## Part 1 General

### 1.1 General

.1 This section covers items common to all sections of Division 15.

### 1.2 Equipment List

.1 Complete list of equipment and materials to be used on this project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

.2 Submit for approval.

### 1.3 Equipment Installation

.1 Unions or flanges: provide for ease of maintenance and disassembly.

.2 Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer or as indicated.

.3 Equipment drains: pipe to floor drains.

.4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.

### 1.4 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with good practice as per City requirements.

.2 Place materials defined as hazardous or toxic waste in designated containers.

.3 Ensure emptied containers are sealed and stored safely for disposal away from children.

### 1.5 Anchor Bolts and Template

.1 Supply anchor bolts and templates for installation by other divisions.

### 1.6 Trial Usage

.1 The Engineer or Owner may 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 All HVAC systems and building system controls.

.2 All plumbing and domestic water systems.

.3 All fire protection systems.

.4 All compressed air and service systems.

**1.7 Protection of Openings**

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

**1.8 Electrical**

.1 Electrical work to conform to Division 16 including the following:

.1 Unless noted otherwise, control wiring under 50 V to be supplied and installed by the Mechanical Control Subcontractor (Division 15900) in accordance with Division 16 specifications.

.2 Control wiring over 120 V is to be installed by Division 16.

.2 Motors to be provided with mechanical equipment.

.3 Variable frequency drives provided by Division 16.

**1.9 Motors**

.1 Provide motors for mechanical equipment as specified.

.2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by Contract Administrator for temporary use. Final acceptance of equipment will not occur until specified motor is installed.

.3 Motors under 373 W (½ HP): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120V, unless otherwise specified or indicated.

.4 Motors 373 W (½ HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C (72°F), 3 phase, voltage as indicated, unless otherwise specified or indicated.

**1.10 10 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 specified.

.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 to be 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 center line adjustment.

.8 Supply one set of spare belts for each set installed.

**1.11 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 (18 gauge) sheet metal tops and bottoms.
.3 38 mm (1-1/2") diameter holes on both shaft centers 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.

.5 Guard for flexible coupling:

.1 "U" shaped, minimum 1.6 mm thick (16 gauge) galvanized mild steel.
.2 Securely fasten in place.
.3 Removable for servicing.

.6 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.

**1.12 Equipment Supports**

.1 Equipment supports supplied by equipment manufacturer: specified elsewhere in Division 15.

.2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of CAN/CSA-G40.20/G40.21-M92 "General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels". Submit structural calculations with shop drawings.

.3 Mount base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 50 mm (2") larger than equipment dimensions all around.

**1.13 Temporary Use of Systems**

.1 Use of new permanent heating and ventilating systems for supplying temporary heat or ventilation is permitted only under the 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 from any cause.

.5 Supply ventilation systems are protected by filters, which shall be inspected daily, changed every 2 weeks or more frequently as required.

.6 Return systems have approved filters over all openings, inlets, outlets.

.7 All systems will be:

.1 operated as per manufacturer’s recommendations or instructions,

.2 operated by Contractor,

.3 monitored continuously by Contractor.

.8 Warranties and guarantees are not thereby relaxed.

.9 Regular preventative and all other manufacturer’s recommended maintenance routines are performed by the Contractor at his own expense and under supervision of the Engineer.

.10 Before substantial completion, entire system to be refurbished, cleaned internally and externally, restored to “as-new” condition, filters in air systems replaced.

.2 Filters referred to herein are over and above those specified elsewhere in this specification.

.3 Exhaust systems are not included in any approvals for temporary heating ventilation.

**1.14 Preparation for Firestopping**

.1 Firestopping material within annular space between pipes, ducts, insulation and adjacent fire separation shall be in accordance with ASTM E-814 (UL1479) fire test.

.2 The material shall be installed in accordance with UL through penetration firestop system #161 where pipes penetrate rated floors.

.3 Uninsulated unheated pipes not subject to movement: no special preparation.

.4 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe to move without damaging firestopping material.

.5 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.

**1.15 Tests**

.1 Give 24 h written notice of date for tests.

.2 Insulate or conceal work only after testing and approval by Engineer.

.3 Conduct tests in presence of Engineer.

.4 Bear costs including retesting and making good.

.5 Piping:

.1 General: maintain test pressure without loss for 4 h unless otherwise specified.

.2 Hydraulically test steam and hydronic piping systems at 1-1/2 times system operating pressure or minimum 860 kPa (125 psi), whichever is greater.

.3 Test drainage, waste and vent piping to National Plumbing Code and authorities having jurisdiction.

.4 Test domestic hot, cold and recirculation water piping at 1-1/2 times system operating pressure or minimum 860 kPa (125 psi), whichever is greater.

.5 Test fire systems in accordance with authorities having jurisdiction and as specified elsewhere.

.6 Equipment: test as specified in relevant sections.

.7 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.

**1.16 Painting**

.1 To Section 09900- Finish Painting

.2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.

.3 Prime and touch up marred finished paintwork to match original.

.4 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

**1.17 Spare Parts**

.1 Furnish spare parts in accordance with Section 01780 - Closeout Submittals.

.1 One set of belts for each piece of machinery.

.2 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

.3 One head gasket set for each heat exchanger.

.4 Five fusible links for each different type of link installed.

.2 Spare parts are to be provided to an identified Owner's representative complete with transmittal documents showing all materials provided and date of supply. Owner's representative to sign for all materials received.

**1.18 Special Tools**

.1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01780 - Closeout Submittals.

.2 Furnish one commercial quality grease gun and adaptor to suit different types of grease fittings. Provide grease to suit manufacturer's recommendations for all greasable systems.

.3 Spare parts are to be provided to an identified Owner's representative complete with transmittal documents showing all materials provided and date of supply. Owner's representative to sign for all materials received.

**1.19 Access Doors**

.1 Supply access doors to concealed mechanical equipment for operating, inspecting, adjusting and servicing.

.2 Flush mounted 600 x 600 mm (24" x 24") for body entry and 300 x 300 mm (12" x 12") for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.

.3 Material:

.1 Use prime coated steel.

.4 Installation:

.1 Locate so that concealed items are accessible.

.2 Locate so that hand or body entry (as applicable) is achieved.

.3 Installation is specified in applicable sections.

.5 Approvals:

.1 Where access doors are to be installed in fire rated assemblies, provide ULC listed and labelled access doors meeting rating requirements.

.6 Acceptable material: Acudor Access Doors.

**1.20 Drain Valves .**

.1 Locate where indicated on the drawings, and at low points and at section isolating valves unless otherwise specified.

.2 Minimum NPS 3/4 unless otherwise specified: bronze, with hose end male thread and complete with cap and chain.

**1.21 Demonstration and Operating and Maintenance Instructions**

.1 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.

.2 Where specified elsewhere in Division 15, manufacturers to provide demonstrations and instructions.

.3 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

.5 Where deemed necessary, Engineer may record these demonstrations on video tape for future reference.

**1.22 Operation and Maintenance Manual**

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01780 - Closeout Submittals.

.2 Operation and maintenance manual to be approved by, and final copies deposited with, Contract Administrator before final inspection.

.3 Operation data to include:

.1 Control schematics for each system including environmental controls.

.2 Description of each system and its controls.

.3 Description of operation of each system at various loads together with reset schedules and seasonal variances.

.4 Operation instruction for each system and each component.

.5 Description of actions to be taken in event of equipment failure.

.6 Valves schedule and flow diagram.

.7 Colour coding chart.

.4 Maintenance data shall include:

.1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.

.2 Data to include schedules of tasks, frequency, tools required and task time.

.5 Performance data to include:

.1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Special performance data as specified elsewhere.

.4 Testing, adjusting and balancing reports as specified in Section 15950 - Testing, Adjusting and Balancing (TAB) of Mechanical Systems.

.6 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manual to Contract Administrator for approval. Submission of individual data will not be accepted unless so directed by Contract Administrator.

.2 Make changes as required and re-submit as directed by Contract Administrator.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

**1.23 Shop Drawings and Product Data**

.1 Submit shop drawings and product data in accordance with Section 01330 - Submittal Procedures.

.2 Shop drawings and product data shall show:

.1 Mounting arrangements.

.2 Operating and maintenance clearances. eg. access door swing spaces.

.3 Shop drawings and product data shall be 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 as to current model production.

.5 Certification of compliance to applicable codes.

.4 In addition to transmittal letter referred to in Section 01330 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

**1.24 Existing Systems**

.1 Connections into existing systems to be made at time approved by Engineer. Request written approval of time when connections can be made.

.2 Be responsible for damage to existing plant by this work.

**1.25 Cleaning**

.1 Clean mechanical systems in accordance with Section 15095- Cleaning and Start-up of Mechanical Piping Systems.

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

.3 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.

**1.26 26 As-Built Drawings**

.1 .1 Site records:

.1 Engineer will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur. This shall include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection at all times.

.2 .2 As-built drawings:

.1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.

.2 Identify each drawing in lower right hand corner in letters at least 12 mm (1/2") high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN

REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).

.3 Submit to Contract Administrator for approval and make corrections as directed.

.4 TAB to be performed using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

.3 .3 Submit copies of as-built drawings for inclusion in final TAB report.

**1.27 Breakdown of Costs and Progress Claims**

.1 Price to be broken down at the time of tender in accordance with Contract Documents.

.2 Following award of contract, each section of this Division is to provide breakdown of tendered prices into categories required for submission of Progress Claim. Sufficient categories to be provided to permit evaluation of the claim and approval of payment. Modify or add categories as requested.

.3 Progress claims to indicate for each category:

.1 Total

.2 Total to date

.3 Monthly claim

.4 Categories to include or as appropriate for the project:

.1 Refurbishment

.2 Air conditioning units

.3 Flexible connections and vibration isolation

.4 Steam system piping, valves and fittings

.5 Hydronic system piping, valves, coils, wallfin heaters, unit heaters and pumps

.6 Ductwork

.7 Humidification

.8 Terminal units

.9 Diffusers and grilles

.10 Pipe insulation

.11 Duct insulation

.12 Identification

.13 Controls

.14 Testing and balancing

**END OF SECTION**

## Part 1 General

### 1.1 References

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

.1 ANSI/ASME B31.1-2004, Power Piping.

.2 ANSI/ASME Boiler and Pressure Vessel Code-2004:

.1 Section 1: Power Boilers.

.2 Section V: Nondestructive 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 C1.1-2000, Recommended Practices for Resistance Welding.

.2 AWS Z49.1-1999, Safety in Welding, Cutting and Allied Processes.

.3 AWS WI-80, Welding Inspection 2nd Edition.

.4 Canadian Standards Association (CSA)

.1 CSA W47.1-03, Certification of Companies for Fusion Welding of Steel.

.2 CSA W47.2-M1987(R2003), Certification of Companies for Fusion Welding of Aluminum.

.3 CSA W48-06, “Filler Metals and Allied Materials for Metal Arc Welding”.

.4 CSA B51-2003, Boiler, Pressure Vessel and Pressure Piping Code.

.5 CAN/CSA-W117.2-06, Safety in Welding, Cutting and Allied Processes.

.6 CSA W178.1-02, Certification of Welding Inspection Organizations.

.7 CSA W178.2-01, Certification of Welding Inspectors.

.5 Manitoba Labour – Certificate of Authorization Program.

.6 Manitoba Regulation 108/87R as amended by Regulation 80/2005 “Steam and Pressure Plants Regulation”

### 1.2 Welders Qualifications

.1 Welding qualifications to be in accordance with CSA B51.

.2 Use qualified and licensed welders possessing certificate for each procedure to be performed from authority having jurisdiction in the province of application.

.3 Furnish welder's qualifications to Contract Administrator and authority having jurisdiction.

.4 Each welder to possess identification symbol issued by authority having jurisdiction.

**1.3 Inspectors Qualifications**

.1 Inspectors to be qualified to CSA W178.2.

**1.4 Welding Procedures**

.1 Registration of welding procedures in accordance with CSA B51.

.2 Copy of welding procedures to be available for inspection at all times.

.3 Safety in welding, cutting and allied processes to be in accordance with CAN/CSA-W117.2 and AWSZ 49.1.

**1.5 Waste Management and Disposal**

.1 Separate and recycle waste materials in accordance with City requirements.

.2 Place materials defined as hazardous or toxic waste in designated containers.

.3 Ensure emptied containers are sealed and stored safely for disposal away from children.

## Part 2 Products

**2.1 Electrodes**

.1 Electrodes: in accordance with CSA W48.

## Part 3 Execution

**3.1 Workmanship**

.1 Welding to be in accordance with ANSI/ASME B31.1, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B2.1 series, AWS C1.1, and applicable requirements of provincial authority having jurisdiction.

**3.2 Installation Requirements**

.1 Identify each weld with welder's identification symbol.

.2 Backing rings:

.1 Where used, fit to minimize gaps between ring and pipe bore.

.2 Do not install at orifice flanges.

.3 Fittings:

.1 NPS 2 and smaller: install welding type sockets.

.2 Branch connections: according to the following schedule:

Schedule:
T: Forged tee or reducing tee
S: Socolet
W: Weldolet

| HEADER | BRANCH | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 12(1/2”) | 20(3/4”) | 25(1”) | 32(1-1/4”) | 38(1-1/2”) | 50(2”) | 65(2-1/2”) | 75(3”) | 100(4”) | 150(6”) | 200(8”) | 250(10”) | 300(12”) |
| | 12(1/2”) | T | | | | | | | | | | | | |
| | 20(3/4”) | T | T | | | | | | | | | | | |
| | 25(1”) | T | T | T | | | | | | | | | | |
| | 32(1-1/4”) | T | T | T | T | | | | | | | | | |
| | 38(1-1/2”) | T | T | T | T | T | | | | | | | | |
| | 50(2”) | S | S | S | T | T | T | | | | | | | |
| | 65(2-1/2”) | S | S | S | S | T | T | T | | | | | | |
| | 75(3”) | S | S | S | S | S | T | T | T | | | | | |
| | 100(4”) | S | S | S | S | S | T | T | T | T | | | | |
| | 150(6”) | S | S | S | S | S | W | T | T | T | T | | | |
| | 200(8”) | S | S | S | S | S | W | W | W | T | T | T | | |
| | 250(10”) | S | S | S | S | S | W | W | W | W | T | T | T | |
| | 300(12”) | S | S | S | S | S | W | W | W | W | W | T | T | T |

**3.3 Inspection and Tests – General Requirements**

.1 Review all weld quality requirements and defect limits of applicable codes and standards with Contract Administrator before any work is started.

.2 Formulate "Inspection and Test Plan" in co-operation with Contract Administrator.

.3 Do not conceal welds until they have been inspected, tested and approved by inspector.

.4 Provide for inspector to visually inspect all welds during early stages of welding procedures in accordance with AWS W1. Repair or replace all defects as required by codes and as specified herein.

**3.4 Specialist Examinations and Tests**

.1 General

.1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Contract Administrator.

.2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.

.3 Inspect and test all welds in accordance with "Inspection and Test Plan" by non-destructive visual examination.

.2 Hydrostatically test all 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 any weld by visual examination, perform additional testing as directed by Contract Administrator of a total of up to 10% of all welds, selected at random by Contract Administrator by radiographic tests.

.5 Radiographic testing of piping systems following failure of visual examination:

.1 Spot radiography to CAN/CGSB-48.2:

.1 Conduct spot radiographic tests of tie-in welds, or welds selected at random by Contract Administrator from all welds which would be most difficult to repair in event of failure after system is operational.

.2 Radiographic film:

.1 Identify each radiographic film with date, location, name of welder, and submit to Contract Administrator. Replace film if rejected because of poor quality.

.3 Interpretation of radiographic films:

.1 To be by qualified radiographer.

.4 Failure of radiographic tests:

.1 If any weld fails tests, tests will be extended to all welds made by welder responsible.

**3.5 Defects Causing Rejection**

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

**3.6 Repair of Welds Which Failed Test**

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

**END OF SECTION**

## Part 1 General

### 1.1 General Conditions

.1 Mechanical General Conditions 15010 shall be part of this section.

### 1.2 Work Included

.1 The work described in this section includes testing work for the following systems:

.1 Plumbing and drainage.
.2 Domestic water supply.
.3 Plant water supply.
.4 Fire protection system.
.5 Heating water system.
.6 Natural gas piping.

## Part 2 Products

.1 Refer to relevant sections of specification for materials by system.

## Part 3 Execution

### 3.1 Test Requirements

.1 Plumbing and drainage shall be tested in full conformance with the requirements of the National Plumbing Code of Canada, and as required by local inspection authority.

.2 Domestic water and plant water piping shall be tested to a pressure of 350 KPa over the expected working pressure. Test to be completed with air over water and maintained over 6 hours with no loss.

.3 The fire protection system shall be inspected and tested as required by the Contract Administrator. Generally, all piping and fittings in the standpipe system shall be hydrostatically tested at a pressure of 1360 KPa for 2 hours without evidence of loss or leakage.

.4 The hot water heating systems shall be tested to a pressure of 690 KPa over the design working pressure, plus system height for a period of twelve (12) hours.

.5 Natural gas piping shall be tested as required by B149.1.

**3.2 Procedures**

.1 The testing of the individual systems shall be completed by the trade responsible for installing the system.

.2 Provide all necessary equipment and perform all work required to field test all piping systems, including all remedial and re-testing work.

.3 Clean all piping systems by flushing with water or blowing with air with all valves wide open prior to testing and before installing any primary element instrumentation on the piping systems.

.4 Timely notification shall be given to the Engineer of the schedule for all tests. A minimum of three working days is required to schedule witnessing of tests.

.5 All piping must pass all field tests in the presence of the Engineer.

.6 Completion of tests is not evidence of acceptance of tested part of Contract.

.7 No claim for damage will be made for injury or breakage of parts due to tests.

.8 Piping, which has to be concealed prior to the completion of the service as a whole, shall be tested in sections to the pressures and for the periods specified, prior to the piping being concealed.

.9 No insulation shall be applied until testing has been completed.

**END OF SECTION**

## Part 1 General

### 1.1 Related Sections

.1 Section 03300 Cast-in-Place Concrete

.2 Section 05500 Metal Fabrications

.3 Section 15010 – Mechanical General Requirements

### 1.2 References

.1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)

.1 ANSI/ASME B31.1- 2004, Power Piping, (SI Edition).

.2 American Society for Testing and Materials (ASTM)

.1 ASTM A125- 96(2001), Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307- 04, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563- 04a, Specification for Carbon and Alloy Steel Nuts.

.3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

.1 MSS SP-58- 2002, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 MSS SP-69-2003, Pipe Hangers and Supports - Selection and Application.

.3 MSS SP-89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.

### 1.3 Design Requirements

.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.

.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP-58.

.3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

.4 Design hangers and supports to support systems under all 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 to be in accordance with MSS SP-58.

**1.4 Shop Drawings and Product Data**

.1 Submit shop drawings and product data in accordance with Section 01330 - Submittal Procedures.

.2 Submit shop drawings and product data for following items:

.1 All bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

**1.5 Closeout Submittals**

.1 Provide maintenance data for incorporation into manual specified in Section 01780 - Closeout Submittals.

**Part 2 Products**

**2.1 General**

.1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP-58.

.2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

**2.2 Pipe Hangers**

.1 Finishes:

.1 Pipe hangers and supports: galvanized after manufacture for use in crawlspaces, outside installation, all plant process areas and all mechanical rooms.

.2 Use electro-plating galvanizing process or hot dipped galvanizing process.

.3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.

.2 Upper attachment structural: Suspension from lower flange of I-Beam.

.1 Cold piping NPS 2 maximum: Malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.

.1 Rod: 9 mm (3/8”) UL listed

.2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP-58 and MSS-SP-69.

.3 Upper attachment structural: Suspension from upper flange of I-Beam.

.1 Cold piping NPS 2 maximum: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed.

.2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut, UL listed.

.4 Upper attachment to concrete.

.1 Ceiling: Carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm (1/4") minimum greater than rod diameter.

.2 Concrete inserts: wedge shaped body with knockout protector plate, UL listed to MSS-SP-69.

.5 Shop and field-fabricated assemblies.

.1 Trapeze hanger assemblies: in accordance with requirements of ASME B31.1 and MSS-SP-58.

.2 Steel brackets: in accordance with requirements of ASME B31.1 and MSS-SP-58.

.6 Hanger rods: threaded rod material to MSS SP-58.

.1 Ensure that hanger rods are subject to tensile loading only.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.3 Do not use 22 mm (7/8") or 28mm (1 1/8") rod.

.7 Pipe attachments: material to MSS SP-58.

.1 Attachments for steel piping: carbon steel, galvanized finish.

.2 Attachments for copper piping: copper plated black steel.

.3 Use insulation shields for hot pipework.

.4 Oversize pipe hangers and supports to fit over insulation.

.8 Adjustable clevis: material to MSS SP-69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

.1 Ensure "U" has hole in bottom for rivetting to insulation shields.

.9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP-69.

.10 U-bolts: carbon steel to MSS SP-69 with 2 nuts at each end to ASTM A563.

.1 Finishes for steel pipework: galvanized.

.2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated.

.11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP-69.

**2.3 Riser Clamps**

.1 Steel or cast iron pipe: galvanized carbon steel to MSS-SP-58, type 42, UL listed.

.2 Copper pipe: carbon steel copper plated to MSS-SP-58, type 42.

.3 Bolts: to ASTM A307, or SAE GR5.

.4 Nuts: to ASTM A563, or SAE GR2.

**2.4 Insulation Protection Shields**

.1 Insulated cold piping:

.1 64 kg/$m^3$ (4 pcf) density insulation plus insulation protection shield to: MSS SP-69, galvanized sheet carbon steel. Length designed for maximum 3 m (10 ft.) span.

.2 Insulated hot piping:

.1 Curved plate 300 mm (12") long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP-69.

**2.5 Equipment Supports**

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of CAN/CSA-G40.20. Submit calculations with shop drawings.

**2.6 Equipment Anchor Bolts and Templates**

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

**2.7 Housekeeping Pads**

.1 For base-mounted equipment: Concrete, at least 100 mm (4") high, 50 mm (2") larger all around than equipment, and with chamfered edges.

**2.8 Anchors**

.1 Construct pipe anchors in accordance with Section 15010, the details shown on the drawings and as specified herein.

.2 Submit calculations and dimensional drawings, including welding procedures under the seal of a Professional Engineer registered in the Province of Manitoba.

**2.9 Seals**

.1 Annular space compression seals:

.1 Nitrile elastomeric segment elements, sized to suit pipe O.D. and opening I.D., compatible with diesel fuel and water.

.2 Glass reinforced nylon pressure plates.

.3 Type 304 stainless steel compression cap screw and nut.

.4 Service temperature: -40°C to +120°C (-40° to 250°F).

.5 Acceptable material: Thunderline “Link Seal”, service type “O”, or equivalent.

**Part 3 Execution**

**3.1 Workmanship**

.1 Hangers and supports are to secure all equipment in place, prevent vibration, maintain uniform slope and provide for expansion and contraction.

.2 Locate supports adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Review all drawings prior to drilling for inserts and supports for piping systems.

.4 Obtain Engineer’s approval prior to using percussion type fastenings.

.5 Use of piping or equipment for hanger supports or piercing of ductwork is not permitted.

.6 Use of perforated band iron, wire or chain as hangers is not permitted.

.7 Install all hangers, supports, anchors and seals in accordance with the manufacturer’s recommendations.

**3.2 Installation**

.1 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

.1 Install on piping systems at pumps, boilers, chillers, cooling towers, elsewhere as indicated.

.3 Clamps on riser piping:

.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.

.2 Bolt-tightening torques to be 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 The vertical movement of pipework is 13 mm (1/2") or more,

.2 The transfer of load to adjacent hangers or connected equipment is not permitted.

**3.3 Hanger Spacing**

.1 Plumbing piping: most stringent requirements of National Plumbing Code, or authority having jurisdiction.

