equipment.

2.3 Auxiliaries

- .1 Provide auxiliaries for each boiler and to meet ASME requirements.
- .2 Hot water boilers:
 - .1 Relief valve: ASME rated, set to release entire boiler capacity.
 - .2 Pressure gauge: 90 mm diameter complete with shut-off cock.
 - .3 Thermometer: 115 mm diameter range 10 to 150 degrees C.
 - .4 Low water cut-off: with visual and audible alarms.
 - .5 Auxiliary low water cut-off: with separate cold water connection to boiler.
 - .6 Isolating gate valves: on supply and return connections.
 - .7 Drain valve: NPS 2.
 - .8 Stack thermometer: range 65 to 400 degrees C.
 - .9 Outdoor controller: to reset operating temperature controller.
 - .10 2 sets of cleaning tools.
- .3 Heating media: propylene glycol 50%.
- .4 Acceptable Products: Fulton Vantage, Viessmann, Cleaver Brooks, or approved equivalent.

2.4 Oil Burners

- .1 General:
 - .1 The burner shall be a single-unit, single-stage #2 fuel oil burner, complete with fan and integrated oil pump. Burner shall use direct spark ignition. The certified burner provided shall be listed on the boiler rating plate.
 - .2 Pressure-mechanical atomizing forced draft with:
 - .1 Built-in blower to supply combustion air, complete with motor, silencer and damper with dynamically balanced, forward-curved blades in a centrifugal blower design. The blades shall be directly driven by a single-phase capacitor start/run, thermally protected (automatic reset) motor. The motor and fan blades shall be easily removable for inspection and cleaning.
 - .2 Single stage oil pump driven by blower motor and complete with integral relief valve.
 - .3 Oil filter.
 - .4 Pressure gauge.

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- .5 High voltage ignition transformer.
 - .6 Flame observation port.
 - .7 Easy access to nozzles and electrodes.
 - .8 Gas ignition.
 - .9 Oil and air metering controls for maximum burner efficiency throughout operating range.
 - .3 Electric oil heater: to heat fuel oil from pre-heat temperature to combustion temperature, even with voltage reduced by 20%, complete with 63 mm diameter thermometer on inlet and outlet.
 - .2 Turndown ratio: at least 3:1.
 - .3 Controls:
 - .1 Electronic combustion control relay with scanner for combustion control and flame supervision.
 - .2 Control to shut off fuel within 5 seconds upon flame failure or upon signal of safety interlock and to ensure, when restarted, in sequence, ignition and resumption of supervision of burner operation.
 - .3 Burner operation to include:
 - .1 Pre-purge.
 - .2 Pilot ignition and supervision.
 - .3 Burner operation.
 - .4 Post-purge upon burner shut-down.
 - .4 Immersion controllers:
 - .1 Operating: to start and stop burner, and operating between adjustable setpoints.
 - .2 Modulating: to modulate burner output.
 - .3 High limit: manual reset
 - .4 Controller range: 60 to 85 degrees.
 - .5 Visual and audible alarms: to indicate burner shutdown due to flame failure, low water level, high pressure, high temperature, low air pressure, low fuel pressure.
 - .6 Selector switch: to permit manual and automatic firing at any rate between low and high fire.
 - .7 Pilot lights: to indicate:
 - .1 Normal burner operation.
 - .2 All stages of burner operation.
 - .8 Controls to provide boiler output, and boiler efficiency to Building Automation System.
 - .9 Burner to start up in low fire position.

2.5 Emission Control

- .1 Rate of discharge of air contaminants from boiler not to exceed:
 - .1 For nitrogen oxides expressed as nitrogen dioxide:
 - .1 43 ng/J of heat input when fired with oil specified as type1 or 2, according to CGSB classification.
 - .2 For sulphur dioxide:
 - .3 25 ng/J of heat input when fired with oil specified as type1 or 2, according to CGSB classification.
 - .2 For carbon monoxide, 50 ppm.

2.6 Boilers Sequencing System

- .1 When multiple hydronic boilers are to be installed in a common loop, a boiler sequencing control system shall be used. The sequencing system will monitor, enable/disable and control the firing rate of each boiler in the loop. To ensure accurate temperature control and optimized boiler operating efficiencies. The hydronic boilers shall be controlled as follows to maximize their operating efficiency:
 - .1 The sequencing system shall monitor the outdoor temperature and calculate a hydronic loop temperature setpoint based on touchscreen selectable user-defined values. The boiler sequencing system will stage operation of the hydronic boilers based on the difference between the actual hydronic loop temperature and the calculated (outdoor air reset) hydronic loop temperature setpoint.
 - .2 When a requirement for heat is determined by the boiler sequencing system, the lead boiler is energized and its firing rate is maintained at low fire.
 - .3 If the hydronic loop temperature continues to decrease, the boiler sequencing system will enable a lag boiler. The first lag boiler is energized and the lag boiler's firing rate is maintained at low fire.
 - .4 As additional heat is required, the boiler sequencing system will enable the remaining lag boiler stages individually until all of the available boilers in the hydronic loop have been energized. Each boiler will remain at low fire until all of the stages have been enabled.
 - .5 If all of the hydronic boilers are enabled and additional heat is required, the boiler sequencing system will release the boilers to modulate. Hydronic boilers will modulate together as a single unit to keep the hydronic boiler system at the lowest possible firing rate, while satisfying the building load demands.
 - .6 As the hydronic loop temperature increases, the boiler sequencing system will decrease the firing rate of the hydronic boilers to maintain the hydronic loop temperature. If all of the hydronic boilers are at low fire and the hydronic loop temperature continues to rise, the boiler sequencing system will begin to stage the boilers off. The first lag boiler stage energized will be the last stage to be disabled. The hydronic boilers will continue to be disabled by the boiler sequencing system based on the temperature rise of the hydronic loop.
 - .7 The lead boiler is disabled when the hydronic loop temperature reaches a selectable value referenced around the hydronic loop setpoint.
- .2 The boiler sequencing system will be a microprocessor based process controller with a graphical user interface and touchscreen capabilities. Boiler sequencing systems designed with alpha-numeric displays will not be acceptable due to their limited functionality.
- .3 The active touchscreen display area will be a minimum of 5.7" with a color TFT display resolution of 256 colors.
- .4 The boiler sequencing system enclosure will be NEMA 4X construction. Power requirements for the boiler sequencing panel will be 120/60/1.
- .5 The boiler sequencing system will be a wall mounted, stand-alone unit capable of accepting the addition of two (2) more boilers to the plant in the future. .
- .6 Password requirements will prevent access to any of the screens where system configuration parameters can be adjusted, while maintaining the ability of viewing the system performance.