.2 Fire protection: to applicable fire code.

.3 Gas piping: to CAN/CGA-B149.1 Natural Gas and Propane Installation Code.

.1 For piping up to NPS ½: provide supports every 1.8 m (6 ft.).

.4 Copper piping: up to NPS 1/2: every 1.5 m (5 ft.).

.5 Provide hangers for steel and copper piping systems as follows:

| Maximum Pipe Size: NPS | Maximum Spacing Steel | Maximum Spacing Copper |
|---|---|---|
| up to 1-1/4 | 2.1 m (7 ft.) | 1.8 m (6 ft.) |
| 1-1/2 | 2.7 m (9 ft.) | 2.4 m (8 ft.) |
| 2 | 3.0 m (10 ft.) | 2.7 m (9 ft.) |
| 2-1/2 | 3.6 m (12 ft.) | 3.0 m (10 ft.) |
| 3 | 3.6 m (12 ft.) | 3.0 m (10 ft.) |
| 3-1/2 | 3.9 m (13 ft.) | 3.3 m (11 ft.) |
| 4 | 4.2 m (14 ft.) | 3.6 m (12 ft.) |
| 5 | 4.8 m (16 ft.) | |
| 6 | 5.1 m (17 ft.) | |
| 8 | 5.7 m (19 ft.) | |
| 10 | 6.6 m (22 ft.) | |
| 12 | 6.9 m (23 ft.) | |

.6 Provide hangers within 300 mm (12") of each horizontal elbow.

.7 Pipework greater than NPS 12: to MSS SP-69.

.8 For flexible joint roll groove pipe, support in accordance with 3.3.6, but not less than one hanger at each joint.

**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 45° from vertical.

.2 Where horizontal pipe movement is less than 13 mm (1/2”), 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 .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 Seals Installation**

.1 Clean I.D. of opening cored or formed for seal to fit into.

.2 Remove all projections of materials which project into the cored opening or create an irregular surface for the seal to bear on.

.3 Assemble seal around pipe passing through opening.

.4 Position and tighten seal fasteners in accordance with the manufacturer's recommendations.

**3.8 Painting**

.1 Shall be in accordance with Section 09900 – Finish Painting.

.2 Supports, anchors and seals inaccessible after installation shall be painted prior to installation.

.3 All pipe supports, hangers and anchors that do not have a galvanized finish are to receive a minimum of two coats of corrosion resistant primer and two finish coats of colour specified for service, and as specified in Section 09911 and 09912. Galvanized parts will receive a minimum of one coat of primer and one coat of colour.

**END OF SECTION**

## Part 1 General

### 1.1 Shop Drawings

.1 Submit shop drawings in accordance with Section 01330 - Submittal Procedures.

.2 Provide separate shop drawings for each isolated system complete with performance and product data.

## Part 2 Products

### 2.1 General

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

### 2.2 Elastomeric Pads

.1 Type EP1 - neoprene waffle or ribbed; 9mm (3/8") minimum thick; 50 durometer; maximum loading 350 kPa (50 psi).

.2 Type EP2 - rubber waffle or ribbed; 9mm (3/8") minimum thick; 30 durometer natural rubber; maximum loading 415 kPa (60 psi).

.3 Type EP3 - neoprene-steel-neoprene; 9mm (3/8") minimum thick neoprene bonded to 1.71mm (1/16") steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa (50 psi).

.4 Type EP4 - rubber-steel-rubber; 9mm (3/8") minimum thick rubber bonded to 1.71mm (1/16") steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa (50 psi).

### 2.3 Elastomeric Mounts

.1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

### 2.4 Springs

.1 Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with levelling devices.

.2 Ratio of height when loaded to diameter of spring to be between 0.8 to 1.0.

.3 Cadmium plate for all installations.

.4 Colour code springs.

**2.5 Spring Mount**

.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.2 Type M2 - stable open spring: support on bonded 6mm (1/4") minimum thick ribbed neoprene or rubber friction and acoustic pad.

.3 Type M3 - stable open spring: 6mm (1/4") minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.

.4 Type M4 - restrained stable open spring: supported on bonded 6mm (1/4") minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.

.5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg (2000 lbs) maximum.

**2.6 Hangers**

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.

.2 Type H1 - neoprene - in-shear, molded with rod isolation bushing which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with molded isolation bushing which passes through hanger box.

.4 Type H3 - stable spring, elastomeric element, cup with molded isolation bushing which passes through hanger box.

.5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.

## Part 3 Execution

**3.1 Installation**

.1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.

.2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25mm (1") minimum static deflection as follows:

.1 Up to NPS4: first 3points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.

.2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 50mm (2").

.4 Where isolation is bolted to floor use vibration isolation rubber washers.

.5 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

**3.2 Site Visit**

.1 Manufacturer to visit site and provide written certification that installation is in accordance with manufacturer's instructions and submit report to Contract Administrator.

.2 Provide Contract Administrator with notice 48h in advance of visit.

.3 Make adjustments and corrections in accordance with written report.

**END OF SECTION**

## Part 1 General

### 1.1 Related Sections

.1 Section 09900- Finish Painting

### 1.2 Product Data

.1 Submit product data in accordance with Section 01330 - Submittal Procedures.

.2 Product data to include paint colour chips, all other products specified in this section.

### 1.3 Samples

.1 Submit samples in accordance with Section 01330 - Submittal Procedures.

.2 Samples to include nameplates, labels, tags, lists of proposed legends.

## Part 2 Products

### 2.1 Manufacturer's Equipment Nameplates

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers to be 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 3mm (1/8”) 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 | Size mm (inches) | No. of Lines | Height of Letters mm (inches) |
|---|---|---|---|
| 1 | 10 x 50 (3/8" x 2") | 1 | 3 (1/8") |
| 2 | 13 x 75 (1/2" x 3") | 1 | 5 (3/10") |
| 3 | 13 x 75 (1/2" x 3") | 2 | 3 (1/8") |
| 4 | 20 x 100 (3/4" x 4") | 1 | 8 (5/16") |
| 5 | 20 x 100 (3/4" x 4") | 2 | 5 (3/10") |
| 6 | 20 x 200 (3/4" x 8") | 1 | 8 (5/16") |
| 7 | 25 x 125 (1" x 5") | 1 | 12 (1/2") |
| 8 | 25 x 125 (1" x 5") | 2 | 8 (5/16") |
| 9 | 35 x 200 (1 3/8" x 8") | 1 | 20 (3/4") |

.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.

**2.3 Existing Identification Systems**

.1 Where existing identification system does not cover for new work, use identification system specified this section.

.2 Before starting work, obtain written approval of identification system from Engineer.

**2.4 Piping Systems Governed by Codes**

.1 Identification:

.1 Natural gas: To CAN/CGA B149.1.

.2 Propane gas: To CAN/CGA B149.2.

.3 Sprinklers: To NFPA13.

.4 Standpipe and hose systems: To NFPA14.

**2.5 Identification of Piping Systems**

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Pictograms:

.1 Where required, to 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 75mm (3”): 100mm (4”) long x 50mm (2”) high.

.2 Outside diameter of pipe or insulation 75mm (3”) and greater: 150mm (6”) long x 50mm (2”) 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 20mm (3/4”) and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 All other pipes: Pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100%RH and continuous operating temperature of 150°C (300°F) and intermittent temperature of 200°C (392°F).

.7 Colours and Legends:

.1 Where not listed, obtain direction from Engineer.

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

| Background colour: | Legend, arrows: |
|---|---|
| Yellow | Blacke |
| Green | White |
| Red | White |

.3 Background colour marking and legends for piping systems:

| Contents | Background Colour Marking | Legend |
|---|---|---|
| City water | Green | CITY WATER |
| Heating water supply | Yellow | HEATING SUPPLY |
| Heating water return | Yellow | HEATING RETURN |
| Heating glycol supply | Yellow | HEATING GLY SUPPLY |
| Heating glycol return | Yellow | HEATING GLY SUPPLY |
| Chilled drinking water | Green | CH. DRINK WTR |
| Drinking water return | Green | CH. DRINK WTR. CIRC |
| Domestic hot water supply | Green | DOM. HW SUPPLY |
| Dom. HWS recirculation | Green | DOM. HW CIRC |
| Domestic cold water supply | Green | DOM. CWS |

| Contents | Background Colour Marking | Legend |
|---|---|---|
| Waste water | Green | WASTE WATER |
| Storm water | Green | STORM |
| 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 |
| Natural gas | to Codes | |
| Gas regulator vents | to Codes | |
| Fire protection water | Red | FIRE PROT. WTR |
| Sprinklers | Red | SPRINKLERS |
| Conduit for low voltage control wiring | To Section 15950 | |

**2.6 Identification Ductwork Systems**

.1 50mm (2") high stencilled letters and directional arrows 150mm (6") long x 50mm (2") high.

.2 Colours: Black, or co-coordinated with base colour to ensure strong contrast.

**2.7 Valves, Controllers**

.1 Brass tags with 12mm (1/2") high 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.

**2.8 Controls Components Identification**

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

**2.9 Language**

.1 Identification to be in English.

## Part 3 Execution

### 3.1 Timing

.1 Provide identification only after all painting specified Section 09900 - Finish Painting has been completed.

### 3.2 Installation

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and/or CSA registration plates as required by respective agency.

### 3.3 Nameplates

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection

.1 Do not paint, insulate or cover in any way.

### 3.4 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 17m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 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, other confined spaces, at entry and exit points, and at each access opening.

.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, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification to be easily and accurately readable from usual operating areas and from access points.

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

**3.5 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 Engineer. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

**END OF SECTION**

## Part 1 General

### 1.1 Related Sections

.1 Section 15188 - HVAC Water Treatment Systems .

.2 Section 15950 - Testing, Adjusting and Balancing (TAB) of Mechanical Systems .

### 1.2 References

.1 American Society for Testing and Materials.

.1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

## Part 2 PRODUCTS

### 2.1 Cleaning Solutions

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system (1 lb. per 20 IG).

.2 Sodium carbonate: 0.40 kg per 100 L water in system (1 lb. per 20 IG).

.3 Low-foaming detergent: 0.01 kg per 100 L water in system (0.35 ounces per 20 IG).

## Part 3 Execution

### 3.1 Cleaning Hydronic and Steam Systems

.1 Timing

.1 Systems to be 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 to be 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 to be used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems

.1 Systems to be free from construction debris, dirt and other foreign material.

.2 Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers to be 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 Use water meter to record volume of water in system to +/- 0.5%.

.3 Add chemicals under direct supervision of chemical treatment supplier.

.4 Closed loop systems: circulate system cleaner at 60°C (140°F) for at least 36 hours. Drain as quickly as possible. Refill with water plus inhibitors. Test concentrations and adjust to recommended levels.

.5 Flush velocity in system mains and branches to be adequate so as to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.6 Add chemical solution to system.

.7 Establish circulation, raise temperature slowly to maximum design or 82°C (180°F) minimum. Circulate for 12 hours, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38°C (100°F). Drain as quickly as possible. Refill with clean water. Circulate for 6 hours 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 procedures specified herein.

.2 Test to prove concentration will prevent freezing to -40°C (-40°F). Test inhibitor strength and include in procedural report. Refer to ASTM E202.

**3.2 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 all 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 Section 15188 - 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 all other noises.

.10 Bring system up to design temperature and pressure slowly.

.11 Perform TAB as specified Section 15950 - Testing, Adjusting and Balancing (TAB) of Mechanical Systems.

.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 all bolts, etc. 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 all 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.

**END OF SECTION**

## Part 1 General

### 1.1 Related Sections

.1 Section 07840 - Firestopping.

.2 Section 15095 - Cleaning and Start-up of Mechanical Piping Systems.

## Part 2 Products

.1 Not Used.

## Part 3 Execution

### 3.1 Connections to Equipment

.1 In accordance with manufacturer's instructions unless otherwise indicated.

.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

### 3.2 Clearances

.1 Provide clearance around all systems, equipment and components for observation of operation, inspection, servicing, maintenance.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.

### 3.3 Drains

.1 Install piping with grade in direction of flow except as indicated or specified otherwise.

.2 Install drain valve where indicated on the drawings, at low points in piping systems, at equipment and at section isolating valves.

.3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or ball valves unless indicated otherwise, with hose end male thread, cap and chain.

**3.4 Air Vents**

.1 Install manual air vents at high points in piping systems.

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

**3.5 Dielectric Couplings**

.1 General: Compatible with system, to suit pressure rating of system.

.2 Locations: Where dissimilar metals are joined.

.3 NPS 2 and under: isolating unions or bronze valves.

.4 Over NPS 2: Isolating flanges.

**3.6 Pipework Installation**

.1 Provide clearances and access for maintenance of equipment, valves, fittings as specified and as per manufacturer's installation instructions.

.2 Install so that equipment can be isolated and removed without interruption to operation of any other equipment or systems.

.3 Assemble piping using fittings manufactured to ANSI standards.

.4 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of the main. Hole saw (or drill) and ream main so as to maintain full inside diameter of branch line prior to welding saddle.

.5 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.6 Install so as to minimize furring space, maximize headroom, conserve space.

.7 Except where indicated, install so as to permit separate thermal insulation of each pipe.

.8 Group piping wherever possible and as indicated.

.9 Ream pipes, remove scale and other foreign material before assembly.

.10 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.11 Valves: Install with stems above the horizontal position unless otherwise indicated.

**3.7 Sleeves**

.1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.

.2 Material: Schedule 40 black steel pipe.

.3 Construction: Foundation walls and where sleeves extend above finished floors - to have annular fins continuously welded on at mid-point.

.4 Sizes: 6 mm (1/4") minimum clearance all round between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:

.1 Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.

.2 All other floors: Terminate 25 mm (1") above finished floor.

.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

.6 Sealing:

.1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.

.2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.

.3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.

.4 Ensure no contact between copper pipe or tube and sleeve.

**3.8 Escutcheons**

.1 Install on all pipes passing through walls, partitions, floors, and ceilings in finished areas.

.2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.

.3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

**3.9 Preparation for Firestopping**

.1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07840 - Firestopping.

.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.

**3.10 Flushing out of Piping Systems**

.1 Before start-up, clean interior of piping systems in accordance with requirements of Section 01740 - Cleaning supplemented as specified in Section 15095- Cleaning and Start-up of Mechanical Piping Systems for all steam, hydronic heating and chilled water systems and all systems circulating glycol.

**3.11 Pressure Testing of Equipment and Pipework**

.1 Advise Contract Administrator 48 hours minimum prior to performance of pressure tests.

.2 Pipework:

.1 Hydraulically test hydronic piping systems at 1 ½ times system operating pressure or minimum 960 kPa (125 psi) whichever is greater.

.2 Test drainage, waste and vent piping to the National Plumbing Code and authorities having jurisdiction.

.3 Test domestic hot, cold and recirculation water piping at 1 ½ times system operating pressure or 960 kPa (125 psi) whichever is greater.

.4 Test fire systems in accordance with authorities having jurisdiction and as specified elsewhere.

.3 Maintain specified test pressure without loss for four (4) hours minimum unless specified for longer period of time elsewhere.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Conduct tests in presence of Engineer

.6 Bear costs for repairs or replacement, retesting, and making good. Contract Administrator to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by Engineer.

**3.12 Existing Systems**

.1 Connect into existing piping systems at times approved by Contract Administrator.

.2 Request written approval 10 days minimum, prior to commencement of work.

.3 Be responsible for damage to existing plant by this work.

.4 Ensure daily clean-up of existing areas.

**END OF SECTION**

## Part 1 General

### 1.1 General Conditions

.1 Mechanical General Conditions 15010 shall be part of this Section.

### 1.2 Scope

.1 Valves and strainers for domestic water service.

.2 Valves and strainers for the hydronic heating systems.

.3 Valves for natural gas service.

### 1.3 Manufacturer

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Provide valves with manufacturer's name and pressure rating clearly marked on the outside of the body.

### 1.4 Shop Drawings

.1 Submit detailed shop drawings clearly indicating make, model, size, pressure rating, materials of constructed and intended applications.

## Part 2 Products

### 2.1 Hot and Cold Domestic Water Service

.1 Gate valves up to 50 mm (2") (solder joint)

- .1 Solder joint bronze body, solid wedge disc, bronze trim, rising stem.
- .2 860 kPa (125 psig) rating.
- .3 Acceptable material: Crane #1334, Toyo #299 or Kitz #44.

.2 Gate valves up to 50 mm (2") (screwed ends)

- .1 Screwed bronze body, solid wedge disc, bronze trim, rising stem.
- .2 860 kPa (125 psig) rating.
- .3 Acceptable material: Crane #428 solid disc, Toyo #293 or Kitz #24.

.3 Gate valves 65 mm (2 ½") and larger

.1 Flanged cast iron body, solid wedge disc, bronze trim.

.2 Rising stem, outside screw and yoke.

.3 860 kPa (125 psig) rating.

.4 Acceptable material: Crane #465 ½, Toyo #421A or Kitz #72.

.4 Ball valves up to 50 mm (2") (solder joint)

.1 Solder joint brass 2 piece body, blow-out proof stem, PTFE seats, brass chrome plated ball, lever handle operator.

.2 1034 kPa (150 psig) rating.

.3 Acceptable material: Crane #F9222, Toyo #5049A or Kitz #69.

.5 Ball valves up to 50 mm (2") (screwed ends)

.1 Screwed brass 2 piece body, blow out proof stem, PTFE seats, brass chrome plated ball lever handle operator.

.2 1034 kPa (150 psig) rating.

.3 Acceptable material: Crane #F9202, Toyo #5044A or Kitz #68.

.6 Check valves (horizontal) up to 50 mm (2") (solder joint)

.1 Solder joint bronze body, bronze swing disc.

.2 860 kPa (125 psig) rating.

.3 Acceptable material: Crane #1342, Toyo #237 or Kitz #23.

.7 Check valves (horizontal) up to 50 mm (2") (screwed joint)

.1 Screwed bronze body, bronze swing disc.

.2 860 kPa (125 psig) rating.

.3 Acceptable material: Crane #37, Toyo #236 or Kitz #22.

.8 Check valves (horizontal) 65 mm (2 ½") and larger

.1 Flanged cast iron body, bronze or cast iron swing disc, bronze trim.

.2 860 kPa (125 psig) rating.

.3 Acceptable material: Crane #373, Toyo #435A or Kitz #78.

.9 Check valves (vertical upward flow) up to 50 mm (2")

.1 Solder joint bronze, bronze disc.

.2 860 kPa (125 psig) rating.

.3 Acceptable material: Kitz #26.

.10 Check valves (vertical upward flow) 65 mm (2 ½") and larger

.1 Wafer style cast iron body, viton "A" body seat, 304SS clapper, arm and pin, 304SS spring.

.2 PTFE thrust washer.

.3 860 kPa (125 psig) rating.

.4 Acceptable material: Moyes & Groves W12A-16V, or Center Line Series #800.

.11 Butterfly valves 65 mm (2 ½") and larger

.1 Threaded lug style cast iron body

.2 EPDM seat liner

.3 S.S. disc

.4 403SS Stem

.5 10 position lever lock handle operator 150 mm and smaller

.6 1380 kPa (200 psig) rating

.7 Acceptable material: Keystone Fig. #AR2-805 or approved equal, Bray Series #31 or Center Line L200L/G200L (EPDM) or approved equal

.12 Drain valves: shut off 20 mm (3/4") and 25 mm (1")

.1 Screwed brass 2 piece body ball valve, blow-out proof stem, PTFE seats, brass chrome plated ball, hose end connection with cap and chain

.2 1034 kPa (150 psig) rating

.3 Acceptable material: Toyo #5046 or Kitz Fig. 58CC

.13 Strainers: up to 50 mm (2")

.1 Screwed bronze "Y" pattern body, 304SS screen

.2 1034 kPa (150 psig) rating

.3 Acceptable material: Watts #777S, Toyo #380 or Kitz #15

.14 Strainers: 65 mm (2 ½") and larger

.1 Flanged cast iron "Y" pattern body, 304SS screen

.2 860 kPa (125 psig) rating

.3 Acceptable material: Toyo #318A or Kitz Fig. 80

**2.2 Heating, Ventilation and Air Conditioning Service**

.1 Gate valves: up to 50 mm (2")

.1 Screwed bronze body, solid wedge disc, bronze trim, rising stem

.2 860 kPa (125 psig) rating

.3 Acceptable material: Crane #428, Toyo #293 or Kitz Fig. 24

.4 Acceptable material: Crane #438, Toyo #280A or Kitz Fig. 40

.2 Gate valves: 65 mm (2 ½") and larger

.1 Cast iron body, bronze trim, rising stem, solid wedge, flanged ends.

.2 860 kPa (125 psig) rating

.3 Acceptable material: Crane #465 ½, Toyo #421A or Kitz Fig. 72.

Note: If there is insufficient clearance for a rising stem valve, use a non-rising stem valve.

.4 Acceptable material: Crane #461, Toyo 415A or Kitz Fig. 75

.3 Check valves (horizontal): up to 50 mm (2")

.1 Screwed bronze body, bronze swing disc

.2 860 kPa (125 psig) rating

.3 Acceptable material: Crane #37, Toyo #236 or Kitz Fig. 22

.4 Check valves (horizontal): 65 mm (2 ½") and larger

.1 Flanged cast iron body, bronze or cast iron swing disc, bronze trim

.2 860 kPa (125 psig) rating

.3 Acceptable material: Crane #373, Toyo #435A or Kitz Fig. 78

.5 Check valves (vertical upward flow): up to 50 mm (2")

.1 Screwed bronze body, bronze disc

.2 860 kPa (125 psig) rating

.3 Acceptable material: Crane #29, Toyo #231 or Kitz Fig. 36

.6 Check valves (vertical upward flow): 65 mm (2 ½") and larger

.1 Wafer style cast iron body, viton "A" body seat, 304SS clapper, arm and pin, 302SS spring

.2 PTFE thrust washer

.3 860 kPa (125 psig) rating

.4 Acceptable material: Moyes and Groves Fig. W12A-16V or Center Line Series #800.

.7 Butterfly valves: 65 mm (2 ½") and larger

.1 Wafer style or threaded lug style cast iron body

.2 EPDM seat liner

.3 Bronze disc

.4 403SS stem

.5 10 position lever-lock handle operator 150 mm and smaller

.6 For installation between Class 125/150 flanges

.7 1380 kPa (200 psig) rating

.8 Acceptable material: Keystone Fig. #AR2-805, Bray Series #31 or Center Line L200L/G200L (EPDM) (Lug style)

.8 Balance fittings and valves: up to 30 mm (1 ¼"): return side of heating elements

.1 Female by male union bronze body, Teflon disc
.2 Internal adjustable balancing stem
.3 Globe type
.4 (LS) Lockshield
.5 690 kPa (100 psig) rating
.6 Straight pattern or angle pattern
.7 Acceptable material: Toyo Fig. 250 or 251 or Kitz Fig. 100, 101, 102, 103

.9 Drain valves and hose bibs: up to 50 mm (2")

.1 Screwed brass 2 piece body ball valve, blow-out proof stem, PTFE seats, brass chrome-plated ball hose end connection with cap and chain
.2 1034 kPa (150 psig) rating
.3 Acceptable material: Toyo #5046 or approved equal, Kitz Fig. 58CC

.10 Strainers: up to 50 mm (2")

.1 Screwed bronze "Y" pattern body, 304SS screen
.2 1034 kPa (150 psig) rating
.3 Acceptable material: Watts #777S, Toyo #380 or Kitz Fig. 15

.11 Strainers: 65 mm (2 ½") and larger

.1 Flanged cast iron "Y" pattern body, 304SS screen
.2 860 kPa (125 psig) rating
.3 Acceptable material: Sarco, Toyo #318A or Kitz Fig. 80

.12 Suction diffuser

.1 For base mounted or floor mounted vertical inline pumps.
.2 Cast iron construction, NPT connections up to 50 mm: flanged connections.
.3 Over 65 mm: cast iron straightening fitting, stainless steel combination diffuser – strainer – orifice cylinder with 4.8 mm perforations, and permanent magnet. Provide complete with a 16 mesh bronze strainer.

**2.3 Valves for Natural Gas**

.1 Ball valves: 12 mm (1/2") to 50 mm (2")

.1 Brass body, nickel chrome plated ball, threaded ends, quarter turn operation.
.2 CGA approved for natural gas.
.3 860 kPa (125 psi) rated.
.4 Acceptable material: Newman Hattersly Fig. 1969 CGA.

.2 Plug valves: 50 mm (2") and larger

.1 Cast iron body, lubricated plug valve, full bore, Class 125, flanged to ANSI B16.1

.2 CGA approved for natural gas.

.3 100 mm (4") and smaller: wrench operated.

.4 150 mm (6") and larger: gear operated.

.5 Acceptable material: Newman Hattersby, Figure 201M wrench operated and Figure 201 MG gear operated.

## Part 3 Execution

### 3.1 Installation and Application Valves

.1 Install valves with stem upright or horizontal, not inverted.

.2 Provide valves for isolation of all equipment and as shown. Valve type to suit line size.

.3 Provide threaded lug type butterfly valves for equipment isolation service. Provide wafer or threaded lug type valves for zone shut-off service.

.4 Where permitted by codes, butterfly valves may be used in fire protection systems.

.5 Use ball valves in water systems for throttling/balancing service.

.6 For radiant panels and water and glycol system terminal heat transfer units, provide "circuit setter" valves on return line for each zone; and a ball valve for shut-off service.

.7 Provide drain valves at main shut-off valves, low points of piping and apparatus and terminal units.

.8 Size drain lines and drain valves equal to size of apparatus drain connection.

.9 For pipe sizes 20 mm and over, minimum drain size to be 20 mm.

.10 Provide hose thread connection with cap and chain for 20 mm drain valves located in ceiling and public areas.

.11 Provide male NPT nipples with threaded pipe cap for drain sizes over 20 mm where not piped directly to floor drains.

.12 Provide valved drain and hose connections off the bottom of all strainers.

**3.2 Installation and Application 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 and as indicated.

**END OF SECTION**

## Part 1 General

### 1.1 General Conditions

.1 Mechanical General Conditions 15010 shall be part of this Section.

### 1.2 Scope

.1 Provide meters and gauges and taps where shown on drawings and/or specified herein.

.2 Submit shop drawings of proposed products to the Contract Administrator for review.

.3 Submit data sheets on thermometers and pressure gauges indicating service, and temperature or pressure ranges to the Contract Administrator for review.

## Part 2 Products

### 2.1 Thermometers

.1 Dial Thermometers: 3 ½" diameter dial in drawn stainless steel case, stainless steel liquid sensing bulb actuated, brass separable socket of flange and bushing, glass cover, adjustable pointer.

.2 Liquid Thermometer: Red reading non-mercury filled, 2° graduations, aluminium case, 230 mm (9") scale, straight shank, separable socket, adjustable angle.

.3 Acceptable material: Trerice Model L80030-100-B32 sensing range 30-180°F.

### 2.2 Thermometer Well

.1 Copper pipe: copper or bronze.

.2 Steel pipe: brass or stainless steel.

### 2.3 Pressure Gauges

.1 100 mm (4") diameter, drawn stainless steel case, phosphor bronze bourdon tube, brass movement, extruded brass socket, 1% full scale accuracy, front calibration adjustment, black figures on white background. Provide gauge cock and siphon for ½" male NPT system connection steam service, pulsating damper and pet cock for water service. Compound gauge for all pump suctions and vacuum service.

.2 Acceptable material: Trevice A700 Series.

**2.4 Pressure Gauge Taps**

.1 Ball valve as specified in Section 15111 – Valves and Strainers.

**2.5 Static Pressure Gauges**

.1 Dial Gauge: 100 mm (4") dial, diaphragm actuated, suitable for positive, negative or differential pressure measurement. Accuracy within +2% of full scale, complete with static pressure tips and mounting accessories.

.1 Acceptable material: Dwyer.

.2 Inclined Vertical Manometer: Molded plastic manometer, accuracy within +3% of full scale, suitable for positive, negative or differential pressure measurement, complete with static pressure tips and mounting accuracy.

.1 Acceptable material: Dwyer.

**Part 3 Execution**

**3.1 Installation**

.1 Provide one pressure gauge per pump installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

.2 Select gauges so that normal operating point is approximately mid-point of instrument range.

.3 On pipes 65 mm (2 ½") and smaller, place well in tee used in lieu of an elbow to accommodate well.

**3.2 Meters and Gauges Installation Schedule**

.1 Pressure Gauges:

.1 Pumps, inlet and outlet
.2 Standpipe – highest and lowest point of risers
.3 Domestic cold water to standpipe and/or sprinkler
.4 Steam header
.5 Leaving side of automatic make-up valves
.6 and where shown on drawings

.2 Pressure Gauge Taps:

.1 Both sides of two-way control valves
.2 All lines to three-way control valves
.3 Major coils, inlet and outlet

.4 Heat exchangers, inlet and outlet, tube and shell side
.5 Chillers, inlet and outlet
.6 and where shown on drawings

.3 Thermometers:

.1 Supply and return headers of central equipment
.2 Heat exchangers, inlet and outlet tube and shell side
.3 Heating and cooling coils, inlet and outlet
.4 and where shown on drawings

.4 Static Pressure Gauges:

.1 Across built-up filter banks
.2 Across unitary filter sections
.3 and where shown on drawings

**END OF SECTION**

## Part 1 General

### 1.1 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 15010 – Mechanical General Requirements.

.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.

.3 Submit product data of pump curves for review showing point of operation.

.4 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

### 1.2 Closeout Submittals

.1 Provide maintenance data for incorporation into manual specified in Section 01002 – General Instructions.

### 1.3 Extra Materials

.1 Provide maintenance materials in accordance with Section 01002 – General Instructions.

## Part 2 Products

### 2.1 Single Suction Centrifugal Pump (P-1/P-2)

.1 General: bronze fitted pump complete with motor.

.2 Base: structural steel or fabricated steel with fully enclosed sides and ends. Full seam welds, open top.

.3 Volute: cast iron radially split, end suction, flanged suction and discharge, with drain plug and vent cook, suction and discharge pressure gauge tappings. Integrally cast pedestal support feet.

.4 Impeller: cast bronze, keyed to shaft and secured with locking nut or screw.

.5 Shaft: alloy steel. Pump bearing hosing to have heavy duty regreasable ball bearings, replaceable without disturbing piping connections.

.6 Seal assembly: internally flushed mechanical seal.

.7 Coupling: flexible, suitable for absorbing torsional vibration. To come with coupling guard.

.8 Motor: continuous duty, drip proof, ball bearing, maximum temperature rise 50°C.

.9 Capacity: as scheduled.

.10 Design pressure and temperature: 107°C (225°F) and 1200 kPa (175 psi).

.11 Acceptable material: Bell & Gossett, Taco, Armstrong.

## Part 3 Execution

### 3.1 Installation

.1 In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible.

.2 Base mounted type: supply templates for anchor bolt placement. Furnish anchor bolts with sleeves. Place level, shim unit and grout. Align coupling in accordance with manufacturer's recommendation tolerance. Check oil level and lubricate.

.3 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

.4 Pipe drain tapping to drain.

.5 Install volute venting pet cock in accessible location.

.6 Check rotation prior to start-up.

**END OF SECTION**

## Part 1 General

### 1.1 Description

.1 Comply with requirements of Division 1 and Section 15010.

.2 All drawings and all sections of the specifications shall apply to and form an integral part of this section.

.3 Contract documents of this section are diagrammatic and approximate to scale. The drawings and specifications establish scope for material and installation quality and are **not** detailed installation instructions. Follow Manufacturer's recommendations for installation supplemented by contract documents.

### 1.2 Work Performed By This Section

.1 Labour, material, plant, tools, equipment and services for the supply and installation of piping, ductwork, and equipment insulation.

### 1.3 Quality Assurance

.1 Qualifications: Execute work of this section only by certified tradespeople, regularly employed in the application of insulation to piping, ductwork, plenums, tanks, pressure vessels, equipment casings and heating panels for building heating, cooling, ventilating and plumbing systems.

.2 Insulation, self adhesive tape, adhesives and any insulation finishes to be ULC labelled and listed for flame spread rating of less than 25 and smoke development classification of less than 50.

### 1.4 Definitions

.1 The word "exposed", where used in this Section, means any work, which is not concealed in wall, shaft, or ceiling cavities or spaces. Work behind doors in closets or cupboards or under counters is considered exposed.

## Part 2 Products

### 2.1 Materials

.1 All insulation systems shall have composite (insulation, jacket and adhesive used to adhere the jacket to the insulation) Fire and Smoke Hazard ratings as tested under procedure ASTM E 84, NFPA 225, or UL 723.

.2 Never is asbestos in any form to be used for any type of insulation work. All products must be certified “asbestos free”.

.3 All final pipe and duct installations including insulation, covering and adhesive shall have a flame spread rating of not greater than 25.

.4 All canvas shall be treated to be fire retardant in accordance with ULC standards.

.5 Wire to be 1.2mm (18 ga.) soft annealed, type 304 stainless steel,.

.6 U.L.C. label or satisfactory certified report from approved testing laboratory is required to demonstrate that the fire hazard ratings for materials proposed for use do not exceed those specified.

.7 Flame proofing treatments subject to deterioration due to effects of high humidity are not acceptable.

.8 The Contract Administrator reserves the right to demand test samples of components of insulation systems for fire and smoke hazard ratings.

.9 In general, piping systems shall be insulated with fibreglass piping insulation with an all-purpose jacket. Fittings, flanges, and valves shall be insulated with fibreglass inserts and pre-molded polyvinyl or PVC jackets.

.10 Duct systems to be insulated with fibreglass duct insulation with an all-purpose jacket.

.11 Refrigerant piping systems shall be insulated with elastomeric pipe insulation.

.12 Special insulation protection shall be considered for areas subject to abuse and moisture, as indicated.

## 2.2 Compatibility of Components

.1 All adhesives, sealers, vapour coating, mastics, laggings and bedding compounds, shall be compatible with materials to which they are applied. They shall not soften, corrode, or otherwise attack such material in either wet or dry state. Materials shall only be those recommended by manufacturer or insulation as suitable for application proposed and be applied within ambient temperature range recommended by the manufacturer.

## 2.3 Insulation

.1 Premolded fibreglass pipe insulation

.1 ULC Listed sectional fibreglass pipe insulation in compliance with ASTM C547 in pre-moulded sections 900 mm (36") long, split and ready for application with a minimum Thermal Conductivity of 0.033 W/m°C (0.23 Btu.in/h.ft$^2$°F) at 24°C (75°F) mean temperature and be capable of use on service from -18°C to 454°C

(0°F to 850°F) and with factory applied vapour seal jacket of vinyl coated foil Kraft laminate with reinforcing of open mesh glass fibre. Jacketing with factory applied double pressure sensitive adhesive system.

.2 Acceptable material: Owens Corning Fiberglas SSL-II.

.2 Pipe and tank insulation

.1 ULC listed fibreglass semi-rigid board, factory jacketed with a laminated kraft-aluminum foil all service jacket. A minimum thermal conductivity of 0.039 W/m°C (0.27 Btu.in/h.ft$^2$°F) at 24°C (75°F) mean temperature. Suitable for an operating range of -18°C to 343°C (0°F to 650°F).

.2 Acceptable material: Owens Corning Fibreglass Pipe and Tank Insulation.

.3 Vapourwick pipe insulation

.1 ULC listed sectional fibreglass pipe insulation in compliance with ASTM C547 in pre-moulded sections 900 mm (36”) long, split and ready for installation. Minimum thermal conductivity of 0.034 W/m°C (0.24 Btu in/h.ft$^2$°F) at 25°C (75°F) mean temperature. Operating temperature range of 0°C to 104°C (32°F to 220°F). Synthetic wicking material on inner surface of insulation to assist in transporting moisture to the outside of the system. Factory jacketed with a polymer facing. Insulation to be provided as a system including wick material for use on valves and fittings and matching butt joint sealing tape.

.2 Acceptable material: Owens Corning Vapourwick.

.4 High temperature pipe insulation:

.1 ULC listed pre-moulded mineral fibre (non-asbestos) insulation in compliance with ASTM C547. 900 mm (36”) long, split and hinged. Minimum thermal conductivity of 0.059 W/m°C (0.41 Btu.in/h.ft$^2$°F) at a mean temperature of 204°C (400°F). Service temperature of -84°C to 649°C (-120°F to 1200°F)

.2 Acceptable material: Fibrex Coreplus 1200.

.5 Elastomeric pipe insulation:

.1 ULC listed, flexible elastomeric insulation, pre-slit with factory applied sealing system. Minimum thermal conductivity of 0.039 W/m°C (0.27 Btu.in/h.ft$^2$°F) at 25°C (75°F) mean temperature. Operating temperature range of -57°C to 104°C (-70°F to 220°F).

.2 Acceptable material: AP Armaflex SS.

.6 Duct insulation: board

.1 ULC listed semi-rigid board, nominal density 48 kg/m$^3$ (3 pcf). Minimal thermal conductivity of 0.036 W/m°C (0.25 Btu.n/h.ft$^2$°F) at 25°C (75°F) mean temperature. Operating temperature to 232°C (450°F). Factory applied foil reinforced kraft (FRK).

.2 Acceptable material: Owens Corning Fibreglass 703.

.7 Duct insulation: flexible

.1 ULC listed, flexible blanket of glass fibre insulation, factory laminated to foil reinforced kraft (FRK). Operating temperatures to 121°C (250°F). Minimum thermal conductivity of 0.039 W/m°C (0.27 Btu.in/h.ft$^2$°F) at mean temperature of 25°C (75°F). Nominal density of 16 kg/m$^3$ (1.0 pcf).

.2 Acceptable material: Owens Corning All Service Duct Wrap Type 100.

.8 Elastomeric: sheet

.1 ULC listed, flexible, elastomeric, thermal insulation. Expanded closed cell. Minimum thermal conductivity of 0.039 W/m°C (0.27 Btu.in/h.ft$^2$°F) at a mean temperature of 25°C (75°F). Operating temperature range of -57°C to 104°C (-70°F to 220°F). Self-adhering.

.2 Acceptable material: AP Armaflex SA.

**2.4 Finishes and Protective Coverings**

.1 Canvas: 170 g/m$^2$ w (0.6 ounces/ft$^2$) with lagging adhesive, ULC labelled.

.2 Aluminum: Protective covering to be 0.5 mm (0.020") thick Childers aluminium pre-formed covering complete with matching strapping and seals. The texture of both the lagging and fittings shall be stucco embossed.

.3 Trowelled-on weather protective coating: Bakor 110-14 asphalt mastic vapour barrier coating.

**2.5 Insulation Protection Shields**

.1 Insulation protection shields shall be installed at all pipe hangers and supports. Shields shall span an arc of 180°.

.2 A 1.2 mm thick (18 gauge) stainless steel shield shall be installed fully over all insulated piping located on the roof. The shield shall be a minimum length of 900 mm (36") and field located to prevent damage to the insulation while walking over the piping.

## Part 3 Execution

**3.1 Installation**

.1 Insulation shall be applied on clean, dry surfaces and only after tests and approvals required by the specifications have been completed.

.2 All pipe insulation on piping operating below ambient temperature shall be continuous through wall and ceiling openings and sleeves.

.3 Insulation on all cold surfaces must be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold surfaces shall be adequately insulated and vapor sealed to prevent condensation.

.4 Specified adhesives, mastics, and coatings shall be applied at the manufacturer's recommended minimum coverage per gallon.

.5 Edges of vapor barrier insulation at valve stems, instrument wells, unions, and other raw edges shall be sealed adequately to prevent moisture from penetrating the insulation.

**3.2 Workmanship**

.1 Work shall be performed by licensed journeymen.

.2 Apply insulation materials, accessories and finishes in accordance with Manufacturer’s recommendations.

.3 Do not apply coverings until hydrostatic tests have been completed, surfaces are free of grease, scale, moisture, and heat tracing where required has been installed. Insulation shall be clean and dry when installed and during application of any finish.

.4 Cold surfaces to be dry and ferrous surfaces to be coated with rust penetrating protective paint before applying insulation and vapour barriers.

.5 Vapour barriers and insulation to be complete over full length of pipe or surface, without penetration for hangers, duct or seams, and without interruption at sleeves, pipe and fittings.

.6 Install insulation with smooth and even surfaces, with round shapes laid to true circular and concentric shape, shaped to blend with fitting insulation and adjacent covering; with full length section and tight to insulated object.

.7 Pack solid around all pipes where they pass through sleeves in walls, floor slabs, etc. for full thickness of floor with fibreglass or rockwool. Insulated pipes having vapour barrier jacket to pass through wall, floors, etc. to accommodate full insulation thickness. Protect insulation of exposed pipes passing through floors with 1.2mm (18 ga.) galvanized iron 150mm (6") from finished floor.

.8 On piping, gouge out insulation for proper fit where there is interference between weld bead and insulation. Bevel insulation away from studs and nuts to permit their removal without damage to insulation. Closely and neatly trim around extending parts of pipe saddles, supports, hangers and clamp guides. Seal with insulating cement.

.9 Use pipe covering protection saddles with roll type hangers unless otherwise indicated.

.10 Butt joints

.1 Place joints on top of duct wherever practical. Butt joints on side of duct for flexible duct insulation.

.2 Adhere and seal laps of vapour barrier cover or vapour barrier strip of 100mm (4") minimum width furnished with insulation, using vapour seal adhesives.

.11 Sagging of duct insulation will not be acceptable.

.12 Stagger both longitudinal and horizontal joints, on duct insulation of multi-layered construction.

.13 Duct insulation with vapour barrier shall be continuous, except at fire dampers.

.14 Ducts acoustically lined need no external insulation, unless specifically noted otherwise.

.15 Existing duct and pipe covering damaged or cut back during installation work to be made good with same insulation as specified for new work.

.16 Protect insulation against elements during all stages of application.

.17 Do not cover Manufacturer's nameplates on equipment. Cut insulation on 45 deg. angle to nameplate edge and seal.

.18 Covering to be uniform in diameter, smooth in finish. Place longitudinal seams so as to be invisible.

**3.3 Pipe Insulation**

.1 Fibreglass

.1 Insulate all piping flanges, fittings and valve bodies, etc. Insulate valve bonnets on chilled water systems.

.2 Fasten longitudinal laps with staples and seal with Swifts Adhesive #3218.

.3 Butt joints wrapped with a 100mm (4") strip of ASJ. Stagger joints on multiple layers.

.4 Refinish exposed piping with brush coat of Flintguard No. 120 white fire retardant lagging adhesive.

.5 45° and 90° to be insulated with Aercore, lagged on both sides, mudded then canvassed and lagged. Surface shall be wrapped with Friction Tape and sealed with an asphaltic sealing compound. Over this to be applied a smooth coating of insulating cement. Recover fittings with ASJ vapour seal jacket and brush coat with fire retardant white lagging adhesive.

.2 Elastomeric

.1 Insulate all piping, flanges, fittings and valve bodies.

.2 Apply to clean dry pipe.

.3 Snap pre-slit tubing over piping. Remove the release paper and the protective strip from the adhesive film. Apply firm pressure along the joint.

.4 Secure butt joints with manufacturer's approved adhesive.

.5 Use larger insulation sizes at flange, etc. to suit.

.6 Do not install at temperatures below 10°C (50°F) or above 35°C (95°F).

.7 Install manufacturer's approved finish when installed outside.

**3.4 Vapour Barrier Flexible Duct Insulation**

.1 Rectangular Ductwork

.1 On ducts 600mm (24") wide and wider apply welded pin fasteners to bottom surface of duct by impaling on welded pins on 300mm (12") centres. Spot adhesive on 300mm (12") centres on all sides of duct. Apply insulation with edges tightly butted together and secured with 100% coverage of 3-M No. 17 or approved alternate. Staple joints and seal with 100mm (4") strips of vapor barrier foil of same quality as duct insulation membrane sealed with BF 85-15.

.2 After installation of fasteners, cut pins and apply foil tape to cover completely.

.3 On ducts 575mm (23") wide or less insulation applied as above but welded pins may be omitted.

.2 Round Ducts

.1 Adhere to duct surface applied in strips 150mm (6") wide, 300mm (12") o.c. Butt all edges of insulation, staple and seal all joints with tape adhered over the joint. Seal all breaks with vapor barrier type.

.3 Exposed Ducts Indoors

.1 Recover ducts exposed to view with 170 g. (6 oz.) canvas secured with Flintguard No. 120 white fire retardant lagging adhesive. Finish with brush coat of same adhesive.

**3.5 Vapour Barrier Rigid Insulation**

.1 Insulation applied with edges tightly butted and secured by impaling on pins welded to duct. Pins to be staggered, minimum 300mm (12") o.c. in every direction. This applies to all sides. Secure insulation to pins with metal fasteners. Pins shall be long enough to bend after fasteners have been applied. Install two fasteners to all insulation on roof. Dab adhesive over pins and fasteners.

.2 After installation of fasteners, cut pins and apply foil tape to cover completely.

.3 Seal all joints, edges and breaks in vapor seal jacket with vapor barrier foil of the same quality as that of duct membrane 100mm (4") wide with BF 85-15 lagging adhesive.

.4 Wrap exposed ducts with fire retardant paper recovered with 170 g. (6 oz.) canvas secured with Flintguard No. 120 white fire retardant lagging. Brush coat with same adhesive. Do not use staples.

**3.6 Equipment and Miscellaneous Applications**

.1 Water meter, hydropneumatic tank, domestic water booster pump casing and chilled water pump casings: 25mm (1") thick blanket insulation. On steel or cast iron surfaces, apply one coat of Densopaste Primer prior to applying insulation. Apply flexible blanket insulation and seal all joints in vapour seal facing with self-adhesive foil tape. Finish with insulating cement and canvas.

.2 Heat exchangers and tanks: shell and tube type and hot water storage tanks: 50mm (2") thick rigid board or pre-formed. Score and mitre to fit contours of equipment and secure with 12mm x 0.38mm (½" x 0.015") galvanized steel bands 600mm (24") OC. Point up all joints with insulating cement. Finish with specified canvas. Do not insulate over registration and nameplates.

.3 Chiller vessels and refrigerant suction lines: 20mm ( 3/4") fire retardant closed cell Armaflex on evaporator, suction piping, and chilled water headers. Apply Armaflex with suitable adhesive and seal all joints with suitable plastic tape. For chiller heads, provide one or two-piece slip-on field fabricated and fitted sections held in place with metal bands with screwdriver operated tightening devices. Cover all Armaflex with specified canvas. Do not insulate over registration and nameplates.

.4 Drains and water supplies for wall hung handicapped lavatories: blanket type on exposed water supplies and drain under lavatory. Finish with canvas.

.5 Radiant Ceiling Panels: Provide 50mm (2") thick fibreglass batt insulation over all active sections of radiant ceiling panels as shown on drawings.

.6 Test ports and areas which must be accessed for maintenance or testing, shall be insulated using techniques that allow for easy removal and reinstallation without re-insulating.

**3.7 Finishes**

.1 Canvas over insulated items where exposed indoors and cover with 2 coats of lagging installed to manufacturer’s specifications.

.2 Install 0.5 mm thick (28 ga) aluminium over all insulated piping exposed to outdoors.

.3 Weatherproof mastic, two 3 mm (1/8”) thick coats trowelled smooth over mesh screen on all ductwork insulation where exposed outdoors.

.4 Breeching Insulation: Apply 13mm (½") coat of hydraulic setting insulating cement trowelled smooth over metal mesh.

**3.8 Radiant Panels**

.1 Radiant ceiling panels: lay insulation over active sections only.