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- .7 Outdoor and Supply Header Temperature sensors supplied with the boiler sequencing system shall be PT-100 RTD type for precise temperature monitoring. Return Temperature monitoring capabilities shall be available and used when power calculation is used. The boiler sequencing system will also have the ability to receive temperature values from the Building Management System through a communication protocol. Each temperature input shall have a selection button that allows for independent configuration of where the temperature value will be received from.
 - .8 The boiler sequencing system will provide a series of "Question and Answer" screens to simplify the commissioning process.
 - .9 Multiple Status and Configuration Screens will be available for easy interpretation of the hydronic loop status and simplified control configuration of the multiple hydronic boiler system.
 - .10 Minimum screens available shall include:
 - .1 Outdoor Reset Configuration.
 - .2 Setback Schedule.
 - .3 Lead/Lag Configuration.
 - .4 Boiler Configuration.
 - .5 System Status.
 - .6 Alarm Status.
 - .7 Alarm history.
 - .8 Input power (kW)
 - .9 Output power (kW).
 - .11 Lead/Lag Configuration screens shall be used to configure how the hydronic boilers will be assigned and enabled in the control sequence.
 - .1 The boiler sequencing system will include automatic rotation of the lead boiler based on a user configured lead boiler cycle count or run hours, whichever setting occurs first.
 - .2 When the lead cycle or run hours rotation value is reached, the boiler sequencing system will assign each boiler's position in the lead/lag sequence based on their previous operating history.
 - .3 The boiler sequencing system will stage the boilers based on a PID generated control variable value. The Proportional, Integral and Derivative values shall be user-defined through the Lead/Lag Configuration screen. Each lag boiler stage will be enabled and disabled based on a user-defined control variable percentage. Properly tuned loops will provide temperature control accuracy up to +/- 1°C, based on load demand.
 - .4 Lead boiler start and stop parameters shall be user-defined through the touchscreen operator interface. A Manual Reset parameter will allow the Proportional Band to be shifted around setpoint.
 - .5 A user-defined time delay parameter will be provided that delays enabling and disabling of the lag boiler stages. This helps to decrease cycling of the lag stages when the building load is close to being satisfied.
 - .6 The boiler sequencing system will have the ability to monitor the outlet temperature of each hydronic boiler in the system. This feature is beneficial for systems that will incorporate variable flow designs. If the boiler outlet temperature exceeds setpoint by a user-defined amount, the boiler sequencing system will automatically lower the firing rate of the boiler to help prevent a high limit trip at the boiler. As the boiler outlet temperature decreases below a defined variable, the boiler sequencing system will allow the firing rate of the boiler to increase.

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- .12 Boiler Configuration screens will display information regarding each boiler stage in the hydronic loop.
 - .1 The boiler configuration screens will detail and provide:
 - .1 Hydronic Boiler Status.
 - .2 Hydronic Boiler Cycles, Run Hours and Cycle/Hour Ratio calculation.
 - .3 Hydronic Boiler Outlet Temperature.
 - .4 Hydronic Boiler Enable/Disable touchscreen selection.
 - .5 Hydronic Boiler Auto/Manual touchscreen control mode selection.
 - .6 Hydronic Boiler Manual touchscreen Start/Stop and Firing Rate control.
 - .2 The boiler sequencing system shall include capabilities to enable/disable the boilers through the operator interface. Boilers that are disabled will not be included in the sequencing logic.
 - .13 The boiler sequencing system will monitor the operation and status of all temperature sensors and hydronic boilers in the loop. Sensor errors will be annunciated on the boiler sequencing systems alarm screen. If an outdoor temperature sensor error occurs, the boiler sequencing system will automatically switch to manual setpoint mode and will annunciate the alarm condition.
 - .14 The boiler sequencing system will start a timer when each boiler stage is enabled to run. If the main fuel valves do not energize within the user-defined timeframe then a local limit is preventing the boiler from operating. The boiler sequencing system will immediately remove the boiler from the lead/lag sequence and annunciate that a local boiler error exists. An automatic reset option will allow the boiler to be re-enabled after a user-defined timeframe has elapsed.
 - .15 An Alarm Status screen will give a text description of any current alarm conditions. The boiler sequencing system will automatically adjust the boiler sequencing status and remove the boiler from the sequencing logic if an alarm occurs. The boiler will automatically be added back into the rotation loop as soon as the boiler sequencing system senses that the alarm has been cleared.
 - .16 The boiler sequencing panel will include an Alarm History screen that allows for the last 100 alarm conditions to be viewed. A Date/Time stamp and text description of each alarm condition in the history will be available.
 - .17 A System Status screen will detail current outdoor, hydronic system and control variable values. The status screen will also display enable/disable and firing rate information for each of the boilers in the hydronic loop.
 - .18 Trending of the supply temperature, system setpoint and outdoor temperature will be displayed to provide system operational history for tuning of the PID and lead/lag parameters.
 - .19 The boiler sequencing system shall have the ability to communicate to a Building Management System using multiple protocols including Modbus RTU, BacNet, LonWorks or N2. Standard point mapping will be provided with the boiler sequencing system. Selection of modbus serial connectivity (RS-232/RS-485) and baud rate will be field-adjustable using a configuration screen on the boiler sequencing system. Selection of BacNet MS/TP or IP shall be field adjustable through a dip-switch setting. The ability to field adjust custom project points will be available through a easy to configure and freely distributed software package.

- .20 The boiler sequencing system shall have the ability for the internal control logic to be field-modified to meet system design changes that may arise during commissioning of the hydronic system or future system expansion. The control logic shall be field adjustable through a downloadable, freely distributed software package that does not require a licensing fee. Sequencing systems with fixed control logic that cannot be modified in the field will not be acceptable due to their inherent limitations.

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for heating boiler 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 Install in accordance with ASME Boiler and Pressure Vessels Code, regulations of Territory of Nunavut having jurisdiction. Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .2 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.
- .3 Mount unit level using specified vibration isolation in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .4 Pipe hot water relief valves full size to nearest drain.
- .5 Pipe blowdown/drain to blowdown floor drain.
- .6 Oil fired installations - in accordance with CSA B139.

3.4 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.

- .2 Blowdown valves:
 - .1 Run discharge to terminate as indicated.

3.5 Field Quality Control

- .1 Commissioning:
 - .1 Manufacturer to:
 - .1 Certify installation.
 - .2 Start up and commission installation.
 - .3 Carry out on-site performance verification tests.
 - .4 Demonstrate operation and maintenance.
 - .2 Provide Departmental Representative at least 72 hours notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.
 - .3 Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boilers and piping. Obtain certification for completed boiler units and deliver to Departmental Representative.

3.6 Start-Up and Commissioning

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41, 01 91 51.
- .2 Have manufacturer certify installation.
- .3 Have manufacturer present during start-up tests and start up units and certify performance.
- .4 Submit written start-up and commissioning reports to Departmental Representative.

3.7 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

1. GENERAL

1.1 References

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 84-1991, Method of Testing Air-to-Air Heat Exchangers (ANSI approved).
- .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.
- .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.
 - .2 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .5 Certificates:
 - .1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
 - .2 Provide confirmation of testing.

1.3 Quality Assurance

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

1.4 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.

1.5 Maintenance

- .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 include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing or replacing.

2. PRODUCTS**2.1 General**

- .1 Comply with ASHRAE 84.

2.2 Heat Recovery Unit (VRE-1)

- .1 Construction
 - .1 Unit with extruded aluminum channel posts and galvanized panels secured with mechanical fasteners. All access doors shall be sealed with permanently applied bulb-type gasket.
 - .1 Panels and access doors shall be constructed as a 50mm nominal thick; with injected polyurethane foam insulation. R value shall be 6.5 per inch of wall thickness. The outer panel shall be constructed of G90 galvanized steel. The inner liner shall be constructed of G90 galvanized steel. Module to module assembly shall be accomplished with self adhering foam gaskets.
 - .2 Access Doors shall be flush mounted to cabinetry, with minimum of two hinges, locking latch and full size handle assembly. Provide visual inspection windows and tests port in the doors leading to the fan sections.
 - .3 Weather proof LED lighting fixtures shall be provided inside the fans module. Provide a light switch on the outside panel to control the lighting fixtures.
- .2 Dual Core Energy Recovery
 - .1 Unit shall be equipped with Dual Core energy recovery technology. The unit shall be 90% efficient (sensible +-5%) at equal airflow in winter and up to 80% sensible in summer. It shall also provide up to 70% latent recovery. Unit shall accomplish this recovery without a defrost cycle. Energy recovery device shall not require frost protection in applications down to -40 degrees. Cores shall be Generation 3, comprised of precisely corrugated high grade aluminum.
 - .2 Switchover damper section shall be comprised of multi section low leakage dampers operated by fast acting electric actuators Damper switching times of 0.75 seconds. Single blade damper sections are not acceptable. Each damper shall control one of the 4 airways, upper-horizontal, lower-horizontal, forward-vertical and rear-vertical. Dampers shall be capable of orienting to close off outside air to the building without needing external shut off dampers. Dampers shall also be capable of orienting to allow 100% recirculation of air without using heat recovery device for off peak or unoccupied heating modes.
 - .3 Recovery cycles shall be controlled by internal programmed thermostats measuring both supply and exhaust air, and optimizing performance of both heat recovery and free cooling modes.

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- .3 Supply fan:
 - .1 One direct drive centrifugal plenum fan
 - .2 Capacity: As indicated.
 - .4 Exhaust fan:
 - .1 One direct drive centrifugal plenum fan.
 - .2 Capacity: As indicated.
 - .5 Filters:
 - .1 MERV 10.
 - .6 Adjustable Frequency Drive (AFD)
 - .1 AFD designed for use with NEMA B squirrel cage induction motors, with a 1.15 service factor.
 - .1 Ambient operating conditions: 0 to 40° continuously.
 - .2 Altitude: 0 to 1 000 m above sea level.
 - .3 Humidity: less than 95% without condensation.
 - .4 Voltage: 600 V, 3 phase.
 - .5 Overload capacity: 110% of normal running current for one (1) minute and every ten (10) minutes
 - .6 Overcurrent capacity: 130% of normal running current for two (2) minutes.
 - .7 Rated current at AFD entry: less than 3% of rated output current.
 - .8 Integrated impedance of 5% to reduce harmonic current distortions of the supply current and to increase protection against transients.
 - .9 AFD is able to start from a stopped position, accelerate and decelerate without triggering the supply breaker or damaging components.
 - .10 AFD is able to automatically restart after an overvoltage, a current surge, an undervoltage or after a signal loss protection device is activated; the number of restart attempts, the length of the attempts and the time between the attempts must be programmable.
 - .11 AFD to detect a pressure loss and to signal the problem by displaying a message on the keypad, by transmitting a signal to a relay and/or a series communication bus.
 - .12 All drives to be protected against invalid I/O supply connections and display an alarm on the keypad.
 - .2 User Interface
 - .1 AFD equipped with removable keypad and digital screen.
 - .2 AFD protected by a password.
 - .3 Menu function keys included.
 - .4 Backlit LCD display.
 - .5 Entry of complete words for programming and trouble shooting.
 - .6 Alphanumerical codes not accepted.
 - .7 Assistants provided:
 - .1 Start-up.
 - .2 Parameter programming.
 - .3 Maintenance.
 - .4 Trouble shooting.

- .8 Minimum of three (3) of the following operating data displayed at the same time in engineering values;
 - .1 Output frequency.
 - .2 Motor speed.
 - .3 Motor current.
 - .4 Calculated motor torque.
 - .5 Calculated motor strength, kW.
 - .6 DC bus voltage.
 - .7 Output voltage.
- .9 «Programmable integrated clock with calendar, equipped with a ten (10) year battery life.
- .3 Controls and Communication
 - .1 AFD equipped with PC software to permit copying, programming and supervision of operating parameters.
 - .2 AFD must use application programs specially designed to facilitate start-up; provide a minimum of ten (10) pre-programmed operating software.
 - .3 In case of loss of reference input (4-20 ma or 2-10 V), provide user with the following options;
 - .1 To stop and display a defect.
 - .2 To operate at a programmable pre-defined speed.
 - .3 To maintain speed based on the last reference data received.
 - .4 To issue a warning.
 - .4 AFD controls;
 - .1 Three (3) programmable frequency lock-in ranges.
 - .2 Two (2) standard PID set point controllers.
 - .3 Two (2) programmable analog inputs accepting voltage or current signals.
 - .4 Two (2) programmable analog outputs.
 - .5 Six (6) programmable digital inputs.
 - .6 Three (3) programmable digital outputs for form C relays.
 - .7 Seven (7) pre-defined programmable speeds.
 - .8 Two (2) independently adjustable acceleration/deceleration ranges with adjustable with adjustable throughputs of 1 to 1 800 seconds.
 - .5 AFD to include a motor power supply.
 - .6 AFD to include a carrier frequency control circuit.
 - .7 AFD to include a bypass input for fire services.
- .4 Serial Communications
 - .1 AFD must be compatible with standard RS-485 access compatible with BACnet protocol.
 - .2 Each AFD must be equipped with base certified protocols.
 - .3 All serial communication functions of each AFD must be compatible with the BAS.
- .5 Additional Features
 - .1 All components installed within a single NEMA 1 enclosure.
 - .2 Input disconnect switch with interlocking device mounted on the enclosure door.
- .6 Capacity: As indicated.

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 manufacturers recommendations.
- .2 Support independently of adjacent ductwork with flexible connections.
- .3 Install access doors in accordance with Section 23 33 00 - Air Duct Accessories for access to coils, dampers.

3.3 Field Quality Control

- .1 Tests:
 - .1 Perform tests in accordance with Section 01 91 13 – Commissioning General requirements and Section 01 91 31 – Commissioning Plan.
 - .2 Perform tests in accordance with Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.
 - .3 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

3.4 Start-Up and Commissioning

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41 and 01 91 51.
- .2 Submit written start-up and commissioning reports to Departmental Representative.

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

1. GENERAL

1.1 References

- .1 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
 - .1 ANSI/AHRI 430-10, Performance Rating of Central Station Air-Handling Units.
- .2 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)
 - .1 ANSI/ASHRAE 52.2-2012, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - .2 ANSI/ASHRAE/IES 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 Green Seal (GS)
 - .1 GS-11-11, Standard for Paints and Coatings.
 - .2 GS-36-11, Standard for Adhesives for Commercial Use.
- .4 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
 - .1 MPI #18.
- .5 South Coast Air Quality Management District (SCAQMD)
 - .1 SCAQMD Rule 1113-11, Architectural Coatings.
 - .2 SCAQMD Rule 1168-05, Adhesives and Sealants.

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 insulation, filters, adhesives, and paints and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings for review and approval.
 - .2 Indicate on drawings: fan, fan curves showing point of operation, motor drive, bearings, filters, mixing box, dampers, VAV, coil; include performance data.

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 air handling equipment for incorporation into manual.
- .3 Include following: fan, bearings, motor, damper, VAV control, air volume, total heating, EDB, LAT.

1.4 Maintenance Material Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide 1 spare set of filters.
- .3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.
- .4 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank.

1.5 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air handling equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.