**3.9 Application Schedule**

.1 Ductwork:

| | Location/Service | Insulation Thickness | Type |
|---|---|---|---|
| .1 | Supply ductwork in unconditioned spaces and where indicated on drawings | 25 mm (1”) | See Note 1 |
| .2 | All ductwork conveying unheated outside air in a heated building space | 50 mm (2”) | See Note 1 |
| .3 | Combustion air ducts | 25 mm (1”) | Duct board |
| .4 | All ductwork conveying heated air in an unheated building area or outside a building | 50 mm (2”) | See Note 1 |
| .5 | Ducts penetrating an exterior building surface (last 3 m (10 feet)) | 25 mm (1”) | See Note 1 |
| .6 | Relief air ducts | 25 mm (1”) | See Note 1 |
| .7 | Drip pans | 25 mm (1”) | Elastomeric |

Notes:

1. Utilize duct blanket insulation on all round ductwork and all rectangular supply ductwork less than 1200 mm wide (48”).

.2 Piping:

| | Location/Service | Insulation Thickness | Type |
|---|---|---|---|
| .1 | Heating supply and return (water or glycol)<br>20 mm (¾”) and smaller piping<br>25 mm to 37 mm (1” to 1 ½”) piping<br>over 50 mm (2”) | <br><br>25 mm (1”)<br>37 mm (1 ½”)<br>50 mm (2”) | <br><br>Fibreglass pipe<br>Fibreglass pipe<br>Fibreglass pipe |
| .2 | Domestic cold water | 25 mm (1”) | Vapourwick |
| .3 | Domestic hot and recirculation | 25 mm (1”) | Fibreglass pipe |
| .4 | Refrigerant suction lines | 25 mm (1”) | Elastomeric |
| .5 | Plumbing vents (last 3 m (10 ft) in ceiling space) | 12 mm (1/2”) | Fibreglass pipe |
| .6 | Rain water leaders and drain bodies | 25 mm (1”) | Elastomeric or Vapourwick |

* Temperatures below 39°C (100°F)

.3 Equipment:

| | Location/Service | Insulation Thickness | Type |
|---|---|---|---|

| | | | |
|---|---|---|---|
| .1 | Expansion tanks | 25 mm (1”) | Fibreglass pipe & tank |
| .2 | Air eliminators | 25 mm (1”) | Fibreglass pipe & tank |
| .3 | Domestic hot water tanks* | 50 mm (2”) | Fibreglass pipe & tank |
| .5 | Water meter | 25 mm (1”) | Fibreglass pipe & tank |

* Factory insulated tanks not included

**END OF SECTION**

## Part 1 General

### 1.1 Summary

.1 Section Includes:

.1 Materials and installation for copper piping, valves and fittings for hydronic systems.

.2 Mechanical General Conditions 15010 shall be part of this Section.

.3 Provide piping, pipe fittings, pipe supports to connect new mechanical equipment to the new and existing hydronic heating systems.

.4 Modification of existing hydronic heating system as required to suit the application.

.5 Provide thermowell and pipe fittings for control system devices.

.2 Related Sections.

.1 Section 01330 - Submittal Procedures.

.2 Section 01705 - Health and Safety.

.3 Section 01780 - Closeout Submittals.

.4 Section 15010 - Mechanical General Requirements.

.5 Section 15095 - Cleaning and Start-up of Mechanical Piping Systems.

.6 Section 15101 - Installation of Pipework.

.7 Section 15111 - Valves and Strainers.

.8 Section 15950 - Testing, Adjusting and Balancing (TAB) of Mechanical Systems.

### 1.2 References

.1 American National Standards Institute (ANSI)/American Welding Society (AWS)

.1 ANSI/AWS A5.8-92, Specification Filler Metals for Brazing and Bronze Welding.

.2 American Society of Mechanical Engineers (ASME)

.1 ANSI/ASME B16.4-99, Gray-Iron Threaded Fittings.

.2 ANSI/ASME B16.15-1985(R1994), Cast Bronze Threaded Fittings.

.3 ANSI B16.18-1984(R1994), Cast Copper Alloy, Solder Joint Pressure Fittings.

.4 ANSI/ASME B16.22-95(R1998), Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.

.3 American Society for Testing and Materials (ASTM)

.1 ASTM B32-00, Specification for Solder Metal.

.2 ASTM B61-93, Specification for Steam or Valve Bronze Castings.

.3 ASTM B62-93, Specification for Composition Bronze or Ounce Metal Castings.

.4 ASTM B88M-99, Specification for Seamless Copper Water Tube [Metric].

.5 ASTM E202-00, Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.4 Manufacturers Standardization Society (MSS)

.1 MSS SP67-1995, Butterfly Valves.

.2 MSS SP70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS SP71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS SP80-1997, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS SP85-1994, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

**1.3 Shop Drawings**

.1 Submit shop drawings in accordance with Section 01330 - Submittal Procedures.

**1.4 Closeout Submittals**

.1 Provide maintenance data for incorporation into manual specified in Section 01780 - Closeout Submittals.

**1.5 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.

**1.6 Waste Management and Disposal**

.1 Separate and recycle waste materials.

.2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by the Contract Administrator.

.3 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.4 Dispose of corrugated cardboard, polystyrene and plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

**Part 2 Products**

**2.1 Piping**

.1 Type L hard temper copper.

**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 and Strainers**

.1 Refer to Section 15111 – Valves and Strainers.

## Part 3 Execution

**3.1 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.

**3.2 Valve Installation**

.1 Install ball valves at branch take-offs and to isolate each piece of equipment, and as indicated.

.2 Install silent check valves in vertical pipes with downward flow and as indicated.

.3 Install swing check valves in horizontal lines as indicated.

**3.3 Flushing and Cleaning**

.1 Flush and clean in presence of Contract Administrator or authorized representative.

.2 Flush after pressure test for a minimum of 4h.

.3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8h.

.4 Refill system with clean water. Circulate for at least 4h. Clean out strainer screens/baskets regularly. Then drain.

.5 Refill system with clean water. Circulate for at least 2h. 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 Contract Administrator’s approval.

**3.4 Filling of System**

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

**3.5 Testing**

.1 Test system in accordance with Section 15010 - Mechanical General Requirements.

**3.6 Balancing**

.1 Balance water systems to within plus or minus 10% of design output.

.2 Refer to Section 15950 - Testing Adjusting and Balancing for applicable procedures.

**END OF SECTION**

## Part 1 General

### 1.1 SUMMARY

.1 Section Includes.

.1 Materials and installation for steel piping, valves and fittings for hydronic systems.

.2 Mechanical General Conditions 15010 shall be part of this Section.

.3 Provide piping, pipe fittings, pipe supports to connect new mechanical equipment to existing hydronic heating system.

.4 Modification of existing hydronic heating system as required to suit the application.

.5 Provide thermowell and pipe fittings for control system devices.

.2 Related Sections.

.1 Section 01330 - Submittal Procedures.

.2 Section 01705 - Health and Safety.

.3 Section 01780 - Closeout Submittals.

.4 Section 15010 - Mechanical General Requirements.

.5 Section 15051 - Pipe Welding.

.6 Section 15095 - Cleaning and Start-up of Mechanical Piping Systems.

.7 Section 15101 - Installation of Pipework.

.8 Section 15111 - Valves and Strainers.

.9 Section 15950 - Testing, Adjusting and Balancing (TAB) of Mechanical Systems.

### 1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).

.1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.

.2 ASME B16.3-98, Malleable Iron Threaded Fittings.

.3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.

.4 ASME B16.9-01, Factory-Made Wrought Buttwelding Fittings.

.5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).

.6 ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

.3 ASTM A536-84(1999)e1, Standard Specification for Ductile Iron Castings.

.4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.

.5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.

.6 ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.3 American Water Works Association (AWWA).

.1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 Canadian Standards Association (CSA International).

.1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.

.2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

.5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).

.1 MSS-SP-67-025, Butterfly Valves.

.2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.

.4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

## 1.3 SUBMITTALS

.1 Submit shop drawings in accordance with Section 01330 - Submittal Procedures.

.2 Closeout Submittals.

.1 Provide maintenance data for incorporation into manual specified in Section 01780 - Closeout Submittals.

## 1.4 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal.

.1 Separate waste materials for reuse and recycling.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling.

.4 Fold up metal and plastic banding, flatten and place in designated area for recycling.

**1.5 MAINTENANCE**

.1 Extra Materials.

.1 Provide following spare parts:

.1 Valve seats: one for every ten valves, each size. Minimum one.

.2 Discs: one for every ten valves, each size. Minimum one.

.3 Stem packing: one for every ten valves, each size. Minimum one.

.4 Valve handles: two of each size.

.5 Gaskets for flanges: one for every ten flanges.

**Part 2 Products**

**2.1 PIPE**

.1 Steel pipe: to ASTM A53, Grade B, ERW as follows:

.1 50 mm (2") and below: Schedule 40, threaded ends.

.2 65 mm (2 ½") to 250 mm (10"): Schedule 40 bevelled ends.

.3 300 mm (12") and up: 9.5 mm (0.375"), bevelled ends.

**2.2 PIPE JOINTS**

.1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.

.2 NPS2-1/2 and over: welding fittings and flanges to CAN/CSA W48.

.3 Roll grooved: standard rigid coupling to CSA B242.

.4 Flanges: plain or raised face, slip-on weld neck to AWWA C111.

.5 Orifice flanges: slip-on raised face, 2100 kPa.

.6 Flange gaskets: to AWWA C111.

.7 Pipe thread: taper.

.8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.

.9 Roll grooved coupling gaskets: type EPDM.

**2.3 Fittings**

.1 50 mm (2") and below: Class 150, 1.0 MPa malleable iron ASTM A197, screwed to ANSI/ASME B16.3.

.2 65 mm (2 ½") to 250 mm (10"): Schedule 40 carbon steel ASTM A234 WPB, butt weld to ANSI/ASME B16.9.

.3 300 mm (12”) and above: 9.5 mm (0.375”) thick wall carbon steel ASTM A234 WPB, butt weld to ANSI/ASME B16.9.

**2.4 Flanges**

.1 50 mm (2”) and below: Class 150, 1.0 MPa raised face, screwed, forged carbon steel ASTM A105, to ANSI/ASME B16.5. Note: Use flanges 50 mm (2”) and below only for connections to flanged equipment.

.2 65 mm (2 ½”) and larger: Class 150, 1.0 MPa slip-on or weld neck, raised face, forged steel ASTM A105, ANSI/ASME B16.5. Bore of welding neck flanges to suit pipe inner diameter.

.3 Flat faced flanges required at cast iron valves and equipment flanges for all sizes.

**2.5 Unions**

.1 50 mm (2”) and below: Class 150, 1.0 MPa malleable iron union, ASTM A197, brass to brass seats, ground joint.

**2.6 Flange Bolting**

.1 Carbon steel bolts to ASTM A307 Grade B with hex nuts to ASTM A563 Grade A. Dimensions to ANSI B18.2.1 and ANSI/ASME B18.2.2.

**2.7 Thread Sealant**

.1 Teflon tape.

**2.8 Gaskets**

.1 Non-asbestos, to suit flat face or raised face flanges.

.2 Selected for compatibility with circulating fluid

**2.9 Valves and Strainers**

.1 Refer to Section 15111 – Valves and Strainers.

**2.10 Automatic Air Vent**

.1 Standard float vent: brass body and NPS 1/8 connection and rated at 690 kPa (100 psig) working pressure.

.2 Industrial float vent: cast iron body and NPS ½ connection and rated at 860 kPa (125 psig) working pressure.

.3 Float: solid material suitable for 115°C (240°F) working temperature.

**2.11 Air Separator (AS-1, AS-2)**

.1 Each separator must be designed with a removable end cover. The separator shall have connections for a Blow Down Valve, Skim Valve and Automatic Air Vent. The separator must also utilize in its design a stainless steel coalescing medium to aid in the separation of air and dirt in the system entrained water. The separator must be constructed in accordance with the latest revision of the ASME Boiler and Pressure Vessel Code and stamped for 125 psi (862 kPa) working pressure.

.2 Refer to equipment schedule.

.3 Equipment shall be painted.

.4 Acceptable Material: Armstrong, Taco.

**2.12 Expansion Tank (ET-1, ET-2)**

.1 Provide pre-pressurized, replaceable bladder expansion tanks meeting current ASME and CSA code requirements designed for a minimum working pressure of 860 kPa (125 psi).

.2 Tanks to be constructed of mild steel with finish painted surface and complete with all necessary tappings in combination with valve and automatic vent, angle cocks and guards.

.3 Bladders to be EPDM or heavy duty butyl.

.4 Refer to equipment schedule.

.5 Adjust expansion tank pressure to suit.

.6 Install pressure gauge and lockshield valve at inlet to tank.

.7 Provide drain connection downstream of expansion tank isolation valve.

.8 Acceptable Material: Armstrong, Taco, Hamlet & Garneau, Expanflex.

**2.13 Multi-Purpose Valves (MPV-1 to MPV-4)**

.1 Body: cast iron with threaded or flanged connections, refer to the equipment schedule.

.2 Unit shall feature bronze gland, stainless steel stem sleeve, cast iron plug, brass clapper and brass seat with o-ring seal.

.3 The units shall serve the following functions:

.1 Plug type flow control.
.2 Non-slam check service.
.3 Bubble-tight shut-off.

.4 To aid in flow control adjustment, units shall feature the following:

.1 Memory stops.

.2 Pointer and scale.

.3 Shrader valve metering connections.

.5 Acceptable material: Taco, Bell & Gossett, Armstrong.

**2.14 Automatic Balancing Valves (ABV-1)**

.1 Provide automatic flow control balancing valves where indicated on the drawings.

.2 The valves shall feature an internal, stainless steel one piece cartridge with segmented port designs and full travel linear coil spring.

.3 The valves shall be capable of providing +/-5% of the flows specified. The valves shall operate under an operating differential pressure at least 14 times the minimum pressure required for control.

.4 The valves shall feature threaded end connections.

.5 Acceptable material: Griswold.

**2.15 Flexible Connection**

.1 Application: to suit lateral motion of up to 13 mm (1/2”) and angular offset of up to 2° simultaneously.

.2 Minimum length in accordance with manufacturer’s recommendations to suit offset.

.3 Hose: reinforced neoprene arch type flexible connector/expansion joint.

.4 Diameter and type of end connection: size as indicated, flanges to floating type steel flange drilled to match ANSI Class 150 flanges.

.5 Operating conditions:

.1 Working pressure: 1550 kPa (225 psig) max at 76.7°C (170°FR).

.2 Working temperature: 76.7°C (170°F) average, 107.2°C (225°F) max.

.6 Acceptable Material: Senior Flexonics.

**Part 3 Execution**

**3.1 PIPING INSTALLATION**

.1 Install pipework in accordance with Section 15101 - Installation of Pipe Work.

**3.2 Valve Installation**

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

.2 Install gate, ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.

.3 Install globe valves for balancing and in by-pass around control valves as indicated.

.4 Provide silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.

.5 Provide swing check valves in horizontal lines on discharge of pumps and as indicated.

.6 Install chain operators on valves NPS2-1/2 and over where installed more than 2400 mm (8 feet) above floor in Boiler Rooms and Mechanical Equipment Rooms.

**3.3 Flushing and Cleaning**

.1 Flush and clean in presence of Contract Administrator.

.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 Drainage to include drain valves, dirt pockets, strainers, every low point in system.

.6 Re-install strainer screens/baskets only after obtaining Contract Administrator’s approval.

**3.4 Filling of System**

.1 Refill system with clean water with water treatment as specified or glycol solution as noted.

**3.5 Testing**

.1 Test system in accordance with Section 15010 - Mechanical General Requirements.

**3.6 Glycol Charging**

.1 Provide mixing tank and positive displacement pump for glycol charging.

.2 Retest for concentration to ASTM E202 after cleaning.

.3 For glycol systems, retest with ethylene propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

**3.7 Balancing**

.1 Balance water systems within plus or minus 10% of design output.

.2 Refer to Section 15950 – Testing Adjusting and Balancing (TAB) of Mechanical Systems for applicable procedures.

**3.8 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.

**3.9 Air Vents**

.1 Install at high points of systems and as shown.

.2 Install gate valve on automatic air vent inlet.

.3 Install industrial float vents at all air handler coils and on all lines 100 mm (4”) and larger.

**3.10 Expansion Tanks (ET-1, ET-2)**

.1 Adjust the existing expansion tank pressure as required after the system is refilled.

**3.11 Air Separator (AS-1, AS-2)**

.1 Install with automatic air vent and connection to the expansion tank as noted on the drawings.

**3.12 Pressure Safety Relief Valves**

.1 Run discharge pipe to terminate above nearest drain.

**3.13 Multi-Purpose Valves (MPV-1 to MPV-4)**

.1 Install with sufficient clearance to allow adjustment with a wrench; refer to the manufacturer’s recommendations.

**3.14 Automatic Balancing Valves (ABV-1)**

.1 Install in accordance with the manufacturer’s instructions and where indicated on the drawings.

**3.15 Flexible Connections**

.1 Install flexible connections in accordance with manufacturer's instructions.

.2 Install flexible connections on pump suction and discharge connections and where indicated on the drawings.

**END OF SECTION**

## Part 1 General

### 1.1 General Conditions

.1 Mechanical General Conditions 15010 shall apply to this Section.

## Part 2 Products

### 2.1 Tubing

.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.

.1 Annealed copper: to ASTM B 280, with minimum wall thickness as per CSA B52 and ANSI/ASME B31.5.

### 2.2 Fittings

.1 Service: design pressure 2070 kPa (450 psig) and temperature 121°C (250°F).

.2 Brazed:

.1 Fittings: wrought copper to ANSI/ASME B16.22.

.2 Joints: silver solder, 45% Ag-15% Cu and non-corrosive flux.

.3 Flanged:

.1 Bronze or brass, to ANSI/ASME B16.24, Class150 and Class300.

.2 Gaskets: suitable for service.

.3 Bolts, nuts and washers: to ASTM A 307, heavy series.

.4 Flared:

.1 Bronze or brass, for refrigeration, to ANSI/ASME16.26.

### 2.3 Pipe Sleeves

.1 Hard copper or steel, sized to provide 6mm clearance all around between sleeve and uninsulated pipe or between sleeve and insulation.

### 2.4 Valves

.1 22 mm (0.866”) and under: Class500, 3.5Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moistureproof seal for below freezing applications, brazed connections.

.2 Over 22 mm (0.866”): Class375, 2.5Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moistureproof seal for below freezing applications, brazed connections.

## Part 3 Execution

### 3.1 General

.1 Install in accordance with CSA B52, EPS1/RA/1 and ANSI/ASME B31.5.

.2 Connect to equipment with isolating valves and unions.

.3 Provide space for servicing, disassembly and removal of equipment and components all as recommended by manufacturer.

.4 Protect all openings in piping against entry of foreign material.

### 3.2 Brazing Procedures

.1 Bleed inert gas into pipe during brazing.

.2 Remove valve internal parts, solenoid valve coils, sight glass.

.3 Do not apply heat near expansion valve and bulb.

### 3.3 Piping Installation

.1 General:

.1 Soft annealed copper tubing: bend without crimping or constriction

.2 Hot gas lines:

.1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.

.2 Provide trap at base of risers greater than 2400 mm (8 feet) high and at each 7600 mm (25 feet) thereafter.

.3 Provide inverted deep trap at top of each riser.

.4 Provide double risers for compressors having capacity modulation.

.1 Large riser: install traps as specified above.

.2 Small riser: size for 5.1m/s (1000 ft/min) at minimum load. Connect upstream of traps on large riser.

### 3.4 Pressure and Leak Testing

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation to 2 MPa (300 psig) and 1 MPa (150 psig) on high and low sides respectively.

.3 Test Procedure: Build pressure up to 35 kPa (5 psig) with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

**3.5 Dehydration and Charging**

.1 Close service valves on factory charged equipment.

.2 Ambient temperatures to be at least 13°C (55°F) for at least 12h before and during dehydration.

.3 Use copper lines of largest practical size to reduce evacuation time.

.4 Use 2-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa (0.0006 psig) absolute and filled with dehydrated oil.

.5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.

.6 Triple evacuate all system components containing gases other than correct refrigerant or having lost holding charge as follows:

.1 Twice to 14 Pa (0.002 psig) absolute and hold for 4h.

.2 Break vacuum with refrigerant to 14k Pa (2 psig).

.3 Final to 5 Pa (0.0006 psig) absolute and hold for at least 12h.

.4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.

.5 Submit all test results to Contract Administrator.

.7 Charging:

.1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.

.2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.

.3 Re-purge charging line if refrigerant container is changed during charging process.

.8 Checks:

.1 Make all checks and measurements as per manufacturer's operation and maintenance instructions.

.2 Record and report all measurements to Contract Administrator.

**END OF SECTION**

## Part 1 General

### 1.1 Related Sections

.1 Section 01330 - Submittal Procedures.

### 1.2 References

.1 American Society of Mechanical Engineers (ASME)

.1 ASME Boiler and Pressure Vessel Code, Section VII-2001.

### 1.3 Shop Drawings

.1 Submit shop drawings in accordance with Section 01330 - Submittal Procedures.

### 1.4 Closeout Submittals

.1 Submit operation and maintenance data for incorporation into manual specified in Section 01780 - Closeout Submittals.

.2 Include following:

.1 Log sheets as recommended by manufacturer and Contract Administrator.

### 1.5 Waste Management and Disposal

.1 Unused metal and wiring materials are to be diverted from landfill to a metal recycling facility as approved by the Contract Administrator.

.2 Dispose of unused water treatment chemicals at official hazardous material collections site approved by Contract Administrator.

.3 Do not dispose of unused water treatment chemicals into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.

.4 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.5 Dispose of corrugated cardboard, polystyrene, plastic packaging material in appropriate bin for recycling.

## Part 2 Products

### 2.1 Manufacturer

.1 Equipment, chemicals, service by one supplier.

**2.2 Pot Feeder**

.1 Welded steel, pressure rating 100 kPa. Temperature rating: 90°C.

**2.3 Chemical Feed Piping**

.1 Resistant to chemicals employed. Pressure rating: 100 kPa.

**2.4 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.

**2.5 Shipping/ Feeding Chemical Containers**

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

**2.6 Water Treatment for Hydronic Systems**

.1 Hot water heating system: Pot feeder, 19 L, operating pressure 350 kPa.

.2 Glycol system: Pot feeder, 19L, operating pressure 350 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.

**2.7 Chemicals**

.1 Provide 1 years supply.

**2.8 Test Equipment**

.1 Provide one set of test equipment for each system to verify performance.

.2 Complete with carrying case, reagents for chemicals, all specialized or supplementary equipment.

## Part 3 Execution

### 3.1 Installation

.1 Install HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.

.2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

### 3.2 Chemical Feed Piping

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

### 3.3 Cleaning of Mechanical System

.1 Provide copy of recommended cleaning procedures and chemicals for approval by Contract Administrator.

.2 Thoroughly 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. Chemicals to inhibit corrosion of various system materials and be safe to handle and use.

.3 During circulation of cleaning solution, periodically examine and clean filters and screens 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 to be approved by authority having jurisdiction.

### 3.4 Water Treatment Services

.1 Provide water treatment monitoring and consulting services for period of one year after system start-up. Service to include:

.1 Initial water analysis and treatment recommendations.
.2 System start-up assistance.
.3 Operating staff training.
.4 Provide necessary recording charts and log sheets for one year operation.
.5 Instructions and advice to operating staff to be clear, concise and in writing.

### 3.5 Start-up

.1 Start up water treatment systems in accordance with manufacturer's instructions.

**3.6 Commissioning**

.1 Commissioning Agency: To be Water treatment supplier.

.2 Timing:

.1 After start-up deficiencies rectified.

.2 After start-up and before TAB of connected systems.