2. PRODUCTS**2.1 Air-Handling Units (AHU-1)**

- .1 General
 - .1 Factory assembled components to form units supplying air at designed conditions, as indicated.
 - .2 Certify ratings: to ANSI/AHRI 430 with AHRI seal.
 - .3 Horizontal or vertical type, as indicated, having air tight modular components, consisting of 50 mm double wall casing, fan section with motor and drive, filter section, dampers, bypass section, heating coil, mixing box .
- .2 Casings
 - .1 Outer panel: Painted steel panels, thickness 1.6 mm (16 ga) reinforced and braced for rigidity.
 - .2 Inspection doors and Walk-in access doors: provide access for maintenance of internal parts. Each door shall be equipped with a visual inspection window and test port.
 - .3 Paint steel parts, where not galvanized, with corrosion resistant paint to MPI #18.
 - .4 Paint: maximum VOC limit 250 g/L to GS-11 and to SCAQMD Rule 1113.
 - .5 Finish units, inside and out, with rust resistant enamel.

- .6 Enamel Finish: maximum VOC limit 250 g/L to Standard GS-11 and to SCAQMD Rule 1113.
 - .7 Line casing with galvanized steel liner.
 - .8 Units are insulated with injected foam with a minimum of R-13 insulation value.
 - .9 Air Leakage: less than 1% of supplied air volume.
 - .10 Each section or module shall be equipped with a weather proof LED light. At least one light switch shall be provided to control the lighting in the air handler.
 - .11 Provide one 15 A, 120 V electrical outlet installed on the door side panel for maintenance purpose.
 - .3 Drain Pans
 - .1 Construction: stainless steel, rounded corners.
 - .2 Insulation: external foam type, minimum 13 mm thick.
 - .3 Drain connection: in bottom at low point.
 - .4 Installation: slope without sag minimum 1% to ensure no standing water at any time or at any point.
 - .5 Dimensions: minimum 75 mm from upstream face of coil to 150 mm beyond downstream face of coil or eliminator and to include return bends and headers.
 - .4 Fans
 - .1 Free standing AMCA-rated for sound and performance centrifugal plenum fans with backward inclined, forward curved or airfoil wheels, selected to operate in stable part of performance curve at times and heavy duty 200,000 hours service self aligning split pillow block bearings.
 - .1 Provide internally direct drive motor as indicated.
 - .2 Motor: to ANSI/ASHRAE/IES 90.1 capacity as indicated.
 - .2 Maximum sound power levels, as indicated.
 - .5 Vibration Isolation
 - .1 Flexible connections at inlet and outlet of fan: to Section 23 33 00 - Air Duct Accessories.
 - .2 Vibration isolators on fan section as indicated complete with seismic restraints: in accordance with Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
 - .6 Adjustable Frequency Drive (AFD)
 - .1 AFD designed for use with NEMA B squirrel cage induction motors, with a 1.15 service factor.
 - .1 Ambient operating conditions: 0 to 40° continuously.
 - .2 Altitude: 0 to 1 000 m above sea level.
 - .3 Humidity: less than 95% without condensation.
 - .4 Voltage: 600 V, 3 phase.
 - .5 Overload capacity: 110% of normal running current for one (1) minute and every ten (10) minutes
 - .6 Overcurrent capacity: 130% of normal running current for two (2) minutes.
 - .7 Rated current at AFD entry: less than 3% of rated output current.
 - .8 Integrated impedance of 5% to reduce harmonic current distortions of the supply current and to increase protection against transients.
 - .9 AFD is able to start from a stopped position, accelerate and decelerate without triggering the supply breaker or damaging components.

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- .10 AFD is able to automatically restart after an overvoltage, a current surge, an undervoltage or after a signal loss protection device is activated; the number of restart attempts, the length of the attempts and the time between the attempts must be programmable.
 - .11 AFD to detect a pressure loss and to signal the problem by displaying a message on the keypad, by transmitting a signal to a relay and/or a series communication bus.
 - .12 All drives to be protected against invalid I/O supply connections and display an alarm on the keypad.
 - .2 User Interface
 - .1 AFD equipped with removable keypad and digital screen.
 - .2 AFD protected by a password.
 - .3 Menu function keys included.
 - .4 Backlit LCD display.
 - .5 Entry of complete words for programming and trouble shooting.
 - .6 Alphanumerical codes not accepted.
 - .7 Assistants provided:
 - .1 Start-up.
 - .2 Parameter programming.
 - .3 Maintenance.
 - .4 Trouble shooting.
 - .8 Minimum of three (3) of the following operating data displayed at the same time in engineering values;
 - .1 Output frequency.
 - .2 Motor speed.
 - .3 Motor current.
 - .4 Calculated motor torque.
 - .5 Calculated motor strength, kW.
 - .6 DC bus voltage.
 - .7 Output voltage.
 - .9 «Programmable integrated clock with calendar, equipped with a ten (10) year battery life.
 - .3 Controls and Communication
 - .1 AFD equipped with PC software to permit copying, programming and supervision of operating parameters.
 - .2 AFD must use application programs specially designed to facilitate start-up; provide a minimum of ten (10) pre-programmed operating software.
 - .3 In case of loss of reference input (4-20 ma or 2-10 V), provide user with the following options;
 - .1 To stop and display a defect.
 - .2 To operate at a programmable pre-defined speed.
 - .3 To maintain speed based on the last reference data received.
 - .4 To issue a warning.
 - .4 AFD controls;
 - .1 Three (3) programmable frequency lock-in ranges.
 - .2 Two (2) standard PID set point controllers.
 - .3 Two (2) programmable analog inputs accepting voltage or current signals.
 - .4 Two (2) programmable analog outputs.

- .5 Six (6) programmable digital inputs.
- .6 Three (3) programmable digital outputs for form C relays.
- .7 Seven (7) pre-defined programmable speeds.
- .8 Two (2) independently adjustable acceleration/deceleration ranges with adjustable with adjustable throughputs of 1 to 1 800 seconds.
- .5 AFD to include a motor power supply.
- .6 AFD to include a carrier frequency control circuit.
- .7 AFD to include a bypass input for fire services.
- .4 Serial Communications
 - .1 AFD must be compatible with standard RS-485 access compatible with BACnet protocol.
 - .2 Each AFD must be equipped with base certified protocols.
 - .3 All serial communication functions of each AFD must be compatible with the BAS.
- .5 Additional Features
 - .1 All components installed within a single NEMA 1 enclosure.
 - .2 Input disconnect switch with interlocking device mounted on the enclosure door.
- .7 Filter Box
 - .1 Material to match casing. For flat, V, bag type filter arrangement: as indicated.
 - .1 Provide access to filter through hinged door or removable panels 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 Pre Filters: Minimum Efficiency Reporting Value (MERV) value 8 filtration media to ANSI/ASHRAE 52.2, to be used on return air section of air handling unit.
 - .2 Filters: Minimum Efficiency Reporting Value (MERV) value 14 filtration media to ANSI/ASHRAE 52.2, to be after Pre Filters on return air section of air handling unit.
 - .3 Immediately prior to occupancy, replace filtration media with new filtration media with Minimum Efficiency Reporting Value (MERV) of 14 in accordance with ANSI/ASHRAE 52.2.
- .8 Mixing Box
 - .1 Material to match casing and produce uniformly mixed air temperature within plus or minus 5 degrees C of design across face of outlet.
 - .2 Dampers for mixing boxes: Section 23 33 15 - Dampers - Operating.
- .9 Coils
 - .1 Capacity: as indicated.
 - .2 Ratings: AHRI certified.
 - .3 Construction:
 - .1 Casings: 1.5 mm thick galvanized sheet steel.
 - .1 Supports of galvanized steel channel double angle frames.
 - .2 Blank-off plates. Insulated sandwich construction.
 - .2 Hot water coils: cleanable fins.
 - .1 Tubes: copper.
 - .2 Fins: aluminum.
 - .3 Headers: cast iron.