.3 Pre-commissioning Inspections:

.1 Verify:

.1 Presence of test equipment, reagents, chemicals, details of specific tests to be performed, 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 - Closed Circuit Hydronic Systems:

.1 Analyse water in system.

.2 Based upon an assumed rate of loss approved by Engineer, establish rate of chemical feed.

.3 Record types, quantities of chemicals applied.

.5 Training:

.1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.

.6 Certificates:

.1 Upon completion, furnish certificates confirming satisfactory installation and performance.

**END OF SECTION**

## Part 1 General

### 1.1 General Conditions

.1 Mechanical General Conditions 15010 shall be part of this Section.

### 1.2 References

.1 ANSI/ASME B16.3-1992 Malleable Iron Threaded Fittings, Class 150 and 300

.2 ANSI/ASME B16.5-1988, Pipe Flanges and Flanged Fittings.

.3 ANSI B16.18-1984, Cast Copper Alloy Solder Joint Pressure Fittings.

.4 ANSI/ASME B16.22-1989, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

.5 ANSI B18.2.1-1981, Square and Hex Bolts and Screws.

.6 ASTM A 47M-90, Specification for Ferritic Malleable Iron Castings.

.7 ASTM A 53-98, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.8 CAN/CGA B149.1-2000, Natural Gas and Propane Installation Code.

.9 The National Plumbing Code of Canada.

### 1.3 Product Data

.1 Submit product data in accordance with Section 01330 - Submittal Procedures.

.2 Indicate on manufacturers catalogue literature following:

.1 valves

.2 pressure reducing valves

### 1.4 Closeout Submittals

.1 Provide maintenance data for incorporation into manual specified in Section 01780 - Closeout Submittals.

## Part 2 Products

### 2.1 Pipe

.1 Steel pipe: to ASTM A 53, Grade B, seamless as follows:

.1 50 mm (2") and below: Schedule 40, threaded ends.

.2 65 mm (2 ½") to 250 mm (10"): Schedule 40, beveled ends.

### 2.2 Fittings

.1 50 mm (2") and below: Class 150 lb malleable iron ASTM A197, screwed to ANSI/ASME B16.3.

.2 65 mm (2 ½") to 250 mm (10"): Schedule 40 carbon steel ASTM A234 WPB, butt weld to ANSI/ASME B16.9.

### 2.3 Flanges

.1 50 mm (2") and below: Class 150 lb, raised face, screwed, forged carbon steel ASTM A105, to ANSI/ASME B16.5. Note: Use flanges 50 mm (2") and below only for connections to flanged equipment.

.2 65 mm (2 ½") and larger: Class 150 lb, slip-on or weld neck, raised face, forged steel ASTM A105, ANSI/ASME B16.5. Bore of welding neck flanges to suit pipe inner diameter.

.3 Flat faced flanges required at cast iron valves and equipment flanges for all sizes.

### 2.4 Unions

.1 50 mm (2") and below: Class 150 lb, malleable iron union, ASTM A197, brass to brass seats, ground joint.

### 2.5 Flange Bolting

.1 Carbon steel bolts to ASTM A307 Grade B with hex nuts to ASTM A563 Grade A. Dimensions to ANSI B18.2.1 and ANSI/ASME B18.2.2.

### 2.6 Thread Sealant

.1 To ULC Standard CAN/ULC-S642.

### 2.7 Gaskets

.1 Neoprene or other material resistant to any action of natural gas.

.2 Natural rubber shall not be used.

**2.8 Valves**

.1 Refer to Section 15111, Valves and Strainers.

**Part 3 Execution**

**3.1 Piping**

.1 Install in accordance with applicable Provincial/Territorial Codes.

.2 Install in accordance with CAN/CGA B149.1.

.3 Assemble piping using fittings manufactured to ANSI standards.

.4 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

.5 Slope piping down in direction of flow to low points.

.6 Install drip points:

.1 At low points in piping system.
.2 At each connection to equipment.

.7 Use eccentric reducers at pipe size change installed to provide positive drainage.

.8 Provide clearance for access and for maintenance.

.9 Ream pipes, clean scale and dirt, inside and out.

.10 Install piping to minimize pipe dismantling for equipment removal.

**3.2 Valves**

.1 Install valves with stems upright or horizontal unless otherwise approved by Contract Administrator.

.2 Install valves at branch take-offs to isolate each piece of equipment, and as indicated.

**3.3 Field Quality Control**

.1 Test system in accordance with CAN/CGA B149.1 and requirements of authorities having jurisdiction.

**3.4 Purging**

.1 Purge after pressure test in accordance with CAN/CGA B149.1.

**3.5 Pressure Reducing Valve**

.1 Terminate vent in accordance with CAN/CGA B149.1.

**END OF SECTION**

## Part 1 General

### 1.1 Scope of Work

.1 Domestic water supply piping and fittings

.2 Drain, waste and vent

.3 Roof drainage

.4 Fixtures and trim

.5 Plumbing specialties and accessories

### 1.2 Related Work

.1 This Section does not contain all materials, equipment and requirements that may be required on this project. Read this Section in conjunction with the remaining Sections of Division 15 for related work.

.2 Division 1 forms an integral part of Division 15.

.3 Refer to Division 16 for electrical requirements.

### 1.3 Codes and Standards

.1 Refer to Section 15010, "General Mechanical Requirements" for the codes and standards that apply to this project.

### 1.4 Shop Drawings and Product Data

.1 Refer to Section 15010, "General Mechanical Requirements" and Section 01330, "Submittal Procedures " for submission requirements.

.2 Submit shop drawings and product data on the following:

.1 Valves

.2 Fixtures and trim

.3 Specialties and accessories

### 1.5 Operation and Maintenance Data

.1 Refer to Section 15010, "General Mechanical Requirements" and Section 01330, "Submittal Procedures " for submission requirements.

**1.6 Pressure Testing**

.1 Test all piping systems in accordance with code and Section 15010, Mechanical General Requirements.

**1.7 Start-Up and Commissioning**

.1 Potable water system disinfection tests

.2 Flushing

.3 Venting

.4 Flow rate adjustment and balancing of valves and fixtures.

## Part 2 Products

**2.1 General**

.1 Code conformance: All fixtures, equipment, pipe, fittings and valves are to comply with the requirements of The National Plumbing Code of Canada, CSA Standards, ANSI Standards and ASTM Standards as referenced in these Specifications, listed in Section 15010, "General Mechanical Requirements" or as applicable by their scope.

.2 Colour: Fixture colour will be white, unless otherwise noted. Stainless steel fixtures will be a natural brushed or polished finish. All exposed plumbing brass and piping is to be bright chrome finish. Caulking compounds are to match the colour of the fixture or the surface to which the fixture is being sealed. Clear caulking materials may be used for chrome and stainless steel finishes.

.3 All fixtures in the same room are to be from the same manufacturer. Stainless steel products are to be from the same manufacturer unless specified as custom made. Brass and faucets are to be from the same manufacturer, and style when in the same room.

.4 Barrier free design requirements are to be observed where noted, fixtures, trim and accessories are to be compliant with the dimensions, capacities, operating forces, weights and clearances as specified by codes and standards referenced.

**2.2 Pipe, Tube, Fittings and Joints**

.1 Cast Iron Pressure Pipe, Non-Potable: centrifugally cast, bituminous tar coated ductile iron pipe, cast fittings, sizes 75 mm (3”) to 1200 mm (48”) diameter. Pipe end conditions to be as follows:

.1 Plain end for site applied mechanical joint system connections, where indicated.

.1 Ductile iron sleeve and cast steel end frames with lugs, all epoxy coated. Neoprene or EPDM elastomeric seal rings and T304 stainless steel fasteners.

.1 Acceptable material: Robar, Romac or Rockwell couplings.

.2 Ductile iron flange c/w elastomeric seal and setscrew locating fasteners. holes for fasteners and quantity to match Class 125 flange pattern.

.1 Acceptable material: Uniflange.

.2 Integrally cast Class 125 full face flanges c/w bolt holes conforming to ANSI/ASA standards.

.3 Use for buried forcemains and fluid systems where non-potable fluids are involved.

.2 Cast Iron Pressure Pipe, Potable, Cement Lined: Pipe and fittings as for non-potable service, c/w cement mortar lining to ANSI/AWWA standards.

.1 Use for potable water supplies to buildings on fire protection system water supplies, and where plastic and copper lines are not acceptable to the authority having jurisdiction.

.3 Cast Iron Drain, Waste and Vent (DWV) Pipe: Sizes 50 mm (2”) and larger, centrifugally cast bituminous tar coated cast iron pipe and mold cast fittings. Uses and end conditions to be as follows:

.1 Plain or beaded and for mechanical joint (MJ) couplings to be used for above ground DWV pipe and Rainwater Leaders.

.1 Mechanical joint couplings are to be constructed of a neoprene gasket sleeve, stainless steel shear sleeve and stainless steel gear clamps.

.1 Acceptable material: Clamp All Corp, Bibby Ste. Croix.

.4 Copper Tube and Fittings: Sizes up to and including 75 mm (3”) diameter, seamless copper water tube.

.1 Pressure piping, potable water systems:

.1 Below ground: Type K soft temper.

.1 Connectors: bronze flare unions, and threaded adapters to AWWA standards.

.2 Bends: Formed bends in tubing to comply with manufacturer’s tube bending recommendations.

.2 Above ground: Type K or L, hard temper.

.1 Socket solder brass, bronze or wrought copper fittings, 50 mm (2”) and under.

.1 Solder to be 95% tin and 5% antimony, lead free.

.2 Brazing flanges, Class 125 pattern, full face for lines of 63 mm (2 ½”) and 75 mm (3”) size.

.1 Silver solder brazing using Silfos or equivalent brazing filter metal, lead free.

.2 Silver solder all fittings on 63 mm (2 ½") and 75 mm (3") lines.

.2 Atmospheric Equipment Drains, non-potable service: Type M copper water tube, above ground only.

.1 Socket solder brass, bronze or wrought copper fittings, 50 mm (2") and under.

.1 50/50 lead/tin solder.

.3 Drain, Waste and Vent Piping: Sizes 50 mm (2") and under, above ground sanitary and indirect waste piping and vents.

.1 Socket solder brass, bronze or wrought copper fittings and threaded cleanouts.

.1 50/50 lead/tin solder.

.5 Plastic Piping:

.1 Pressure piping, potable and non-potable:

.1 PVC (Polyvinyl Chloride): 150 mm (6") and under, up to 40°C (104°F) and service temperature, minimum 1.1 Mpa (160 psig) pressure rating:

.1 Size 75 mm (3") and under: Schedule 40 wall.

.2 Size 100 mm (4") and over: Schedule 80 wall.

.3 Socket solvent weld fittings of molded PVC construction.

.4 Provide flanges for connection to valves and fittings of 63 mm (2 ½") and larger sizes, Class 150 rated.

.2 CPVC (Chlorinated Polyvinyl Chloride): 100 mm (4") and under, up to 60°C (140°F) service temperature, minimum 1.1 Mpa (160 psig) pressure rating.

.1 Size 63 mm (2 ½") and under: Schedule 40.

.2 Size 75 mm (3") and 100 mm (4"): Schedule 80.

.3 Socket solvent weld fittings of molded CPVC construction.

.4 Provide flanges for connection to valves and fittings of 63 mm (2 ½") and larger sizes, Class 150 rated.

.2 Drain, Waste and Vent (DWV): Sanitary, indirect waste and storm drainage piping:

.1 PVC (Polyvinyl Chloride): Schedule 40 pipe, all sizes, socket solvent welded DWV fittings of molded PVC.

.1 For use in combustible and non-combustible construction, and buried applications.

.2 Provide plastic pipe device firestopping and smoke sealing at the penetration of all fire rated assemblies.

.6 Steel Pipe: Electrogalvanized carbon steel pipe, ASTM A53 Grade B seamless pipe, grooved ends, sizes 100 mm (4") and larger, 1.1 Mpa (160 psig) rated, cut ends to be hot-dip galvanized after cutting/grooving.

.1 Joints are to be made using cast ductile iron grooved couplings with galvanized finish, EPDM elastomeric gasket, and corrosion resistant coupling fasteners:

.1 Acceptable material: Victaulic Style 77 or Grinnell Griwlok Figure 7001.

.2 Fittings are to be hot-dipped galvanized cast ductile iron fittings, integral grove collar, Class 125 flanges and long radius pattern

.1 Acceptable material: Victaulic or Gruvlok

**2.3 Gaskets**

.1 For flanged joints: 3 mm (1/8") thick type SBR red rubber, die cut to ASA Class 125 flange pattern (or ANSI Class 150).

.1 Acceptable material: Garlock No. 22, Polar Bear Rubber Model S012RRS or Argus Industries.

.2 Fasteners: T304 stainless steel studs, plate washers and heavy hex nuts.

**2.4 Valves**

.1 For valves, refer to Section 15111 – Valves and Strainers.

**2.5 Plumbing Specialties and Accessories**

.1 Cleanouts:

.1 Flush mounted:

.1 Floor access: round epoxy coated cast iron body and frame with adjustable secured heavy duty nickel bronze top and no-hub outlet:

.1 Plugs: Taper threaded bronze.

.2 Acceptable material: Zurn Model ZN-1400-HD-BP-NH, or Ancon Model CO-200-R-1-NH-34B.

.2 Wall access:

.1 Sizes 50 mm (2") and under: Neoprene expansion plug with 100 mm (4") round stainless steel access cover and centre securing screw.

.1 Acceptable material: Ancon Model CO-440-RD-3 or Zurn Model ZSS-1666-1.

.2 Sizes 75 mm (3") and larger: Threaded plug in tee or wye of parent pipe material, metallic plugs are to be brass. Install in wall with access door positioned for optimum accessibility. Also suitable for ceiling spaces.

.1 Provide access door in drywall ceilings to permit cleanout use.

.2 Exposed:

.1 In finished areas: Exposed metallic portions are to be chrome plated, provide cap and escutcheon.

.2 In unfinished areas: Threaded plug in ferule of parent pipe material, metallic plugs are to be brass.

.2 Access Doors: Satin coat galvanized steel construction, hinged one side, c/w vandal resistant cam or screw fastener closures. Flanged frame to suit thickness of finish or assembly in which it is installed. No sharp edges.

.1 Provide ULC listed access doors for all penetrations of rated assemblies.

.2 Sizes:

.1 Hand entry: Minimum 203 x 203 mm (8” x 8”).

.2 Arm entry (more than 305 mm (12”) reach required): minimum 305 x 305 mm (12” x 12”).

.3 Head and one arm (more than 610 mm (24 reach required): minimum 457 x 457 mm (18” x 18”).

## 2.6 Water Closets Flush Tank

.1 WC-1: for handicapped and general use.

.1 Bowl: white vitreous china, floor mounted, syphon jet, elongated rim, close coupled, bolt caps, 387 mm (15 ¼”) floor to top of bowl.

.2 Flush tank: white vitreous china, flapper type flush valve assembly, tank liner.

.3 Maximum water consumption: 6.0 LPF (litres per flush).

.4 Acceptable material: American Standard Champion 2018-500.

.5 Seat: white open front molded solid polypropylene plastic, with cover, integrally moulded bumpers, stainless steel check hinge and stainless steel post and fasteners.

.1 Acceptable material: Beneke Model 521 HSS.

.6 Supply: 9 mm (3/8") chrome plated brass angle stop valve with inlet and outlet pipes, escutcheon, and screwdriver operator.

.1 Acceptable material: Crane Model C-3017.

## 2.7 Lavatories

.1 L-1: For handicapped and general use: counter top, white vitreous china, self-rimming, overflow, gasket and swivel clamps, semi-oval bowl, supply openings on 100 mm (4") centres. Size: 525 mm (21") wide x 425 mm (17") deep outside, 470 x 275 mm (18 ½" x 10 ¾”) inside nominal.

.1 Acceptable material: Crane Sutton Model 1-283, American Standard Cadet Universal Access Model AF-9494-0010.

.2 Faucet: chrome plated brass, single lever controls, integral, mixing spout, washerless ceramic disc cartridge, aerator, metal indexed handle, and integral 9 mm (3/8") O.D. supply tubes. 100 mm (4") center punchings.

.1 Acceptable material: Crane Solitaire Model S-1902 c/w C-5099 conversion plate, American Standard Reliant+ Model GD-2385.404C, Delta Model 501.

.3 Trap: chrome plated cast brass adjustable P trap with cleanout and deep wall flange.

.1 Acceptable material: Crane Model P4001, Cambridge Brass Model 33T311.

.4 Waste: open grid strainer, 32 mm (1 1/4") dia. tailpiece, chrome plated, complete with overflow holes.

.1 Acceptable material: Crane Model P3902, Cambridge Brass Model 33T260.

.5 Screwdriver stops and escutcheons: Chrome plated brass to suit supply piping and faucet supplies:

.1 Acceptable material: Brass Craft

.2 Wall plate type fixture carrier: Rectangular steel uprights, welded feet, cast iron adjustable headers, support plate and mounting fasteners. To be suitable for Barrier Free lavatory installation.

.1 Acceptable material: Zurn Model ZX-1224-75.

**2.8 Stainless Steel Countertop Sinks**

.1 S-1: Single compartment, ledge back, Type 304 stainless steel, 1.0 mm thick (20 gauge) self rimming, undercoated, stainless steel basket strainer/stopper, 38 mm (1 1/2") dia. tailpiece, countertop installation with clamps. CSA certified.

.1 Sizes: od 522 x 510 x 250 mm (20 9/16" x 20 1/8" x 10") deep.

.1 Acceptable material: Kindred Industries "Steel Queen" Model LBS6810/10.

.2 Faucet: chrome plated brass, swing spout, aerator, single lever handle, washerless ceramic disc cartridge controls supply tubes. Provide conversion and integral 9 mm (3/8" O.D.) plate for 3 hole 200 mm (8") centre punchings.

.1 Acceptable material: Crane Solitaire Model S-5910 c/w C-5100 conversion plate, Delta Model 100WFELHHDF, Kohler Coralais Model K-15171-TT.

.3 Supply stops: Screwdriver compression stops to suit water supply pipe and faucet supply tubes.

.1 Acceptable material: Brasscraft.

**2.9 Janitor's Sink**

.1 JS-1: Floor mounted mop sink, one piece molded proprietary composition, stainless steel, dome strainer, factory installed drain body with lint basket. Drain connection suitable for 75 mm (3") no-hub cast iron service weight pipe.

.1 Size: 900 x 600 x 250 mm (36" x 24" x 10") deep.

.1 Acceptable material: Fiat Model MSB-3624 c/w QDC - 3SN Quick Drain Connector.

.2 Faucet: Chrome plated brass supply fitting with integral stops, adjustable wall brace, pail hook, hose thread end, rigid spout, indexed handles, integral vacuum breaker.

.1 Acceptable material: Fiat Model 830-AA service faucet, Delta/Cambridge Brass Teck Model 28T9.

.3 Hose and bracket: 750 mm (30") length of 15 mm (5/8") reinforced rubber hose, 19 mm (3/4") hose thread coupling, stainless steel hose bracket with rubber hose grip.

.1 Acceptable material: Fiat Model 832-AA, Delta/Cambridge Brass Teck Model 28T911.

**2.10 Drinking Fountains**

.1 DF-1: Barrier-free water cooler, wall mounted with stainless steel finish.

.1 Acceptable material: Oasis Model M85BPM, Halsey Taylor Model HTER-Q, Elkay Model ERHP-8.

.2 DF-2: Free standing electric water cooler.

.1 Acceptable material: Oasis Model PLF8FA, Halsey Taylor Model S1000-10D, Elkay Model EFA-8.

**2.11 Fixture Supplies**

.1 Chrome plated rigid fixture supplies with screwdriver stops, reducers and escutcheons on each service to each fixture not supplied with integral supplies.

**2.12 Fixture Traps**

.1 Brass P traps complete with cleanouts on all fixtures which do not have built-in traps. Chrome plated in all exposed places.

## Part 3 Execution

### 3.1 General

.1 Perform all work in full compliance with all codes, standards, bylaws and recommended practices referenced.

.2 Only first quality workmanship will be accepted, all deficient and inferior work will be corrected at no additional cost to the Owner.

.3 Codes, standards and bylaws are minimum requirements, and additional work shown or specified in excess of these minimum requirements will be provided as if required by codes, etc.

.4 Layout and installation is to consider access for maintenance, repair, inspection and replacement. Provide sufficient clearances from the building structure, access through finishes, clearance from electrical cables and communication wiring as will be required for these tasks.

.5 Provide all sketches, drawings and product information required for permit applications and pay all fees levied for the issuance of permits, inspections, reports, testing and penalties.

.6 Install fixtures and equipment in accordance with manufacturer's recommendations.

### 3.2 Piping and Fittings

.1 All references to tubing are to include pipe, tube, hose and conduits of other shapes and descriptions.

.2 Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.

.3 Assemble all piping using fittings manufactured to ANSI standards.

.4 Install tubing close to building structure to minimize furring, conserve headroom and space. Group exposed piping and run parallel to walls.

.5 Connect to fixtures and equipment in accordance with manufacturer's instructions unless otherwise indicated.

.6 Buried tubing:

.1 Bend tubing without crimping or constriction. Minimize use of fittings.

.2 Install buried pipe on a minimum 100 mm (4") bed of washed clean sand, shaped to accommodate fittings, to line and grade as indicated. Backfill with washed clean sand. Compact as specified in Section 02315 - Excavating, Trenching and Backfilling.

.7 Install piping with slopes and grades to promote effective venting and drainage.

.8 Provide unions, flanges or other means of quick disconnection of piping from connections at pumps, equipment and fixtures.

.9 Support piping at intervals as specified in Section 15061, "Pipe Hangers and Supports".

.10 Provide the means to accommodate piping expansion, contraction and shock loadings without damage to the piping system, equipment or fixtures.

.11 Provide drain valves at the low points in all pressure piping systems.

.12 Provide the cleanouts necessary to facilitate system maintenance of all gravity drainage lines.

.13 Provide expansion compensators for vertical piping passing through floor slab and roof.

.14 Provide suitable transition couplings when joining pipe of differing materials.

.15 Provide deep seal P-traps for all floor drains directly connected to the building drainage system.

.16 Provide cleanouts on all P-traps for fixtures installed above the floor, or accessible from the crawlspace or lower storey.

**3.3 Valves**

.1 Isolate water meter and provide bypass valve using ball valves.

.2 Use gate valves to isolate equipment or systems where no modulation, throttling or adjustments are required.

.3 Use globe valves or ball valves to provide combination throttling/shut-off capability.

.1 Indelibly mark the position of the operator after setting in a throttling position.

.2 Where valves are required to be closed more than once per year for service or operating reasons, provide a memory stop feature to allow the reliable repositioning of the valve to its design position.

.4 Install check valves in lines where reverse flow would have a detrimental effect on system safety, function or performance.

.1 Swing check valves are to be installed with the hinge pin level and the body in horizontal or up-flow position.

.2 Use spring or counterweight assisted check valves for down flow positions.

.5 Valve stems are to be oriented in the vertical "upright" position where possible. Position above horizontal to full upright will be acceptable in vertical lines and horizontal lines where space is limited.

.6 Provide drain valves per Section 15010, Mechanical General Requirements at all low points and in trapped sections of pressure piping systems.

**3.4 Fixtures**

.1 Water Closets: Set and adjust the float and/or flushing mechanism, clean trapways and fill with clean water ready for use.

.2 Urinals: as for water closets, plus install trapway strainer.

.3 Lavatories: clean aerators, adjust and tighten faucet handle(s), flush out trap and fill with clean water.

.4 Showers: clean debris and foreign matter from head, adjust stops on the hot and/or cold water supplies, clean traps and fill with clean water.

.5 Drinking fountains: adjust water supply stop, clean and flush traps, fill trap with water.

.6 Floor drains: Remove strainers, clean traps, fill with clean water and reinstall strainers.

.7 Roof drains: Remove any rocks, ballast or debris from line, install strainer.