.4 Pressure tests: 1.7 MPa.

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

3.3 Fans

- .1 Install fan sheaves required for final air balance.
- .2 Install flexible connections at fan inlet and fan outlets.
- .3 Install vibration isolators.

3.4 Drip Pans

- .1 Install deep seal P-traps and trap seal primer on drip lines.
 - .1 Depth of water seal to be 1.5 times static pressure at this point.

3.5 Start-Up and Commissioning

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41 and 01 91 51.
- .2 Submit written start-up and commissioning reports to Departmental Representative.

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 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.

End of Section

1. GENERAL

1.1 References

- .1 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
 - .1 ANSI/AHRI 430-10, Performance Rating of Central Station Air-Handling Units.
- .2 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)
 - .1 ANSI/ASHRAE 52.2-2012, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- .3 National Fire Protection Association
 - .1 NFPA 96-2014 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

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 insulation, filters, adhesives, and paints and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings for review and approval.
 - .2 Indicate on drawings: fan, fan curves showing point of operation, motor drive, bearings, filters, mixing box, dampers, VAV, coil; include performance data.

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 exhaust hoods and supporting equipment for incorporation into manual.
- .3 Include following: fan, bearings, motor, damper, VAV control, air volume, fire protection devices.

1.4 Maintenance Material Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide 1 spare set of filters.
- .3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

- .4 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank.

1.5 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air handling equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.

2. PRODUCTS

2.1 All-in-one exhaust hood built-in with radial fan turbine and automatic fire suppression system

- .1 General
 - .1 Wall mounted Stainless steel hood with centrifugal grease extractor. The air crosses a series of adjustable blades resulting in degreasing by centrifugal effect. Front part of the grease extractor is removable and serve as grease cup.
 - .2 An inline fan is integrated in the hood.
 - .3 Two halogen lamps are recessed under the hood.
 - .4 A fire suppression system is factory installed and is hidden behind a removable stainless-steel skirting. The Fire Suppression System consists of automatic chemical extinguishers in canisters. The chemical extinguisher is sprayed onto kitchen appliances once a fusible link is released. All the pipe work inside the hood for the fire suppression system is stainless steel or chrome plated. The chemical liquid utilised in the fire suppression system has a PH of 8.2. The fire suppression system is guaranteed for 5 years.
 - .5 In case of a fire, exhaust fan stays on and any hood lighting is turned off. The cooking appliances, modular grease extractors and duct collars are sprayed with the chemical extinguisher. All sources of electricity and gas supplying the cooking equipment protected by the Fire Suppression System are shut off and a signal is sent to the alarm system.
 - .6 The hood is ULC approved and built of 304 stainless steel in accordance with NFPA 96. Installation shall meet NFPA 96.
- .2 Capacity: 236 l/s at 100 Pa.
- .3 Dimensions: 300L X 300L X 400W X 175D (mm)

2.2 Operation

.1 Ventilation system and lights :

- .1 The 3 positions selector allows the air flow and the air compensation via 3 modes "Manuel", "Off", "Auto".
- .2 The "manual" and "auto" mode allow the operation of the ventilation (On/Off).
- .3 The "Auto" mode allows the PLC in the control box to give the start-up and shut-off authorization according to the programmed schedule OR The "Auto" mode allows the use of a digital entree linked to a dry contact of the building central system. The dry-contact allows remote management of the ventilation system.
- .4 A digital input can stop the system.
- .5 Hood lights are interlocked with exhaust. If user want to change light state, it is always possible to use push button.
- .6 When the system is turned on, the exhasut fan motor starts for 10 seconds at 100% capacity and then shift to the manual dimmer.
- .7 At all the times, except at start-up, the dimmer control the evacuation speed (engine 120/1/60, max 1/2hp).

.2 When the fire suppression system is triggered

- .1 The exhaust fan remains in function.
- .2 The air intake is interrupted. Opening of the dry-connect at maximum of 10 amps.
- .3 The exhaust hood lights are switched off. (Opening of a dry-connect at maximum 10 amps).
- .4 The cooking equipment's electrical supply is switched off. Opening of the dry-connect linked to the cooking equipment's magnetic contactor. (The magnetic contactor is supplied by others).
- .5 The electric valve's electrical supply is shut-off to stop the gas supply to the cooking equipment. (Opening of a dry-connect at maximum 10 amps);.
- .6 The « COOKING APPLIANCES OFF » LED lights up.
- .7 The « FIRE » LED lights up
- .8 Following a fire or a power outage at the control box, the cooking appliances electricity supply isn't automatically restored. You must:
 - .1 Open the control box
 - .2 Push the « RESET » button
 - .3 Close control box

2.3 Control Panel BC-1

- .1 16-gauge steel control box, CSA listed, with a polyester grey paint.
- .2 The control box can be wall-imbedded or surface-mounted.
- .3 The control box allows the activation of the evacuator and the 2 positions zone flow dampers via a selector and a manual dimmer of the hood, of the air supply as well as the control of the hood lights.
- .4 The control box comes with a reset function and allows the control sequence to be done in accordance with the NFPA 96 norm.

- .5 The control box is pre-wired and is equipped with a fuse, one PLC, one micro-processor and a series of connection terminals.
- .6 The front of the control box presents:
 - .1 One three positions selector for ventilation;
 - .2 One dimmer to modulate the ventilation;
 - .3 One three positions selector for ventilation;
 - .4 One "FIRE" LED;
 - .5 One "Cooking Appliances OFF" LED.
- .7 Acceptable product: Cadexair, model CC35-VI-ZP1, CSA listed, or approved equivalent.

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 handling equipment 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.
- .2 Installation
- .3 Provide appropriate protection apparatus.
- .4 Install units in accordance with manufacturer's instructions and as indicated.
- .5 Ensure adequate clearance for servicing and maintenance.
- .6 Vapor hood installed at 2000 mm from the lower edge of the canopy to the floor.
- .7 Exhaust hoods installed at 2000 mm from the lower edge of the canopy to the floor, 75 mm from the semi-combustible contents and 457 mm from the combustible contents. The exhaust hood must over-hang the cooking appliance by 305 mm in the front and 150 mm on each side.

3.2 Fans

- .1 Install fan sheaves required for final air balance.
- .2 Install flexible connections at fan inlet and fan outlets.
- .3 Install vibration isolators.

3.3 Drip Pans

- .1 Install deep seal P-traps and trap seal primer on drip lines.

- .1 Depth of water seal to be 1.5 times static pressure at this point.

3.4 **Start-Up and Commissioning**

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41 and 01 91 51.
- .2 Have manufacturer certify installation.
- .3 Have manufacturer present during start-up and certify performance.
- .4 Submit written start-up and commissioning reports to Departmental Representative.

3.5 **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 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.

End of Section

1. GENERAL

1.1 References

- .1 ASTM International
 - .1 ASTM E84-11a, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .2 ASTM C916-1985(R2007), Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C1071-05e1, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-2012, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-2012, Standard for the Installation of Warm Air Heating and Air Conditioning Systems (ANSI).

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 unit heaters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence and cleaning procedures.
- .4 Shop Drawings:
 - .1 Submit drawings for review and approval.
 - .2 Indicate on drawings:
 - .1 Equipment, capacity and piping connections.
 - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

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 unit heaters for incorporation into manual.

1.4 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect unit heaters from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 Horizontal Unit Heaters

- .1 Horizontal Unit Heaters: to UL 2021.
- .2 Casing: 1.6 mm thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.
- .3 Coils: hydrostatically test to 1 MPa.
 - .1 Hot water coil: copper tube, mechanically bonded aluminum fins spaced 25 mm maximum rated 1378 kPa minimum working pressure and 104 degrees C maximum entering-water temperature. Include manual air vent and drain.
- .4 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard.
- .5 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor explosion proof supports.
- .6 Air outlet: two-way adjustable louvres.
- .7 Capacity: as indicated, base hot water heating capacity on a supply heating water temperature of 71 degrees C and a 11 degrees C temperature drop.
- .8 Control room thermostat: by division 25.

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for unit heaters 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 Install in accordance with manufacturer's instructions.
- .2 Include double swing pipe joints as indicated.
- .3 Check final location with Departmental Representative if different from that indicated prior to installation.
 - .1 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .4 Hot water units: for each unit, install ball valve on inlet and outlet of each unit. Install drain valve at low point.
 - .1 Install manual air vent at high point.
- .5 Clean finned tubes and comb straight.
- .6 Provide supplementary suspension steel as required.
- .7 Install thermostats in locations indicated.
- .8 Before acceptance, set discharge patterns and fan speeds to suit requirements.

3.3 Start-Up and Commissioning

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41 and 01 91 51.
- .2 Have manufacturer certify installation.
- .3 Have manufacturer present [during start-up] [tests and start up units] and certify performance.
- .4 Submit written start-up and commissioning reports to Departmental Representative.

3.4 Cleaning

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

3.5 Protection

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

End of Section

1. GENERAL

1.1 References

- .1 ASTM B-75: copper tubing.
- .2 Institute of Boiler and Radiator Manufacturers (IBR).
- .3 ASHRAE: Fundamentals.
- .4 ASHRAE: standard 55.

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 radiant panels and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings for review and approval.
 - .2 Indicate on drawings:
 - .1 Equipment, capacity, piping, and connections.
 - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.
 - .3 Finishes.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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 radiant panels for incorporation into manual.

1.4 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic radiant panels from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 Capacity

- .1 As indicated, based on 74 degrees C average water temperature, 15 degrees C temperature drop and 20 degrees C at entering air temperature.
- .2 Pressure Ratings: Pressure ratings shall be as follows:
 - .1 Working pressure: 410 kPa maximum
 - .2 Test Pressure-770 kPa maximum
- .3 Heating media: Propylene glycol 50%

2.2 Baseboard Hydronic Radiator:

- .1 Steel double panel radiators of the lengths and in locations as indicated, and of capacities, style and having accessories as scheduled. The double heating panel radiation shall be of one-piece all-welded steel construction, consisting of a pair of flattened water tube panels welded to headers at each end. Welded to the inside of each panel shall be steel corrugated fins to increase the convective output of the radiator. The fins shall start at no less than 75 mm from the end of the radiator, and shall have no less than 100 fins per meter. The radiators shall include an integral heavy gauge all-welded perforated top grille, which will cover the top of all of the finned areas.
- .2 The headers shall include all necessary inlet, outlet and vent connections as required. Standard connection sizes are NPS 1/2 tapered thread for supply and return piping, and NPS 1/8 for the vent connection. Internal baffling is provided where required for proper water flow.
- .3 The radiant heating panels shall be available in lengths of 50 mm (two inches) even increments without the need for splicing. The panel radiator shall be capable of being mounted to typical stud wall construction without additional blocking or strapping. Appropriate wall mounting brackets shall be provided with the radiation heaters.
- .4 Panel radiation expansion shall not exceed 1.25 mm per meter of radiator at 100°C. The installer shall provide adequate expansion compensation for each radiator.
- .5 Finishes: The panel radiator shall be cleaned and phosphatized in preparation for the powder coat finish. The radiator is then finish painted with a gloss powder coat finish, for a total paint thickness of 2-3 mils (0.002" - 0.003"). The color shall be selected by the Departmental Representative.
- .6 Heating media:
 - .1 Propylene glycol 50%
 - .2 Entering temperature: 82 °C
 - .3 Leaving temperature: 65 °C

- .7 Pressure Ratings: Pressure ratings for the radiation shall be as follows:
 - .1 Working pressure: 410 kPa maximum
 - .2 Test Pressure-770 kPa maximum
- .8 Provide all radiator trims.
- .9 Provide for noiseless expansion of components.
- .10 Warranty: All radiators are covered by a 5-Year Warranty
- .11 Dimensions for enclosures: measure site conditions. Do not scale from drawing.
- .12 Design reference: Radiator design is based on Model RF, manufactured by Runtal North America, Inc.

2.3 Hydronic Radiant Floor Heating

- .1 **Radiant Floor tubing (Radiant PEX):**
 - .1 Radiant Floor tubing (Radiant PEX): Provide radiant tubing in lengths and locations as designed by manufacturer, with capacities, sizes, spacing, and depths, computer printout. Radiant tubing shall be a single layer, cross-linked polyethylene extrusion with an outer layer composed of an EVOH oxygen barrier with an integral ethylene vinyl alcohol (EVOH) DIN Standard O2 barrier that limits oxygen diffusion through the walls of the tubing to less than 0,10g/m3/day at 104°F water temperature.
 - .2 Tubing dimensions and capacities shall be as designed by manufacturer. Tubing shall conform to the Standard Thermoplastic Pipe Dimension Ratio (SDR-9). Tubing shall contain a minimum cross-linking value of 65% and no greater than 89%, inclusive. The radiant tubing shall be warranted to 180°F in hydronic heating applications without detrimental effect. Tubing shall conform to the following operational conditions: PEX has a maximum working pressure/temperature of 160 psi at 73.4°F, 100 psi at 180°F, and 80 psi at 200°F.
 - .3 Heat transfer fluids shall only be water or water/glycol mixtures. Use of corrosion-proofing chemicals are permitted and recommended. Use of other heat transfer fluids such as oil, alcohol, or automotive glycol, are not permitted.
- .2 **Manifolds:**
 - .1 Materials shall be of type L copper trunks and copper or brass base branches with brass tee (sweat) branches. Connections shall be soldered with a lead-free, high-strength solder. Manifold to be mounted in manufacturing universal mounting bracket, 1 pair per manifold set. Standard diameter is one inch (1") with other diameters available or as specified up to four inches (4"). Manifolds shall be fitted with ball valves (mini or standard size) or zone valves (electric or non-electric type) for flow control and/or isolation purposes as specified by drawings and/or schedules. Manifolds are optionally fitted with vent/purge assemblies for bleeding air, or unions for acceptance of pressure test kits. PEX shall be attached to the manifold branches by one of the following methods: Crimp Ring, Cinch Clamp, or T-20 Compression. Each to be applied in accordance to manufacturer's specifications.

.3 Hydronic Primary control panel:

- .1 Primary panels shall be made by a recognized manufacturer. Control Panel shall be complete with the following equipment pre-wired, pre-plumbed and tested, High performance air separator, purge and drain valve, primary circulating pump sized for the required system flow rate and pressure drop, service valves, pressure and temperature gauge, Quick-Connect unions, pre-wired power cord. A cold-water make-up system shall be included with shut-off valve, pressure reducing valve, back flow preventer and connection for expansion tank. The control panel will receive a heat demand from the system and turn on the circulator and will in turn close a dry contact to send a signal to the boiler or other device requiring a demand signal. The panel is 31" wide x 28" high x 12" deep and shall be equipped with a white enamel removable cover.