.8 Kitchen sinks: per lavatories above.

.9 Escutcheons: Remove masking, paint splatter and set in place against finished wall.

.10 Caulking to be a uniform bead profile as recommended by manufacturer, continuous and firmly adhering to both surfaces. Minimize post-application tooling.

**3.5 Flushing and Disinfection**

.1 Prior to disinfection, conduct all pressure tests, test all backflow preventors, and flush all lines to remove foreign objects and all loose materials.

.2 Apply sodium hypochlorite (bleach) to the water and circulate to distribute evenly. Let stand for 24 hours.

.3 Drain and flush the piping until the sodium hypochlorite residual is 0.5 ppm or less.

.4 Draw a sample and have it analyzed at the Cadham Provincial Labs for contaminant levels.

.5 When an acceptable water quality result is confirmed, proceed with venting, balancing and adjustment of fixture performance.

.1 If an unacceptable water quality test result is reported, repeat the flushing and disinfection process, then retest.

**END OF SECTION**

## Part 1 General

### 1.1 Scope of Work

.1 The following generally describes the scope of work covered under this Section:

.1 Provision of water supply and drainage system accessories required by; codes, the authorities having jurisdiction, the work shown on the contract documents and as specified herein. They are to include, but not be limited to:

.1 Heavy duty wheeled traffic area floor drains.
.2 General use floor drains.
.3 Combination funnel/floor drains.
.4 Hub drain.
.5 Heavy duty floor drain.
.6 Conventional roof drains.
.7 Non-freeze wall hydrants.
.8 Interior hose bibs.
.9 Tempered water blending unit.
.10 Cleanouts.
.11 Water hammer arrestors.
.12 Backflow preventors.
.13 Vacuum breakers.
.14 Strainers.
.15 Acid waste neutralization tank.
.16 Trap primers.

### 1.2 References

.1 CSA-B64.4-01, Backflow Preventers, Reduced Pressure Principle Type (RP).

.2 CAN/CSA-B64.10-M88, Backflow Prevention and Vacuum Breakers.

.3 CAN/CSA-B64.10-M88, Backflow Prevention Devices - Selection, Installation Maintenance and Field Testing.

.4 CAN/CSA-B125-M89 Plumbing Fittings.

.5 CAN3-B79-M79, Floor Drains and Trench Drains.

.6 PDI-G101-81, Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data.

.7 PDI-WH201-77, Water Hammer Arrestors.

**1.3 Shop Drawings and Product Data**

.1 Submit shop drawings and product data in accordance with 01330 – Submittal Procedures.

.2 Indicate dimensions, construction details, capacities and materials for following:

.1 Floor drains
.2 Roof drains
.3 Hub drains
.4 Wall hydrants
.5 Hose bibbs
.6 Cleanouts
.7 Water hammer arrestors
.8 Backflow preventors
.9 Vacuum breakers
.10 Strainers
.11 Acid neutralizing tanks
.12 Trap primers

**1.4 Maintenance Data**

.1 Provide maintenance data for incorporation into manual.

.2 Data to include:

.1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
.2 Details of operation, servicing and maintenance.
.3 Recommended spare parts list.

**Part 2 Products**

**2.1 Floor Drains**

.1 Floor drains and trench drains: to CAN3-B79.

.2 FD-1: Floor and shower drain: epoxy coated cast iron body, 152 mm dia. round, nickel bronze adjustable strainer, no-hub outlet.

.1 Acceptable material: Zurn Model ZN-211-B6, Ancon Model FD-200-A.

.3 FD-2: combination funnel floor drain; epoxy coated cast iron body with integral seepage pan, polished, nickel-bronze adjustable head strainer and secured grate with integral 83 mm x 203 mm oval funnel, no-hub outlet.

.1 Acceptable material: Zurn Model ZN-211-BF, Ancon Model FD-200-EG.

**2.2 Roof Drains**

.1 Type RD-1: inverted roofing system; gravel as ballast, epoxy coated cast iron body, underdeck clamp and sump receiver to suit roof construction, aluminum dome with clamp ring with integral gravel stop.

.1 Acceptable material: Zurn Model Z-121-8-ARC, Ancon Model RD-220-CV-BD-W-1.

**2.3 Cleanouts**

.1 Exposed cleanout plugs: heavy PVC male ferrule with threaded plug. Sealing neoprene gasket.

.1 Acceptable material: Ipex, Bow or Canplas.

.2 Concealed:

.1 Wall access: face or wall type, polished nickel bronze square cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.

.1 Acceptable material: Zurn Model ZANB-1460.

.2 Floor access: round epoxy coated cast iron body and frame with adjustable secured heavy duty nickel bronze top and no-hub outlet:

.1 Plugs: Taper threaded bronze.

.2 Acceptable Material: Zurn Model ZN-1400-HD-BP-NH.

.3 Stack base cleanout: PVC DWV in-line tee fitting with NPT plug.

.1 Acceptable material: Ipex, Bow or Canplas.

.4 Urinal cleanout: Neoprene rubber expansion stop with stainless steel compression caps, wing nut operated compression screw, stainless steel access cover and centre securing screw.

.1 Acceptable material: Zurn Z-1666-1.

**2.4 Non Freeze Wall Hydrants**

.1 HB-1: Recessed bronze box, all bronze hydrant with integral vacuum breaker, 19 dia. hose outlet, removable operating key, polished bronze finish. Provide casing and operating rod length to suit wall construction.

.2 Provide one (only) hydrant parts repair kit as part of operation and maintenance materials.

.3 Acceptable material: Zurn Model Z-1300.

**2.5 Water Hammer Arrestors**

.1 Stainless steel construction, bellows type: to PDI-WH 201.

.2 Acceptable material: Zurn Z-1700.

**2.6 Back Flow Preventers**

.1 To CAN/CSA-B64 Series.

.2 Reduced pressure principle type, c/w bronze inlet strainer and quarter-turn ball valves.

.1 Acceptable material: Watts Model 909QT-S.

**2.7 Vacuum Breakers**

.1 To CAN/CSA-B64 Series.

.2 Hose connection vacuum breaker:

.1 Acceptable material: Watts No. 8.

**2.8 Pressure Regulators**

.1 NPS 1 bronze body, screwed: to ASTM B62.

.2 Bronze spring chambers with stainless steel trim.

.3 Capacity:

.1 Inlet pressure: 450 kPa (65 psig).

.2 Outlet pressure: 138 kPa (20 psig).

.3 Capacity: 38 litres per minute (10 USgpm) flow at 34.5 kPa (5 psig) pressure fall-off.

.4 Acceptable material: Watts Series 223-LP.

**2.9 Backwater Valves**

.1 Epoxy Coated extra heavy cast iron body with brass seat, revolving brass flapper and bolted cover with gasket.

.1 Access:

.1 Concrete access pit with cover, as indicated.

.2 Acceptable material: Zurn Z-1090.

.2 PVC body and internal parts, screw-in PVC access plug and socket solvent weld ends for in-line installation.

.1 Access:

.1 Concrete access pit with cover, as indicated.

.2 Acceptable material: IPEX 3280 Series.

**2.10 Strainers**

.1 125 psi, Y type with 40 mesh, stainless steel removable screen.

.2 NPS 2 and under, bronze body, screwed ends, with brass cap.

.1 Acceptable material: Spirax BT.

**Part 3 Execution**

**3.1 Installation**

.1 Install in accordance with most recent version of Manitoba Plumbing Code 1992 and local authority having jurisdiction except where specified otherwise.

.2 Install in accordance with manufacturer's instructions and as specified.

**3.2 Cleanouts**

.1 In addition to those required by code, install at base of all soil and waste stacks, and rainwater leaders and where indicated.

.2 Bring cleanouts to wall or finished floor unless serviceable from below floor.

.3 Building drain cleanout and stack base cleanouts: line size to maximum 100 mm dia. (NPS 4).

**3.3 Non Freeze Wall Hydrants**

.1 Install 2'-0" above finished grade at elevations noted unless otherwise indicated.

.2 Demonstrate operation and maintenance procedure. Turn over vandal resistant operators to owner.

**3.4 Water Hammer Arrestors**

.1 Install on branch supplies to each fixture or group of fixtures where such fixtures or groups of fixtures include urinals or water closets and at the dishwasher.

.2 Provide schedule of proposed sizes and locations as part of shop drawing submission.

**3.5 Back Flow Preventors**

.1 Install in accordance with CSA B64.10, where indicated and elsewhere as required by code.

.2 Install as required for proper functioning of equipment and/or systems.

.3 Pipe discharge as indirect waste to nearest floor drain (as means of trap-prime maintenance).

**3.6 Floor Drains**

.1 Protect the threads and provide void form below strainer rim of all floor drains to allow adjustment after installation.

.2 Set and seal strainer into concrete or floor system to promote complete drainage of all liquids on floors.

.3 Refer to structural drawings for floor slopes.

.4 Refer to architectural drawings for locations of floor drains.

**3.7 Roof Drains**

.1 Coordinate the installation of the receiver sump and drain body during roof construction.

.2 Apply dome and sand screen cover prior to placement of topsoil.

.3 Protect the sand screen to prevent damage, crushing or being stepped upon during construction.

**3.8 Backwater Valves**

.1 Install in elevator pit drain line and where indicated.

.2 Install in access pit as indicated.

**3.9 Hose Bibbs and Sediment Faucets**

.1 Install at bottom of all risers, at low points to drain systems, and as indicated.

.2 Install PL-10 shown on plans above finished floor. Secure to wall.

**3.10 Strainers**

.1 Install with sufficient room to remove strainer screen element.

**3.11 Water Meter**

.1 Rough-in for water meter provided by local water authority.

**3.12 Commissioning**

.1 After start-up, test, adjust and prove operation as indicated, to suit site conditions such as:

.1 Clean out strainers periodically until clear.

.2 Commission grease interceptor using manufacturer's activation instructions.

.3 Clean out and prime all floor drain traps using means acceptable to the Manitoba Plumbing Code and Authority having Jurisdiction.

.4 Clean out roof drains. Adjust weirs to suit actual roof slopes.

.5 Prove freedom of movement of cleanouts.

.6 Backflow preventors: confirm operation of backflow preventors and vacuum breakers.

**END OF SECTION**

## Part 1 General

### 1.1 References

.1 Canadian Gas Association (CGA)

.1 CAN1-4.1- M85, Gas-Fired Automatic Storage Type Water Heaters with Inputs Less than 75,000 Btuh.

.2 CAN1-4.3- M85, Circulating Tank, Instantaneous and Large Automatic Storage Type Gas Water Heaters.

.3 CAN/CGA-B149.1- 2000, Natural Gas Installation Code.

.2 Canadian Standards Association (CSA)

.1 CSA B51- 97, Boiler, Pressure Vessel, and Pressure Piping Code.

.2 CAN/CSA C22.2 No.110- 94, Construction and Test of Electric Storage Tank Water Heaters.

.3 CAN/CSA-C191 Series- M90, CSA Standards on Performance of Electric Storage Tank Water Heaters.

.4 CAN/CSA-C309- M90, Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.

### 1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 01330 - Submittal Procedures.

.2 Indicate:

.1 Equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.

### 1.3 Closeout Submittals

.1 Provide maintenance and engineering data for incorporation into manual specified in Section 01780 - Closeout Submittals.

## Part 2 Products

### 2.1 Electric

.1 To CAN/CSA C22.2 No.110, CAN/CSA-C191 and CAN/CSA-C309 for glass-lined storage tanks, with one immersion type elements, 1500 W each, and surface mounted or immersion type adjustable thermostats.

.2 Tank: 23 litres (6 US gallons), glass lined steel, polyurethane foam, enamelled steel jacket, 5 year warranty certificate.

.3 Voltage: 120 V, single phase.

.4 Acceptable material: John Woods SS06SEB.

**2.2 Trim and Instrumentation**

.1 Drain valve: 25 mm (1”) diameter with hose end thread connection.

.2 ASME rated temperature and pressure relief valve sized for full capacity of heater, having discharge terminating over floor drain and visible to operators.

.3 Magnesium anodes adequate for 20 years of operation and located for easy replacement.

## Part 3 Execution

**3.1 Installation**

.1 Install in accordance with manufacturer's recommendations and authority having jurisdiction.

**END OF SECTION**

## Part 1 General

### 1.1 Related Sections

.1 Section 01330 - Submittal Procedures.

.2 Section 01780 - Closeout Submittals.

### 1.2 References

.1 American Boiler Manufacturer's Association (ABMA)

.2 American National Standards Institute (ANSI)

.1 ANSI Z21.13-2000/CSA 4.9-2000, Gas-Fired Low-Pressure Steam and Hot Water Boilers.

.3 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)

.1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV, 2001.

.4 Canadian Gas Association (CGA)

.1 CAN1-3.1-77(R2001), Industrial and Commercial Gas-Fired Package Boilers.

.2 CSA-B149.1-00, Natural Gas and Propane Installation Code.

.5 Canadian Standards Association (CSA)

.1 CSA B51-97, Boiler, Pressure Vessel, and Pressure Piping Code.

.6 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

### 1.3 Shop Drawings

.1 Submit shop drawings in accordance with Section 01330 - Submittal Procedures.

.2 Shop drawings shall indicate the following:

.1 General arrangement showing terminal points, instrumentation test connections.

.2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.

.3 Foundations with loadings, anchor bolt arrangements.

.4 Piping hook-ups.

.5 Equipment electrical drawings.

.6 Burners and controls.

.7 All miscellaneous equipment.

.8 Flame safety control system.

.9 Breeching and stack configuration.

.10 Boiler efficiency at 39°C (100°F), 49°C (120°F), 60°C (140°F), 71°C (160°F), and 82°C (180°F) return water temperature at 100% capacity.

**1.4 Closeout Submittals**

.1 Submit operation and maintenance data for incorporation into manual specified in Section 01780 - Closeout Submittals.

**1.5 Waste Management and Disposal**

.1 Separate and recycle waste materials.

.2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Contract Administrator.

.3 Dispose of unused paint material at official hazardous material collections site approved by Contract Administrator.

.4 Do not dispose of unused paint material into sewer system, into streams, lakes, onto ground or in any other location where it will pose health or environmental hazard.

.5 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.6 Dispose of corrugated cardboard, polystyrene, plastic packaging material in appropriate on-site bin for recycling.

**1.6 Maintenance**

.1 Maintenance materials to include:

.1 Special tools for 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 Safety valve test gauge.

**Part 2 Products**

**2.1 Sealed Combustion Cast Aluminum Boilers (B-1 to B-6)**

.1 Supply sealed combustion boilers and accessories.

.2 The burner shall be capable of a 5:1 modulating turn-down ratio.

.3 The maximum working pressure shall be 210 kPa (30 psig).

.4 The boiler shall be capable of using outside air directly for combustion.

.1 The inlet and outlet combustion pipes shall be capable of terminating through a roof or sidewall penetration.

.2 The inlet and outlet combustion pipes shall be Schedule 40 PVC, ABS or CPVC.

.5 Each boiler shall be supplied with the following:

.1 An electronic display for status, setup and diagnostics.

.2 A high limit temperature controller.

.3 Combustion temperature and pressure gauge.

.4 An ASME relief valve set at 210 kPa (30 psig)

.5 Temperature sensors for the flue gas, supply water and return water.

.6 Low water cut-off.

.7 Freeze protection.

.8 One (1) Taco 0011 circulation pump.

.6 Each boiler module shall be rated for 90.8 kW (310 MBH) input and 87% efficiency at $60^0$C ($140^0$F) return water temperature

.7 The unit dimensions: H 1121 mm (44”), W 581 mm (23”), D 559 mm (22”); operating weight: 125 kg (275 lb.)

.8 Provide Weil-McLain boiler controls package (AM4) to each Weil-McLain boiler.

.9 Acceptable Material: Weil-McLain Ultra 310.

## Part 3 Execution

### 3.1 Installation

.1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.

.2 Make all required piping connections to all inlets and outlets recommended by boiler manufacturer.

.3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.

.4 Pipe hot water relief valves full size to nearest drain.

.5 Pipe drain to floor drain. Refer to manufacturer’s equipment installation manual.

.6 Natural gas fired installations - in accordance with CAN/CGA-B149.1.

.7 Provide appropriate protection apparatus during shipping, hoisting and installation.

.8 Install unit as indicated to manufacturer's recommendations.

.9 Ensure adequate clearances for servicing and maintenance.

.10 Ensure that appropriate manufacturer's service literature and guidelines are available on site.

.11 Assist and coordinate water treatment with Section 15188.

**3.2 Mountings and Accessories**

.1 Safety valves and relief valves:

.1 Run separate discharge from each valve.
.2 Terminate discharge pipe into the drain.
.3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.

.2 Blowdown valves:

.1 Run discharge to terminate into the drain as per manufacturer's recommendations.

**3.3 Start-Up Services**

.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 Contract Administrator at least 24 hours notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

**3.4 Start-Up and Operator Training**

.1 The Contractor shall provide full start-up services and instruction/training to Owner's operating personnel for B-1 to B-6. A minimum of 4 hours training shall be included.

.2 The equipment manufacturer shall provide information, materials and services to the Contractor.

**3.5 Equipment Warranty**

.1 The Contractor shall provide the following services for B-1 to B-12 for 1 year from the date of Substantial Performance:

.1 Correct any installation defects or deficiencies.

.2 Provide routine maintenance in accordance with the manufacturer's recommendations.

.2 The above services shall be provided without cost to the Owner.

**END OF SECTION**

## Part 1 General

### 1.1 Scope

.1 The following generally describes the scope of the work covered by this Section:

.1 Provision of packaged HVAC units with controls and accessories as required by the work shown in the Contract Documents and as specified.

.2 Co-ordinate the installation with Section 15900 and all other trades.

### 1.2 Related Sections

.1 Ductwork and Accessories - Section 15800

.2 Controls - Section 15900

### 1.3 References

.1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)

.1 ANSI/ARI 430- 89, Central Station Air Handling Units.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB 1.181- 92, Ready-Mixed Organic Zinc-Rich Coating.

### 1.4 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 01330 – Submittal Procedures.

.2 The shop drawings shall indicate the following: fan size and configuration, fan curves showing point of operation, motor drive bearings filters, mixing box, dampers, coil, plus all performance data.

### 1.5 Waste Management and Disposal

.1 Separate and recycle waste materials.

.2 Place materials defined as hazardous or toxic waste in designated containers.

.3 Ensure emptied containers are sealed and stored safely for disposal away from children.

**1.6 Extra Materials**

.1 Spare filters: in addition to filters to be installed immediately prior to acceptance by Engineer, supply one (1) complete set of air filters for each filter bank.

.2 Furnish 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.

**Part 2 Products**

**2.1 Packaged Air Handling Units (AH-4, AH-9)**

.1 Furnish outdoor, indirect gas fired heat/cool units with packaged cooling. Units shall be sectionalized, factory assembled and consist of a condensing unit, direct expansion cooling coil with drain pan, blower section, gas heating section, flat filter section and mix box with low-leakage dampers.

.2 Units shall be pre-wired; factory tested and shall bear the CSA and CGA approval as a complete unit.

.3 Unit shall be a single package, piped and wired at the factory. All cooling and heating controls shall be integral to the unit. Unit shall be equipped with low limit freeze protection with by-pass timer.

.4 Unit casing shall be heavy gauge G90 rated steel. Unit roof shall be sloped for water drain off and feature standing seam construction. The entire unit casing shall be insulated with 25 mm (1") thick 0.7 kg (1 ½ lb) fiberglass insulation with hard neoprene backing.

.5 The gas fired heating section shall be four pass design with a primary combustion chamber and multi-tube secondary heat exchanger. Internal turbulators or other flue restrictors to boost efficiency are unacceptable.

.1 Construct entire primary and secondary heat transfer surfaces from Type 409 Series stainless steel.

.2 Type 409 stainless steel burner shall feature an integral combustion air blower and motor; combustion air proving switch, removable pilot assembly and positive pilot combustion air supply.

.3 The combustion air damper shall be interlocked with the main gas valve to insure proper air/gas mixture.

.4 The unit shall be suitable for natural gas and designed and certified by ETL and CGA to provide full gas modulation. The minimum turndown ratio shall be 10:1.

.6 Unit shall feature a cooling section that shall include direct expansion cooling coil, compressors, condenser coils and fans. The direct expansion cooling coil must be ARI Certified; submit proof of certification to the Engineer.

.1 Unit shall provide a minimum of two stages of cooling control.

.7 A mix box with outdoor air and return air dampers shall be provided. The dampers shall be aluminum airfoil low leak type with seals inset into (22 gauge) steel mix box liners.

.1 The dampers shall be equipped with modulating actuators.

.8 The unit shall be provided with a flat filter section. Filter access shall be through latched and gasketed access doors located on both sides of the unit.

.1 The pre-filters shall be 100 mm (4") thick pleated, panel type with a Minimum Efficiency Rating Value of MERV 7 as evaluated under ASHRAE 52.2-1999.

.1 Acceptable Material: Farr 30/30.

.9 Units shall be supplied with a factory fabricated roof curb.

.10 Units shall be served by a single point power connection, all motor starters and internal controls shall be factory wired.

.11 Units shall be supplied with a non-fused disconnect for installation by Division 16.

.12 Acceptable Material: ICE, Engineered Air.

**2.2 Vibration Isolation**

.1 Provide flexible connections at the supply and return inlets as noted in Section 15800.

.2 Factory installed vibration isolators shall be provided on the fan section.

**Part 3 Execution**

**3.1 Packaged Air Handling Units (AH-4, AH-9)**

.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.

.4 Units to be mounted on factory supplied roof curbs.

**END OF SECTION**

## Part 1 General

### 1.1 Shop Drawings

.1 Submit shop drawings in accordance with Section 01330 - Submittal Procedures.

.2 Indicate:

.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 Special enclosures.

### 1.2 Closeout Submittals

.1 Provide maintenance data for incorporation into manual specified in Section 01780 - Closeout Submittals.

## Part 2 Products

### 2.1 Finned Tube Radiation

.1 Heating elements: NPS 3/4 seamless copper tubing, 1.0 mm (0.04”) minimum wall thickness, mechanically expanded into flanged collars of evenly spaced aluminum fins, 105 x 105 mm (4 ¼ ” x 4 ¼ ”) nominal, suitable for sweat fittings.

.2 Element hangers: ball bearings or plastic lined cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets 900mm (36”) centres maximum.

.3 Standard enclosures: 1.2 mm thick (18 gauge) steel up to 450 mm (18”) in height, 1.6 mm thick (16 gauge) steel over 450 mm (18”) in height complete with components for wall-to-wall or complete with die formed end caps having no knock-outs, with inside corners, outside corners, as indicated. Provide full length channel and sealer strip at top of wall edge. Height as indicated. Joints and filler pieces to be flush with cabinet. Support rigidly top and bottom, on wall mounted brackets. Provide access doors at each shutoff, control valve and balancing valve, valves, vents, traps. Finish cabinet with factory applied coating as per schedules.

.4 Acceptable material: Rittling, Rosemex.

**2.2 Cabinet Unit Heaters**

.1 Cabinet: type surface semi-recessed, recessed ducted, as indicated, 1.6 mm thick (16 gauge) steel, with rounded exposed corners and edges, removable panels, glass fiber insulation and integral air outlet and inlet.

.2 Finish with factory applied primer coat.

.3 Coils: aluminum fins mechanically bonded to copper tubes. Hydrostatically tested to 1380 kPa (200 psig).

.4 Fans: centrifugal forward curved, double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.

.5 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.

.6 Filters: removable 25 mm (1”) thick fibrous glass throwaway or permanent washable type.

.7 Acceptable material: Rittling, Rosemex.

**2.3 Radiant Panels**

.1 Panels to be constructed of extruded aluminum. Copper tubing shall be mechanically bonded to the panel.

.2 Colour and capacity as on schedule.

.3 Provide non-active panels as fill pieces at corners, walls and other obstruction.