.4 Hydronic mixing control panel:

- .1 The distribution panels shall be made by a recognized manufacturer. Control mixing panels shall be complete with four (4) independently controlled and pre-wired manifold pumps sized for individual manifold flow rates and pressure drops. Each pump shall be equipped with flanges and individual spring check valves. Panels shall be complete with pre-wired outdoor reset control, temperature gauge, and thermostatically controlled zone pump(s). Each Panel is plumbed in 1.25" L copper, comes complete with pre-wired variable speed digital outdoor reset control, four-pump control module and transformer. Field-wire reset control and boiler contact (end switch) back to Panel to complete installation. The control is pre-wired with an external transformer, and supplied with power by a 10' cord. Upon a call for heat from any zone served by this panel, the end switch (dry contact) on the pump control closes. This dry contact switch will activate any external control to which the Panel is field wired. L = 31" wide x 52" tall x 12".

.5 Hydronic manifold control panel:

- .1 The manifold radiant loop zone control panels shall be made by a recognized manufacturer. The manifold panel shall be complete with stainless steel manifold with balancing valve on return and flow meters on supply side of manifold mounted in a powder-coated steel enclosure (4-1/2" deep) with latched door. The enclosure can be mounted on a wall or recessed between studs. The manifold panel serves 2 to 12 circuits. Manifold shall be complete with pre-installed 24Volt actuators on each manifold circuit and pre-wired for individual circuit control for up to six different zones. Includes a zone relay control, 40-VA transformer, trunk isolation valves, temperature gauges, and vent and purge assemblies. Field-wire thermostats (not included) to zone control module and dry contact switch to distribution panel.

.6 ACCESSORIES (Contractor to provide the following items as required for the proper installation of the radiant heating system):

- .1 Repair Kit: One (1) for each size of radiant floor tubing used in the project.
- .2 Cable Tie: One (1) every eighteen inches (18") of tubing.
- .3 Plate: One (1) every twenty-four inches (24") to thirty inches (30") of tubing for under floor applications.
- .4 Suspension Clip: One (1) every twenty-four inches (24") to thirty inches (30") of tubing for under floor applications.
- .5 Staple: One (1) every eighteen inches (18") of tubing for Thin-slab applications.
- .6 Staple Gun: Minimum of one (1) per project where staples are needed. Contractor to determine if more are needed. Size of staple gun determined by the diameter of tubing.

- .7 PEX Unwinder: Minimum of one (1) per project. Contractor to determine if more are necessary.
- .8 Pressure Test Kit: Minimum of one (1) per project. Contractor to determine if more are necessary.

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for the radiant panels 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 **Install in accordance with manufacturer's instructions.**
- .2 Install in accordance with piping layout and approved reviewed shop drawings.
- .3 Provide for pipe movement during normal operation.
- .4 Maintain sufficient clearance to permit performance of service maintenance.
- .5 Check final location with Departmental Representative if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .6 Valves:
 - .1 Install valves with stems upright or horizontal unless approved otherwise.
 - .2 Install isolating ball valves on inlet and outlet of each unit.
- .7 Venting:
 - .1 Install screwdriver vent on cabinet convector, terminating flush with surface of cabinet.
 - .2 Install a standard air vent with cock on continuous wall or ceiling radiant panels installed in series.
- .8 Install flexible expansion compensators as required.

3.3 Start-Up and Commissioning

- .1 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41 and 01 91 51.
- .2 Have manufacturer certify installation.
- .3 Have manufacturer present during start-up tests and start up units and certify performance.

- .4 Submit written start-up and commissioning reports to Departmental Representative.

3.4 Cleaning

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

End of Section

1. GENERAL**1.1 Action and Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for humidifiers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings for review and approval.
 - .2 Submit shop drawings to indicate project layout, dimensions and extent of humidification system:
 - .1 Indicate following: capacity at required airflow, water flow, compressed air flow.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .6 Manufacturer's Field Reports:
 - .1 Submit manufacturer's field reports specified.

1.2 Closeout Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for humidifiers for incorporation into manual.

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, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing, for inclusion into operating manual.
 - .3 Provide following: one complete set of renewable evaporator media.

1.4 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect humidifiers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 Packaged Electric Resistive Humidifier

- .1 CSA certified and ULC listed.
- .2 Components housed in factory fabricated cabinet with factory enameled finish and electrically interlocked door.
- .3 Factory sealed disposable steam cylinder complete with factory installed electrodes to suit water conditions.
- .4 Controls:
 - .1 Solid state panel.
 - .2 Solenoid valve on water and drain lines.
 - .3 Duct humidistat.
 - .4 Airflow proving switch.
 - .5 Adjustable flush cycle timer.
 - .6 Amp meter.
 - .7 Cylinder replacement indicator light.
- .5 Duct distribution header complete with condensate drain and supply hose.
- .6 Fabrication requirements:
 - .1 Enclosure shall be an 18-gauge steel frame with resin cover suitable for finished spaces. Enclosure frame shall constitute a drip pan, having a threaded connection for drain piping. A separate compartment shall house electrical devices and shall be secured to prevent accidental contact with electrical components. The front exterior of the cabinet shall contain the microprocessor controller's digital keypad.
 - .2 Cleanable vaporizing chamber shall be stainless steel with Heli-arc welded seams. The evaporating chamber shall be mounted on slide rails. Electrical, water supply and drain connections shall have unions and plugs to allow convenient removal of the evaporating chamber for cleaning.
 - .3 The humidifier frame shall have prepunched keyhole-style mounting holes located on 16" (406 mm) centers for ease of wall mounting and leveling.
 - .4 Steam outlet on top of tank shall be configured to connect to two (2) dispersion units in ducts via hoses or pipes.

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- .7 Immersion heater(s): Heater(s) shall be Incoloy alloy-sheathed resistance type designed for no more than 86 watts per square inch and shall be mounted on the vaporizing chamber's removable cover.
 - .8 Temperature sensor: A factory mounted sensor, with a temperature range of -40 to 248 °F (-40 to 120 °C) shall be mounted on the humidifier to enable the following functions:
 - .1 Maintain the evaporating chamber water temperature above freezing
 - .2 Maintain a user-defined preset evaporating chamber water temperature
 - .3 Allow rapid warm-up of water in evaporating chamber after a call for humidity, providing 100% operation until steam production occurs
 - .4 Provide backup over-temperature protection for the over-temperature switch
 - .9 Over-temperature switch: A factory-mounted and -wired UL-listed limit control sensor with manual reset shall sense an over-temperature condition and de-energize heater circuit controls.
 - .10 Water requirements: The humidifier shall be capable of generating steam from tap, softened or DI/RO water.
 - .11 Drain: An electric drain valve shall be mounted on humidifier assembly to allow tank to drain automatically at the end of a humidification season.
 - .12 SSR modulating control option: Humidifier shall have an electronic power controller, surface mounted and wired in humidifier control cabinet assembly to regulate current to humidifier load. This regulation will modulate between 0% to 100% of maximum capacity.
 - .13 Microprocessor controller with the following features or functions:
 - .1 Web interface and server, included standard on all models:
 - .1 Web interface shall have same functionality as Vapor-logic keypad/display
 - .2 Web interface shall allow multiple remotely located users to simultaneously view system operation and/or change system parameters.
 - .3 Web interface shall have password-protected secure access.
 - .4 Web interface shall be compatible with standard Internet browsers.
 - .5 Web interface shall connect directly to a personal computer or through a system network via Ethernet cable. Automatic cable configuration shall allow straight-through or crossover cables.
 - .2 Redundant over-temperature safety control
 - .3 Fully modulating (0% to 100%) control of humidifier outputs
 - .4 PID control capability with field-adjustable settings
 - .5 Water level control for softened or hard water:
 - .1 Automatic refill, low water cutoff, field-adjustable skimmer bleedoff functions and automatic drain-down of humidifier. System shall consist of:
 - .1 A water level sensing unit comprised of three metallic probes screwed into a threaded probe head. Probe head shall incorporate probe isolation chamber to eliminate short-circuiting between probes caused by mineral coating of probe head. Probe head shall be mounted on the humidifier assembly.
 - .2 A solenoid operated fill valve factory mounted on the humidifier assembly