.4 Acceptable material: Airtex.

**Part 3 Execution**

**3.1 Installation**

.1 Install in accordance with manufacturer's instructions.

.2 Install in accordance with piping layout and 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 Contract Administrator if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Contract Administrator's directive.

.6 Valves

.1 Install valves with stems upright or horizontal unless approved otherwise.

.2 Install isolating gate valves on inlet and lockshield balancing valves on outlet of each unit.

.7 Venting:

.1 Install screwdriver vent on cabinet convector, terminating flush with surface of cabinet.

.2 Install standard air vent with cock on continuous finned tube radiation.

.8 Clean finned tubes and comb straight.

.9 Install flexible expansion compensators as indicated.

.10 Provide double swing pipe joints as indicated.

.11 Provide supplementary suspension steel as required.

**END OF SECTION**

## Part 1 General

### 1.1 General

.1 For additional information, refer to Section 15010 - Mechanical General Requirements and the General Conditions of the Contract.

.2 For a list of applicable codes and standards, refer to Section 15010 - Mechanical General Requirements.

.3 The mechanical contractor shall be responsible for coordinating all aspects of this work.

### 1.2 Scope of Work

.1 The scope of work for this section includes, but is not limited to, the following:

.1 Provision of low, medium, and high pressure ductwork and plenums as indicated.
.2 Provision of flexible ducts.
.3 Provision of duct access doors, hangers, supports, bracing, balancing dampers, splitter dampers, backdraft dampers, fire dampers, flexible connections, turning vanes and instrument test ports.
.4 Provision of duct sealants, tapes, reinforcing fabric and gaskets.
.5 Duct cleaning.

### 1.3 Shop Drawings

.1 Shop drawings shall be submitted for the following items:

.1 Flexible ductwork.
.2 Sealant, tape, hangars and supports and fittings.

.2 Shop drawings of high pressure duct fittings shall indicate the following:

.1 Thicknesses.
.2 Welds and configurations.
.3 Sealants.
.4 Tape
.5 Proprietary joints.

### 1.4 Alternatives

.1 Size round ducts installed in place of rectangular ducts indicated from ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration, shape or sizes is permitted except with prior authorization in writing from the Contract Administrator.

**1.5 Definitions**

.1 Low Pressure: Static pressure in ducts less than 500 Pa (2") and velocities less than 10 m/s (2000 FPM).

.2 Medium Pressure: Static pressure in duct of greater than 500 Pa (2"), but less than 1500 Pa (6"), or velocities greater than 10 m/s (2000 FPM).

.3 High Pressure: Static pressure in duct over 1500 Pa (6") and less than 2500 Pa (10") and velocities greater than 10 m/s (2000 FPM).

.4 Duct Sizes: Inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes indicated as clear inside duct liner or insulation.

**Part 2 Products**

**2.1 Ductwork**

.1 Provide galvanized steel low, medium and high pressure distribution ductwork for building supply, return and exhaust air systems as indicated.

| | Pressure Class (Maximum Pressure) (Pa) | | | | | | |
|---|---|---|---|---|---|---|---|
| Duct System or Location | 125 (0.5") | 250 (1") | 500 (2") | 750 (3") | 1000 (4") | 1500 (6") | 2500 (10") |
| Supply Air | | | X | | | | |
| Return Air | | | X | | | | |
| Exhaust Air | | X | | | | | |
| Receiver Air | | X | | | | | |
| Combustion | X | | | | | | |

.2 Construct ducts of galvanized steel, of lock forming quality and having zinc coating to ASTM A653/A653M designation for both sides.

.3 Use rivets or bolts for fastening medium velocity ducts; sheet metal screws are acceptable on low pressure ducts only.

.4 Use water resistant, fire resistive duct sealant which is compatible with mating materials.

**2.2 Seal Classification**

.1 Classification as follows:

| Maximum Pressure Pa (inch) | SMACNA Seal Class |
|---|---|
| 2500 (10") | A |
| 1500 (6") | A |
| 1000 (4") | A |

| | |
|---|---|
| 750 (3") | B |
| 500 and lower (2") | B |

.2 Seal classification:

.1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

.2 Class B: longitudinal seams, transverse joints and connections made airtight with gaskets, sealant, tape, or combination thereof.

**2.3 Flexible Ductwork**

.1 Comply with requirements of ULC "Standards for Safety, Air Ducts", ULC-181 Class I, and NFPA 90A.

.2 Provide at inlet to air control boxes and at diffusers. Length shall not exceed 1500 mm (5') or as shown. Unit must withstand 2500 Pa (10") internal pressure and external pressure.

.3 Ductwork shall be of non-collapsible coated mineral base fabric type, helically supported either by steel wire or flat steel strips.

.4 Provide 25 mm (1") mineral fibre insulation with factory applied vapour barrier on ducting systems which require insulation.

**2.4 Fabrication**

.1 Fabricate metal ducts complete with no single partition between ducts. Where any dimension of duct exceeds 450 mm (18"), cross break all sides for rigidity. Open corners are not acceptable.

.2 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.3 Construct tees, bends, and elbows with centreline radius of not less than 1 1/2 times width of duct in plane of rotation. Where not possible, and where square turn elbows are used, provide air foil turning vanes. Where acoustical lining is required, provide turning vanes of perforated metal with internal mineral fibre cores.

.4 Increase duct sizes gradually, not exceeding 15 degree divergence wherever possible. Maximum divergence upstream of equipment to be 30 degree and 45 degree convergence downstream. Angles are measured as total included angle (both sides).

.5 Rigidly construct low pressure metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate or sag. Caulk duct joints and connections with approved duct sealant during duct assembly.

.6 Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10% of duct area, split into two ducts maintaining original duct area.

.7 Provide necessary baffling in mixed air plenums to ensure good mixed air temperature with cross sectional variations of not more than 5°C (9°F) under all operating conditions.

.8 Fabricate continuously welded medium pressure round and oval duct fittings of one gauge heavier than gauges indicated for duct size. Joints shall be 100 mm (4") cemented slip joint, brazed or electric welded. Prime coat welded joints. Fabricate elbows of five piece construction. Provide standard conical 45° takeoffs unless otherwise indicated where conical 90° tee takeoff connections may be used. Adequately brace with truss couplings or companion angle flanges with gaskets bolted at 150 mm (6") centres.

.9 Fabricate plenums and casings to configurations shown on drawings. Construct plenums of galvanized panels joined with standing seams on outside of casing riveted or bolted on approximately 300 mm (12") centres. Reinforce with suitable angles and provide diagonal bracing as required. Tightly fit at apparatus and caulk with sealant.

.10 Reinforce door frames with angle iron tied to horizontal and vertical plenum supporting angles. Install hinged access doors where shown, specified or where required for access to equipment for cleaning and inspection.

**2.5 Sealant**

.1 Sealant: Oil resistant, polymer type flame resistant duct sealant. Temperature range of -35°C (-31°F) to 93°C (200°F).

.1 Acceptable Material: Duro Dyne S-2.

**2.6 Tape**

.1 Tape: Polyvinyl treated, open weave fiberglass tape, 50 mm (2") wide.

.1 Acceptable Material: Duro Dyne FT-2.

**2.7 Fittings**

.1 Fabrication: to SMACNA.

.2 Mitred Elbows:

.1 To 400 mm (16"): with single thickness turning vanes.

.2 Over 400 mm (16"): with double thickness turning vanes.

**2.8 Hangers and Supports**

.1 Strap Hangers: Of same material as duct but next sheet metal thickness heavier than duct. Maximum size duct supported by strap hanger: 800 mm (32").

.2 Hanger Configuration: to SMACNA.

.3 Hangers: Galvanized steel angle with galvanized steel rods to SMACNA.

.4 Upper hanger rod attachments:

.1 For steel joist: manufactured joist clamp or steel plate washer.

.2 For steel beams: manufactured top chord beam clamps.

.3 Acceptable Material: Figure 93 as manufactured by Grinnell.

**2.9 Access Doors**

.1 Coordinate with Section 15010 for access to concealed areas.

.2 Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and suitable quick fastening locking devices. Install minimum 25 mm (1") thick insulation with suitable sheet metal cover frame for insulated ductwork. Doors shall be minimum 300 mm (12") square, unless indicated otherwise on drawings, of same gauge as duct, and larger doors 2 gauges heavier than duct.

.3 Fabricate with two butt hinges fastened with two sash locks and outside handle for sizes up to 450 mm (18"), two hinges and two compression latches with outside and inside handles for sizes up to 600 x 1200 mm (24" x 48") and an additional hinge for larger sizes. For full body entry, handles that operate door locks are required on the interior as well.

**2.10 Fire Dampers**

.1 Fire dampers: arrangement Type A, B, C, listed and bear label of ULC, meet requirements of provincial fire authority and authorities having jurisdiction. Fire damper assemblies to be fire tested in accordance with CAN4-S112.

Utilization Schedule

| Location | Type |
|---|---|
| Behind grilles and louvers | A |
| Rectangular duct penetrating a rated assembly | B |
| Round duct penetrating a rated assembly | C |

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.3 Top hinged: offset, single damper, round or square; multi-blade hinged or interlocking type; roll door type; guillotine type; sized to maintain full duct cross section or 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 (1 5/8" x 1 5/8" x 1/8") retaining angle frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

**2.11 Fire Stop Flaps**

.1 To be ULC listed and labelled and fire tested in accordance with CAN4-S112.2.

.2 Construct of minimum 1.5 mm (0.06") thick sheet steel with 1.6 mm (16 gauge) thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.

.3 Flaps to be held open with fusible link conforming to ULC-S505 and close at 74°C (165°F).

**2.12 Single Blade Volume Dampers**

.1 Low velocity system single blade volume dampers shall be limited to maximum duct depths of 300 mm (12") and maximum duct widths of 1.2 metres (4').

.2 Volume dampers shall be minimum 0.76 mm (22 gauge) thick steel for duct widths up to 450 mm (18"), and 1.52 mm (0.06") thick steel for widths in excess of 450 mm (18"). Ducts 450 mm (18") maximum width shall utilize 10 mm (3/8") diameter axle pins, and ducts in excess of 450 mm (18") widths shall utilize 12 mm (1/2") axle rod. Pins and rods shall be cold rolled steel.

.3 Damper blades shall be die formed for reinforcement, with centre grooved and edges bent. Centre groove shall hold mounting pins and rod. Damper frame shall be mild steel channel with back stops at top and bottom. Bearings shall be oilite bronze press-fit into frame.

.4 Manual dampers shall have a locking quadrant to hold dampers in fixed position without vibration. Complete assembly shall be galvanized finish.

**2.13 Multiple Blade Volume Dampers**

.1 Use multi-blade dampers where damper width exceeds 300 mm (12"). Dampers to be Tamco Series 1000 except for exhaust/outdoor air intake and relief dampers, which are to be insulated Tamco series, 9000 BF.

.2 Frames shall be welded construction mild steel or aluminum channels, maximum size 1.2 metres (4') by 1.8 metres (6'). Larger sizes shall be made up of damper sections connected together vertically and horizontally. Frame net area shall equal duct area.

.3 Blades shall be 2.0 mm (14 gauge) thick extruded aluminum, with widths varying from 150 to 200 mm (6" to 8"). Blade edges shall be formed 12 mm x 12 mm (1/2" x ½") channel. Blades shall be centre reinforced to take axle rods.

.4 Synthetic bearings for each damper axle shall be press fitted into frame. Centre bar linkage shall be fitted with bearings interconnecting the blades with 8 mm (5/16") tie-rods to provide opposed blade action.

.5 Each damper section shall have side, top and bottom stops welded to frame.

.6 Fit extruded silicone rubber seals to damper sections used for total shut-off application, and face and bypass applications. Opposed blade arrangement to be rated at 0.6% leakage at 2500 Pa (10") static. Operating temperature range to be -40°C (-40°F) to 90°C (195°F).

.7 Manual dampers shall have a locking quadrant control. Motorized dampers shall operate external linkage on single section dampers and centre bar linkage on multiple sections. All steel components to be cadmium plated.

**2.14 Backdraft Dampers**

.1 Fabricate multi-blade, parallel action gravity balanced backdraft dampers with blades a maximum of 150 mm (6") width having felt or flexible vinyl sealing edges, linked together in rattle-free manner and with balance adjustment device to permit setting for varying differential static pressure.

**2.15 Flexible Connections**

.1 General HVAC System: Provide where indicated, at fans and at air handling units, neoprene coated flame proof fabric, minimum density 1.22 kg/$m^2$ (0.25 lb/$ft^2$), factory fabricated, not more than 150 mm (6") long between metal parts and installed with just sufficient slack to prevent vibration transmission. Allow 100 mm (4") movement to medium pressure fans and 50 mm (2") movement to low pressure fans.

**2.16 Turning Vanes**

.1 Provide small arc air foil hollow vanes for square elbows. Where acoustical lining is provided, provide turning vanes of perforated metal type with fibreglass core. Where centreline radius is less than 1-1/2 times turning dimension of duct, provide splitter vanes constructed and spaced according to the latest SMACNA Manuals.

**2.17 Instrument Test Ports**

.1 Zinc plated steel.

.2 Camlock handles with neoprene expansion plug and handle chain.

.3 28 mm (1 1/8”) minimum inside diameter.

## Part 3 Execution

### 3.1 Installation

.1 Provide openings in ductwork where required to accommodate thermometers, controllers and test openings. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.2 Clean duct systems and force air at high velocity through ducts to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect with filters, equipment which may be harmed by excessive dirt, or bypass during cleaning. Alternatively, clean duct systems with high power vacuum machines. Protect with filters, equipment which may be harmed by excessive dirt, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

.3 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

.4 Provide 0.5**%** slope underground ducts to low pumpout points. Provide access doors for inspection. Encase ducts in 80 mm (3.2”) minimum of concrete. Provide adequate tie-down points to prevent ducts from floating during concrete pour. Introduce no heat into ducts until 20 days after pouring of concrete.

.5 Set plenum doors 150 mm to 300 mm (6” to 12”) above floor.

.6 Connect terminal units to medium or high pressure ducts with 300 mm (12”) maximum length of flexible duct. Do not use flexible duct to change direction.

.7 Connect diffusers or troffer boots to low pressure ducts with 1500 mm (5’) maximum length of flexible duct. Hold in place with caulking compound, screws and strap or clamp.

.8 Install balancing dampers at all branch ducts and as indicated.

.9 Anchor all risers.

.10 Install fire dampers in accordance with NFPA 90A and the requirements of the damper listing.

.11 Install airtight access door and clean outs on upstream side of all reheat coils.

.12 Support flexible ducts at 1200 mm (4’) centres. Ensure bends are not tighter radius than standard 1 1/2 times duct width. Use pipe shields to support duct at hanger without sagging or compression.

.13 Do not break continuity of insulation vapour barrier with hangers or rods.

**3.2 Watertight Duct**

.1 Provide watertight ductwork for "Wet" air exhaust, humidifiers for 3000 mm (10') in all directions, fresh air intake and relief ducts under roof hoods, goosenecks or louvred penthouses.

.2 Form bottom of duct without longitudinal seams. Solder or weld joints of bottom sheets and sides. Solder or weld transverse joints and caulk.

.3 Fit base of risers with 150 mm (6") deep drain sump, 32 mm (1 ¼") drain connection, with deep seal trap and valved drain line to open funnel drain. Where ducts convey freezing air, provide remote trap.

**3.3 Plenum Gauges**

.1 Fabricate fan plenums and plenums downstream of fan in accordance with duct gauges.

.2 Fabricate plenums upstream of fan between apparatus of 1.6 mm thick (16 gauge) sheet metal.

.3 Fabricate plenums upstream of filters of 1.2 mm thick (18 gauge) sheet metal.

**3.4 Hangers**

.1 Strap hangers: install in accordance to SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with SMACNA.

**3.5 Sealing and Taping**

.1 Apply sealant to outside of joint to manufacturer's recommendations and specified pressure and seal class.

.2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturer's recommendations and specified pressure and seal class.

**3.6 Application**

.1 Provide adequately sized access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Review locations prior to fabrication.

.2 Provide 100 x 100 mm (4" x 4") quick opening access doors for inspection at balancing dampers on all rectangular ducts and on all round ducts over 250 mm (8") diameter.

.3 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated building components, and where required by authorities having jurisdiction. Fire dampers shall be complete with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges. Apply firestop and smoke seal products to seal all joints to the wall and sleeve.

.4 At each point where ducts pass through partitions, the joints around the duct shall be sealed with non-combustible material.

.5 Provide balancing dampers at points on low pressure supply, return and exhaust systems where branches are taken from larger duct and as required for proper air balancing.

.6 Provide balancing dampers on medium pressure systems where indicated. Splitter dampers shall only be used where indicated on the drawings.

.7 Install flexible connections in ducts connected to fans and equipment subject to forced vibration, immediately adjacent to equipment and where indicated on the drawings.

.8 For connection to medium pressure fans, install 12 mm (1/2") thick neoprene pad over fabric and hold in place with additional metal straps.

.9 Install all accessories in accordance with manufacturers recommendations.

**END OF SECTION**

## Part 1 General

### 1.1 References

.1 AMCA 99-1986, Standards Handbook.

.2 ANSI/AMCA 210-1985, Laboratory Methods of Testing Fans for Rating.

.3 AMCA 300-1985 Revised 1987, Reverberant Room Method for Sound Testing of Fans.

.4 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.5 ANSI/ASHRAE 51- 1985, Laboratory Methods of Testing Fans for Rating.

.6 CGSB 1-GP-181M-77, Coating, Zinc Rich, Organic, Ready Mixed.

### 1.2 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 01330 - Submittal Procedures.

.2 Provide:

.1 Fan performance curves showing point of operation, kW (BHP) and efficiency.

.2 Sound rating data at point of operation.

.3 Indicate:

.1 Motors, sheaves, bearings, shaft details.

.2 Minimum performance achievable with variable frequency drives or variable inlet vanes as appropriate.

### 1.3 Closeout Submittals

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01780 - Closeout Submittals.

### 1.4 Extra Materials

.1 Provide maintenance materials in accordance with Section 01780 - Closeout Submittals.

.1 Spare parts to include:

.1 One matched set of belts for each fan.

**1.5 Manufactured Items**

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

**Part 2 Products**

**2.1 Fans General**

.1 Capacity: flow rate, static pressure, bhp (W), revolutions per minute, power, model, size, and as indicated on schedule.

.2 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.

.3 Sound ratings: comply with AMCA 301, tested to AMCA 300.

.4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51. Unit shall bear AMCA certified rating seal, except for propeller fans smaller than 300 mm (12") diameter.

.5 Motors:

.1 In accordance with Section 15010, supplemented as specified herein.

.2 For use with variable frequency drives (VFDs) where indicated.

.3 Sizes as indicated.

.6 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and/or outlet safety screens as indicated. Inlet or outlet dampers and vanes and as indicated.

.7 Factory primed before assembly in colour standard to manufacturer.

.8 Scroll casing drains: as indicated.

.9 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.

.10 Vibration isolation: to Section 15072 - Vibration Isolation.

.11 Flexible connections: to Section 15800 - Ductwork.

**2.2 Centrifugal Roof Fans (F-1, F-2)**

.1 Fan wheels: Welded steel or aluminum construction.

.2 Housings: Spun aluminum with fabricated steel inlet cones, fabricated steel for wheels 300 mm (12") or greater, cast iron, steel, or aluminum, for smaller wheels, braced, and with welded supports.

.3 Acceptable material: Greenheck, Penn.

**2.3 Cabinet Fans (F-3, F-4, F-5)**

.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 motor.

.3 Fabricate casing of zinc coated or phosphate treated steel, reinforced and braced for rigidity. Provide removable panels for access to interior. Uncoated, steel parts shall be painted over with corrosion resistant paint. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with rigid acoustic insulation, pinned and cemented.

.4 Acceptable material: Greenheck, Penn, Cook.

## Part 3 Execution

**3.1 Fan Installation**

.1 Install fans as indicated, complete with resilient mountings specified in Section 15072 - Vibration Isolation, flexible electrical leads and flexible connections in accordance with Section 15800 - Ductwork.

.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.

**END OF SECTION**

## Part 1 General

### 1.1 General

.1 For additional information, refer to Section 15010 – Mechanical General Requirements and Division 1 - General Conditions of the Contract.

.2 For a list of applicable codes and standards, refer to Section 15010 – Mechanical General Requirements.

.3 The mechanical contractor shall be responsible for coordinating all aspects of this work.

.4 The positions indicated on the drawings are approximate only. Check the location of the outlets and make any necessary adjustments in positions to conform with the architectural features, symmetry and lighting arrangement.

### 1.2 Separate, Alternate Units Prices

.1 Provide the following separate, alternate and unit prices.

### 1.3 Scope of Work

.1 The scope of work for this section includes, but is not limited to, the following:

.1 Provision of all grilles, registers, diffusers and door grilles specified in this Section and shown on the Drawings.

.2 Provision of all exterior louvres, roof mounted hoods and gooseneck hoods specified in this Section and shown on the Drawings.

### 1.4 Shop Drawings

.1 Shop drawings shall be submitted for the following items:

.1 Grilles, registers, diffusers and door grilles.

.2 Exterior louvres, roof mounted hoods and gooseneck hoods.

.2 Shop drawings shall indicate the following:

.1 Size and free area.

.2 Noise level and throw characteristics at the specified air volumes.

.3 Mounting methods.

.4 Finish.

.5 Accessories such as volume control dampers and equalizing grids.

## Part 2 Products

### 2.1 General

.1 Air outlets shall be based on a noise level of NC30 maximum unless otherwise specified.

.2 Provide plaster frames for diffusers located in plaster surfaces.

.3 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces, such as acoustical plaster.

.4 Refer to Diffuser, Grille, Register and Louvre Schedule for Manufacturer's accessories.

### 2.2 Rectangular Ceiling Diffusers

.1 Air Pattern: $360^{o}$, fixed.

.2 Construction: steel, multi-core, stamped with sectorizing baffles where indicated on drawings.

.3 Accessories: frame suitable for ceiling type scheduled.

.4 Volume Control: radial opposed blade damper, adjustable from diffuser face, equalizing grid.

.5 Acceptable material: Price, Nailor, Titus.

### 2.3 Round Ceiling Diffusers

.1 Air Pattern: $360^{o}$, fixed.

.2 Construction: steel, multi-core, stamped or spun with sectorizing baffles where indicated on drawings.

.3 Accessories: 25 mm (1") duct collar and duct ring, plaster ring in plaster ceilings, suitable for ceiling type scheduled.

.4 Volume Control: radial opposed blade damper, adjustable from diffuser face, equalizing grid.

.5 Acceptable material: Price, Nailor, Titus.

### 2.4 Sidewall Supply Grilles

.1 Air Pattern: adjustable pattern with two way deflection.

.2 Construction: streamlined and adjustable 20 mm (3/4") deep curved blades on 20 mm (3/4") centres, constructed of extruded aluminum with mitred corners.

.3 Volume Control: integral, gang operated, opposed blade dampers with removable key operator, operable from face.

.4 Mounting: 30 mm (1-1/4") wide margin border frame with mitred corners and concealed clips.

.5 Acceptable material: Price, Nailor, Titus.

**2.5 Linear Bar Grilles (Sidewall/Sill Floor Mount)**

.1 Air Pattern: $0^{o}$ deflection.

.2 Construction: fixed bar type louvers parallel to long dimensions with 3 mm (1/8") thick x 13 mm (1/2") deep bars on 12 mm (1/2") centres with 25 mm (1") border, extruded aluminum.

.1 Floor mounted grilles shall feature heavy duty construction suitable for pedestrian traffic areas.

.3 Accessories: Provide blank off strips on inactive sessions.

.4 Volume Control: opposed blade damper, operable from face of grille.

.5 Mounting: concealed clips or screws where noted.

.6 Acceptable material: Price, Nailor, Titus.