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- .3 End-of-season drain automatically drains humidifier tank after a user-defined period of system inactivity.
 - .6 USB port on the control board for software updates, data backups, and data restoration
 - .7 Up-time optimizer function to keep humidifier(s) operating through conditions such as fill, drain, or run-time faults, as long as safety conditions are met, minimizing production down-time
 - .8 Real-time clock to allow time-stamped alarm/message tracking, and scheduled events
 - .9 Factory commissioning of humidifier and control board, including system configuration as-ordered
 - .10 Keypad/display operable within a temperature range of 32 to 158 °F (0 to 70 °C), and that provides backlighting for viewing in low light
 - .11 Alarms, unit configuration, and usage timer values shall remain in nonvolatile memory indefinitely during a power outage.
 - .12 The capability to monitor, control, and/or adjust the following parameters:
 - .1 Relative humidity (RH) set point, actual conditions in the space (from humidity transmitter), RH offset
 - .2 Dew point set point, actual conditions in the space (from dew point transmitter), dew point offset
 - .3 Relative humidity (RH) duct high limit set point (switch) and actual conditions
 - .4 Relative humidity (RH) duct high limit set point, actual conditions (from transmitter), high limit span, and high limit offset
 - .5 Total system demand in % of humidifier capacity
 - .6 Total system output in lbs/hour (kg/h)
 - .7 Drain/flush duration
 - .8 End-of-season drain status (on standard water systems and if ordered as a DI water option) and hours humidifier is idle before end of season draining occurs
 - .9 System alarms and system messages, current and previous
 - .10 Adjustable water skim duration
 - .11 Programmable outputs for remote signaling of alarms and/or messages, device activation (such as a fan), or for signaling tank heating and/or steam production
 - .12 System diagnostics that include:
 - .1 Test outputs function to verify component operation
 - .2 Test humidifier function, by simulating demand to validate performance
 - .3 Data collection of RH, air temperature, water use, energy use, alarms, and service messages for viewing from the keypad/display or Web interface
 - .1 Service notification scheduling
 - .2 Password-protected system parameters
 - .3 Keypad/display or Web interface displays in English, French, or German languages
 - .4 Numerical units displayed in inch-pound or SI units
 - .14 A thermostatically controlled water valve shall meter an amount of cold water into a stainless-steel mixing chamber to temper 212 °F (100 °C) water with a 6 gpm (0.38 l/s) in-flow rate to a 140 °F (60 °C) discharge temperature to sanitary system.
 - .15 Humidifier Dispersion Options
 - .1 Dispersion tube(s).
 - .1 Performance:

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- .1 Dispersion assembly shall disperse evaporative, non-pressurized humidification steam into ducted or open spaces. **Absorption distance shall be under 600mm.**
 - .2 Condensate management:
 - .1 Condensate shall return to the steam generator by pitching dispersion tube 2"/ft (15%) toward steam generator.
 - .3 High-efficiency dispersion:
 - .1 Dispersion tubes shall be insulated with a plenum-approved insulating material for in-duct installation and have an R-value not less than 0.5 at a thickness not more than 0.125" (3.2 mm), for minimal increase in dispersion tube diameter.
 - .2 Airstream heat gain shall not exceed the values as scheduled; the values shall be supported by the manufacturer's published data.
 - .1 Insulating material shall meet the following criteria at 0.125" (3.2 mm) thickness:
 - .2 Fire/smoke index shall be 0/0 per any of the following test procedures:
 - .3 UL 723 fire/smoke index (Test for Surface Burning Characteristics of Building Materials)
 - .4 NFPA 255 (Standard Method of Test of Surface Burning Characteristics of Building Materials)
 - .5 ASTM E84 (Surface Burning Characteristics for Materials Used in Plenums)
 - .6 Stable up to 300 °F (148 °C) continuous — to prevent material degradation, hardening, or crumbling at high temperatures
 - .7 Closed-cell construction that does not absorb water or support microbial growth — to negate the need for vapor barriers and jackets
 - .8 Non-toxic and pure as documented in manufacturer's data — to prevent off-gassing and to facilitate use in clean rooms, pharmaceutical applications, and food industries
 - .9 Will not degrade when exposed to UVC light — to negate the need for UV wraps
 - .10 Continuous, seam-welded, and held in place without bands or clamps — to minimize surfaces for the accumulation of particulate matter
 - .4 Fabrication and components:
 - .1 Dispersion tube shall be constructed of stainless steel and have uniformly spaced tubelets for steam dispersion.
 - .1 Dispersion tubes shall be constructed of 304 stainless steel with welded seams
 - .2 Each tubelet shall extend through the wall of the dispersion tube and incorporate a properly sized calibrated orifice.
 - .3 Tubelets shall be constructed of high-temperature resin
 - .4 Dispersion tube(s) shall extend the width of the duct.
 - .5 Two-piece escutcheon plate shall be provided for sealing the duct opening around each dispersion tube.

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for humidifiers 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 Install in accordance with manufacturers instructions.
- .2 Humidifier and evaporator media to be new and clean when project is accepted.
- .3 Install humidistat as indicated in accessible location.
- .4 Water service overflow drain: as indicated to manufacturers' recommendation.
- .5 Install access doors or panels in adjacent ducting.
- .6 When installing in ducting, provide waterproof duct up and downstream in accordance with Section 23 31 13.01 - Metal Ducts - Low Pressure to 500 Pa.
- .7 Install capped drain connection at low point in duct.

3.3 Field Quality Control

- .1 Manufacturer's Field Services:
 - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and site visit for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, at stages listed:
 - .1 Upon completion of the Work, after cleaning is carried out.
 - .4 Obtain reports, within 5 days of review, and submit immediately to Departmental Representative.
- .2 Performance Verification (PV):
 - .1 General: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.
 - .2 Application tolerances: $\pm 3\%$.
 - .3 Timing:
 - .1 After TAB of ducted air systems.
 - .2 At same time as PV of related air handling units.

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- .4 PV procedures:
 - .1 Mechanical Atomizing
 - .3 Start-up:
 - .1 General: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements and Section 01 91 31- Commissioning Plan: General Requirements, supplemented as specified.
 - .2 Verify:
 - .1 Water lines connection to the humidifier.
 - .2 Visually check distribution manifold to ensure:
 - .1 Even distribution of water mist.
 - .2 Freedom from water deposits.
 - .4 Commissioning Reports:
 - .1 General: in accordance with Section 01 91 31 - Commissioning (Cx) Plan and Section 01 91 33 –Commissioning Forms reports, supplemented as specified. Include:
 - .1 Static verification and operational verification on Report Forms in accordance with Section 01 91 31, Appendix B.
 - .2 Product Information Report Forms
- 3.4 **Demonstration**
- .1 Training: in accordance with Section 01 91 41 - General Commissioning (Cx) Requirements: Training of OM Personnel.
- 3.5 **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