**2.6 Ceiling Eggcrate Return/Exhaust Grilles**

.1 Construction: aluminum fixed grid of 13 x 13 x 13 mm (½" x ½" x ½").

.2 Mounting: 30 mm (1-1/4") frame with countersunk oval head screws, lay in frame for suspended grid ceilings, suitable for ceiling scheduled.

.3 Volume Control: integral, gang operated opposed blade damper with removable key operator, operable from face.

.4 Acceptable material: Price, Nailor, Titus.

**2.7 Sidewall Exhaust/Return Grilles**

.1 Construction: extruded aluminum or 0.9 mm thick (20 gauge) steel with 0.8 mm thick (22 gauge) x 20 mm (3/4") deep blades, $0^{o}$ deflection with horizontal blades spaced 20 mm (3/4") on centre.

.2 Volume Control: integral, gang operated, opposed blade dampers with removable key operator, operable from face.

.3 Mounting: 30 mm (1-1/4”) wide margin border frame with mitred corners and countersunk oval head screws.

.4 Acceptable material: Price, Nailor, Titus.

**2.8 Door Grilles**

.1 Construction: V-shaped louvers constructed of 1.0 mm thick (20 gauge) steel, 25 mm (1”) deep, 13 mm (1/2”) on centre with 1.0 mm thick (20 gauge) steel frame with auxiliary frame to give finished appearance on both sides of door.

.2 Mounting: countersunk, oval head screws.

.3 Acceptable material: Price, Nailor, Titus.

**2.9 Air Intake/Exhaust Louvers**

.1 Construction:

.1 Aluminum: 2 mm thick (14 gauge) extruded aluminum blades and frame, welded construction.

.2 Steel: 1.6 mm thick (16 gauge) steel frames and blade, welded construction with exposed joints ground flush and smooth.

.2 Louver Depth: 100 mm (4”).

.3 Blade Configuration: storm-proof blades on 30° slope with 20 mm (3/4”) vertical/horizontal top and bottom margins, horizontal middle "ridge" over entire length on each blade for water protection, blades spaced on 125 mm (5”) centre, maximum blade length 1,500 mm (60”).

.4 Mounting: countersunk screws in frame to fasten into jamb.

.5 Accessories: 13 mm (1/2”) square exhaust, 25 mm (1”) square, 2 mm thick (14 gauge) intake birdscreen in frames; middle mullions at maximum 1,500 mm (60”) on centre, folded extruded aluminum.

.6 Finish:

.1 Steel: baked enamel, colour selected by Contract Administrator from manufacturer's standard colour range.

.2 Aluminum: baked enamel, colour selected by Contract Administrator from manufacturer's standard colour range.

.7 Louver Free Area: as specified in the attached schedule on the drawings.

.8 Air Intake Louver Water Penetration: not to exceed 43 $g/m^2$ (0.14 $oz/ft^2$) of free area when tested to AMCA Standard 500.

.9 Pressure Loss: as specified in the Air Outlet Schedule on the drawings.

.10 Acceptable material: Airolite.

**2.10 Goosenecks**

.1 Construction: fabricate to SMACNA Low Pressure Duct Construction Standards, minimum thickness of 1.2 mm (18 gauge) galvanized steel.

.2 Accessories: 13 mm (1/2") square mesh by 2 mm thick (14 gauge) birdscreen.

.3 Roof Clearance: minimum 900 mm (36") above roof.

## Part 3 Execution

**3.1 Installation**

.1 Make airtight connections between diffusers and ductwork.

.2 Provide balancing damper on duct take-off to each diffuser at main branch take-off, even when volume dampers are specified as part of grille assembly. For details of balancing dampers, refer to Section 15800, Ductwork Accessories.

.3 Sizes indicated are nominal. Provide the correct standard product nearest to nominal, which delivers the capacity listed without an increase in noise level or pressure drop.

.4 Arrange to paint any ductwork which is visible behind air outlets-matte black.

.5 Confirm all air outlet/inlet and louver dimensions. Coordinate mounting details, finish and colours with ceiling and wall construction prior to submitting shop drawings.

.6 Adjust supply outlets to deliver patterns defined on drawings or as directed by Contract Administrator.

.7 Provide factory finish on each air inlet/outlet, louver and intake hood as indicated on the Air Outlet Schedule on the drawings.

.8 Mount roof hoods and goosenecks on a 300 mm (12") high curb base.

**END OF SECTION**

## Part 1 General

### 1.1 General Scope And Related Work

.1 All Work required by these Controls Specifications, Schedules, Point Lists and Drawings shall be coordinated and provided by the single Contractor referenced in these Specifications as the Controls Contractor.

.2 If the Controls Contractor believes there are conflicts or missing information in the Contract Documents then the Contractor shall promptly request clarification and instruction from the Consultant before proceeding.

.3 The Controls Contractor shall have visited the Project site and obtained information as necessary prior to submittal of the bid to ensure that prevailing physical conditions and Project arrangements that may be material to the performance of the Work have been ascertained and accommodated in the bid. No claims for additional payments will be accepted due to the Contractor's failure to complete this survey.

.4 If, in order to complete the Work of the Controls Contract, private and/or public telephone lines and connections, including ISDN lines and/or LAN/WAN support and connections, are required then these shall be provided by the Owner to the Controls Contractor, at the Owner's direct cost, in a timely manner.

.5 The owner has an existing central monitoring system in place. Where DDC points are identified as centrally monitored points, the controls contractor shall provide and install required hardware and software to interface to the owner's Johnson Controls Metasys EA servers and workstations. These are located at the Central Control Offices, 510 Main Street, Winnipeg, Manitoba.

.6 The facility has existing Johnson Controls DDC systems using N2 open communication bus technology. Where required, and identified in this specification, the controls contractor is to provide web sever (NAE) with N2 open bus(s) to interface existing systems to allow monitoring of these systems, per paragraph .5 above.

### 1.2 Controls Systems Description

.1 The Controls Contractor's work shall consist of the provision of all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, warranty, specified services and items required by the Contract that are required for the functional turn-key operation of the complete and fully functional Controls Systems.

.2 Provide a complete, neat and workmanlike installation. Use only employees who are qualified, skilled, experienced, manufacturer trained and familiar with the specific equipment, software and configurations to be provided for this Project.

.3 The Controls Contractor shall employ qualified and experienced Controls Systems, Software, Application Design, Installation and Project Supervision personnel to provide the specific solutions required to meet the Project requirements and who are available to undertake this work as scheduled.

.4 Manage and coordinate the Controls Systems work in a timely manner in consideration of the Project master schedules. Coordinate cooperatively with the associated work of the other trades so as to assist the progress and not impede or delay the work of associated trades.

.5 Controls Systems as provided shall incorporate, at minimum, the following integral features, functions and services:

.1 All automated monitoring, supervision, control, information storage and presentation as required by these Specifications.

.2 Operator information on all supervised building arrangements including but not limited to current status and value, historical archived information, summaries, analysis, displays, reports and operator control and management functions as required by the Specifications.

.3 The detection, annunciation and management of all alarm and unexpected conditions as required by the Specifications.

.4 The diagnostic monitoring and reporting of system functions, Nodes and communication networks.

.5 Interfaces between individual elements and the systems and networks provided by other trades as required by the Contract Documents.

.6 All other Controls Systems functions as required by the Contract Documents.

.6 The Controls System as provided shall comprise, at a minimum, the following primary elements:

.1 Operator Workstation(s) ( quantities and locations as specified in Section 3 of this specification)

.2 NAE Web Server

.3 Network and Application Nodes.

.4 Field Devices.

.5 Control wiring.

**1.3 Quality Assurance**

.1 General Requirements:

.1 The following companies are approved Controls Contractors

.1 Johnson Controls Branch Office

.2 All devices shall be CSA certified and UL or FM listed and labeled for the specific use, application and environment to which they are applied.

.3 All electronic equipment shall conform to the requirements of FCC regulations, part 15, section 15, governing radio frequency electromagnetic interference, and be so labeled.

.2 Workplace Safety And Materials Management

.1 Provide a safety program in compliance with the Contract Documents.

.2 The Controls Contractor shall have a comprehensive Safety Manual and a designated Safety Supervisor for the Project.

.3 The Contractor and its employees and sub trades shall comply with Federal, Provincial and local safety regulations.

.4 The Contractor shall ensure that all subcontractors and employees have written safety programs in place that cover their scope of work.

.5 Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.

.6 Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.

**1.4 Submittals**

.1 Shop Drawings, Product Data and Samples:

.1 The Controls Contractor shall submit shop drawings for review and acceptance by the Architect or Owner.

.2 Provide at minimum the following basic submittals:

.1 Individual System Schematics including sequences of operation.

.2 Complete Bill of Materials.

.3 Valve and Damper Schedules.

.4 Descriptions and/or product data sheets for all equipment, materials, software, firmware components and items to be furnished and provided. Information shall be Project specific and not general advertising.

.5 Samples of system graphic, zone control graphic and overall system Navigation Scheme.

.6 Details of telephone line, ISP and associated requirements to be provided by the Owner, at its cost, in order for the Contractor to complete the work.

.2 Operation and Maintenance Manuals

.1 At the completion of the project the Controls Contractor shall submit three sets of as-built documentation for the Owners Operation and Maintenance Manuals which shall include the following as a minimum:

.1 Name and address of installing contractor along with 24-hour emergency service telephone number.

.2 As-built version of Shop Drawings.

.3 Licenses, Guarantees and warranty documents for all equipment and systems.

.4 Include sections dedicated to software that includes a system overview and a detailed description of each software feature. The manual shall instruct the user on programming or re-programming any portion of the Controls Systems. Include complete documentation on all control programs, algorithms, setpoints, alarms, etc.

**1.5 Warranty**

.1 Standard Material and Labor Warranty:

.1 Provide a one-year labor and material Warranty on Controls Contract work provided under this Contract.

.2 If within twelve (12) months from the date of acceptance of the Controls Contract work and following receipt of written notice from the Owner the product is found to be defective in operation, workmanship or materials, then the product shall be promptly replaced, repaired or adjusted at the option of the Controls Contractor at the cost of the Controls Contractor.

.3 Maintain an adequate supply of materials available directly to the Project site such that replacement of key parts, including programming, may be promptly carried out. Warranty work shall be done during the Controls Contractor's normal business hours.

**Part 2 2.0 Products**

**2.1 Controls System Architecture**

.1 General

.1 The Controls Systems shall consist of Operator Workstations, Web Servers, Network and Application Nodes and their associated equipment connected by an industry standard communication network.

.2 The Interfaces provided shall incorporate complete tool sets, operational information displays, multi-Window displays and other interactive aids to assist interpretation and ease of use.

.3 The Workstations, Servers and principal network computer equipment shall be standard products of recognized major manufacturers available through normal

PC and computer vendor channels – not "Clones" assembled by a third-party subcontractor.

.4 Provide licenses for all software residing on and used by the Controls Systems and transfer these licenses to the Owner prior to completion.

.5 The networks shall, at minimum, comprise, as necessary, the following:

.1 Workstations – fixed and portable as required by the Specifications.

.2 Network computer processing, data storage and communication equipment including Servers and digital data processors.

.3 Routers, bridges, switches, hubs, modems, interfaces and the like communication equipment.

.4 Active processing Network and Application Nodes including programmable field panels and controllers together with their power supplies and associated equipment.

.5 Addressable elements, sensors, transducers and end devices.

.6 Third-party equipment interfaces as required by the Contract Documents.

.7 Other components required for a complete and working Control Systems as specified.

.6 The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, network and application nodes sensors and actuators. The system architecture shall support 300% expansion capacity of all types of nodes and point types included in the initial installation.

.7 The Specifications for the individual elements and component subsystems shall be minimum requirements and shall be augmented as necessary by the Contractor to achieve both compliance with all applicable codes, standards, the requirements of the AHJ (Authority having jurisdiction) at the site and to meet all requirements of the Contract Documents.

.2 Network

.1 The Controls Systems shall incorporate a primary Tier 1 network(s) utilizing standard Ethernet communications operating at a minimum speed of 10 Mb/sec. All Network Nodes, Web Servers, Configuration and Operator Workstations as a minimum shall reside on the primary Tier 1 network. At the Controls Contractor's option, they may also incorporate multiple and integrated secondary Tier 2 and tertiary Tier 3 networks

.2 The communication Network shall be based upon the following open architecture(s); BACnet in accordance with ANSI/ASHRAE Standard 135-2001.

.3 The networks shall utilize only copper and optical fiber communication media as appropriate and to comply with the applicable codes, ordinances and regulations and the AHJ. They may also utilize digital wireless technologies if required by the Project and approved by the Architect or Owner and the AHJ.

.4 The Owner shall provide all private and public telephones lines, ISDN lines and Internet Service Provider services and connections as necessary for the Controls Contractor to complete the work as contracted at the Owner's direct cost. The Controls Contractor shall identify the specific requirements in their shop drawing submittal.

**2.2 Operator Workstations**

.1 The Operator Workstations (OWS) shall provide the primary means of operator communication with the Controls Systems and shall be used for monitoring, operations, management, audit, reporting and other related functions. The OWS shall comprise PC and related facilities that have as their primary function the Operator Interface functionality. Refer to Part 3 herein for details of OWS quantities and locations.

.2 Each fixed OWS shall, at a minimum, consist of:

.1 Personal Computer c/w XP Professional

.2 Intel Pentium 4, 2.8 GHz, 1024 MB SDRAM

.3 120 GB, 7200 RPM Hard Drive

.4 24X DVD/CD-RW Combo Drive

.5 Full ASCII keyboard and optical Mouse.

.6 Full color, 19 inch flat screen display LCD native, minimum 1280 x 1024 resolution.

.7 Ink Jet Printer, 19 ppm monochrome, 14 ppm color

.3 The OWS shall be provided with all required and installed operating system, Application specific software and database support facilities, including the associated original manufacturer software licenses, as part of the base work and price of the Controls Contract. All software shall be to the original manufacturer's latest revision level at the time of delivery to Project site.

.4 Transfer all Controls Systems software licenses to the Owner, at no additional cost to the Owner, before the time of acceptance for the Work.

.5 The Controls Contractor will use the OWS and associated equipment as necessary for the purposes of setting up, calibrating and verifying the Work. This equipment and facilities shall be delivered to site and installed by the Contractor as late as is feasible in the scheduling of the Work and shall comprise the latest versions of these products available at the time of delivery.

**2.3 Operator Interfaces**

.1 General

.1 The Controls Systems Operator Interfaces shall be user friendly, readily understood and shall make maximum use of colors, graphics (floor plans,

individual system schematics), icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the displays by authorized users at the OWS.

.2 User access shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level and partitionable to accommodate the varied access requirements of the different user groups to which individual users may be assigned. Provide the means to define unique access privileges for each individual authorized user. Provide the means to on-line manage password access control under the control of a project specific Master Password.

.3 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

.1 User access for selective information retrieval and control command execution.

.2 Monitoring and reporting.

.3 Alarm and non-normal condition annunciation.

.4 Selective operator override and other control actions.

.5 Information manipulation, formatting, display and reporting.

.6 Controls Systems internal performance supervision and diagnostics.

.7 On-line access to user HELP menus.

.8 On-line access to current as-built records and documentation. At minimum, one (1) copy of all record documentation shall be stored on a designated OWS or Server and be accessible to the Owner.

.9 Means for the controlled re-programming, re-configuration of systems operation and for the manipulation of database information in compliance with the prevailing codes, approvals and regulations for the component applications and elements.

.4 Provide an audit trail of all user activity on the Controls Systems including all actions and changes.

.5 Provide on-line reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations, icons and the like to assist user understanding and interpretation. All text naming conventions shall be consistent in their use and application throughout the Controls Systems.

.2 Operator Interface

.1 The Operator Interface provided shall include the functionality to selectively combine data and information from any system element or component in the Controls Systems Application on a single window display panel at the Operator's option. This shall include both current information and historical data.

.2 Navigation Trees:

.1 Provide the capability to display multiple navigation trees that aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the Controls Systems networks.

.2 Provide the capability for the Operator to add custom trees. The Operator shall be able to define any logical grouping of systems or points and arrange them on the tree in any selected order. Provide the capability to nest groups within other groups.

.3 Divisible Display Windows:

.1 Provide for the operator to divide the display area within a single window into multiple display panels. The content of each display panel can be any of the standard summaries and graphics provided in the Controls Systems Application.

.2 Provide each display panel with minimize, maximize and close icons.

.4 Alarms:

.1 Alarms shall be routed directly from primary Controls Systems Application Nodes to OWS and Server(s). Provide for specific alarms from specific points to be routed to selectable OWS and Server(s). The alarm management portion of the Controls Systems Operator Interface software shall, at minimum, provide the following functions:

.1 Log date and time of alarm occurrence.

.2 Generate a “Pop-Up” window on the display panel, with audible alarm, informing the Operator that an alarm has been received.

.3 Allow an Operator, with the appropriate password, to acknowledge, temporarily silence or cancel an alarm.

.4 Provide an audit trail for alarms by recording user acknowledgement, deletion or canceling of an alarm. The audit trail shall include the ID of the user, the alarm, the action taken on the alarm and a time/date stamp.

.5 Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop-up window described herein. Controls Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.

.6 Provide for any attribute of any object in the Controls Systems to be designated to report as an alarm.

.7 Provide the ability to add, delete or modify alarms.

.2 The Controls Systems Application shall annunciate systems diagnostic alarms indicating system failures and non-normal operating conditions.

.3 Provide the on-line means to display alarms by date/time of occurrence, priority class, point designation, value or other defined text keywords.

.5 Operator Transactions:

.1 Provide the means to automatically record all Operator activities on the Controls Systems Application for the recall of same for reporting.

.2 Provide the means to sort and report activities by Operator, date/time, activity type and system area.

.3 Provide access protection to preclude the unauthorized removal or tampering with records.

.6 Reports:

.1 Reports shall be generated and directed to the user interface display or printer. As a minimum, the Controls Systems Application shall provide the following reports:

.1 All points in the Controls Systems Application.

.2 All points in a user-defined group of points.

.3 All points currently in alarm.

.4 All points locked out.

.5 All Controls Systems Application schedules.

.6 All user defined and adjustable variables, schedules, interlocks, diagnostics, systems status reports and the like.

.2 Provide all applicable original manufacturers standard reports for the Controls Systems.

.7 Dynamic Color Graphics:

.1 Provide for any number of real-time color graphic displays shall be able to be generated and displayed in the Controls Systems Application limited only by memory data storage capacity.

.2 Values of real-time attributes displayed on the graphics shall be dynamic and updated on the displays.

.3 The graphic displays shall be able to display and provide animation based on real-time data that is acquired, derived or entered into the operating Controls Systems.

.4 Provide for the Owner to be able to change values (setpoints) and states in system controlled equipment directly from the graphic display.

.5 Provide a graphic editing tool that allows for the creation and editing of graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the Controls Systems.

.8 Schedules:

.1 Provide multiple schedule input forms for automatic time-of-day scheduling and override scheduling of operations. At a minimum, the following schedule types shall be accommodated:

.1 Weekly schedules.

.2 Temporary override schedules.

.3 Special “Only Active If Today Is A Holiday” schedules.

.4 Monthly schedules.

.2 Schedules shall be provided for each group, system and sub-system in the Controls Systems Application. It shall be possible to include all or any commandable points residing within the Controls Systems in any custom schedule. Each point shall have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.

.3 Multiple monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

.9 Trending And Data Collection:

.1 Trend and store point data for all actual and virtual (software) points and values as required by the Owner.

.2 At a minimum, provide the capability to:

.1 Add / Modify and Delete Trends

.2 Display trend data in textural and / or graphical format

.3 Display multiple points in a single trend study.

.10 Operator Access Security (Combined Password and User ID):

.1 Provide for Operator access into the Controls Systems via the use of on-line Owner defined software Password and User Identification (ID) pairs, unique for each Operator and unique throughout the Controls Systems Application, to supplement standard OWS password access control.

.2 Stored password/user ID definitions shall be stored in encrypted formats.

.3 Password logins shall not be echoed on any screen or printer except during Master Password definition processes. An Operator defining a password shall be required to re-enter to confirm authenticity.

.4 Operator access privileges shall be definable in terms of functions and Project areas.

.5 As part of the access privileges definition for each user the Owner shall be able to define at minimum the following:

.1 Access times by day.

.2 Permanent or temporary, with expiry date, password.

.3 Number of incorrect access attempts allowed before the password is disabled.

.4 Whether or not the Operator is able to redefine their own password.

.5 A field for the Operator's e-mail address.

.6 A field for the Operator's contact phone number.

.7 Definition of the Operator's access privilege functionalities including viewing only, full control, selected functions, etc.

**2.4 Web Server**

.1 General

.1 The Controls Systems shall support multiple remote Web based User Interfaces through a Web Server.

.2 The Web Server shall support an unlimited number (non simultaneous) of remote Web based User Interface(s) utilizing a mix of local Intranet, the Internet, telephone and cable modem connections.

.2 Web Server

.1 The Web Server shall be provided with all required and installed operating system, Browser, management, end user, and application specific software and database support facilities, including the associated original manufacturer software licenses. All software shall be to the original manufacturer's latest revision level at the time of delivery to Project site.

.2 The Web Server hardware and software configuration shall be selected to support the number of installed Network and Application Nodes.

.3 The Web Server shall include either a software or hardware firewall.

.3 Web Based User Interface

.1 The Web Interface(s) shall be provided to operate through an IT industry standard Web Browser such as Internet Explorer or Netscape.

.2 The Web Interface(s) provided shall incorporate complete tool sets, operational information displays, multi-Window displays and other interactive aids to assist interpretation and ease of use.

.3 The Web Interface(s) provided shall not require the procurement or licensing of any special or proprietary software from the Controls Contractor or its suppliers. In the event that specialized proprietary software is required, the Controls Contractor shall provide to the owner under this contract 10 licensed copies of the proprietary software.

.4 The Web Interface(s) shall support the following functions at a minimum:

.1 User Name and Password restricted access.

.2 Easy to use "tree" diagram access to the following functions

.1 Display of Graphical System representations with dynamic real-time data.

.2 Trend Data Display

.3 Addition and Deletion of Trend Studies

.4 Scheduling display and adjustment

.5 Alarm Summary Display and Alarm Management Functions.

.6 Adjustment and Override of Operating Parameters

**2.5 Network and Application Nodes**

.1 General

.1 The Controls Systems shall be composed of a mixture of Network and Application Nodes as required to meet the project requirements.

.2 The Nodes shall be designed, packaged, installed, programmed and commissioned in consideration of their specific service and prevailing operating conditions. They shall be proven standard product of their original manufacturer.

.3 A failure at a Node shall not cause failures or non-normal operation at any other system Node other than the possible loss of active real-time information from the failed Node.

.4 Ancillary equipment, including interfaces and power supplies, shall not be operated at more than 80% of their rated service capacity.

.2 Network Nodes

.1 The Controls Systems Tier 1 Network Nodes shall be designed and implemented entirely for use and operation on an Ethernet TCP/IP network such as the Internet or the Owner's Intranet. This functionality for operational access shall extend down to the field panel and field point level.

.2 The Tier 1 Network Nodes shall be fully IT compatible operating over industry standard IT infrastructure. The Controls Contractor shall coordinate with the IT infrastructure support staff or trade contractors to ensure compatibility and performance of the operation of the Controls Systems over the LAN/WAN made available for its shared use.

.3 The Tier 1 network shall be configured on IT industry standard off-the-shelf technologies

.4 Network Nodes may act as Application Nodes.

.3 Application Nodes:

.1 Application Nodes (AN) shall provide both standalone and networked direct digital control of mechanical and electrical building systems as required by the Specifications.

.2 Each AN shall retain program, control algorithms, and setpoint information for at least 72 hours in the event of a power failure and shall return to normal operation upon stable restoration of normal line power.

.3 Each AN shall monitor its communication status and provide a system advisory upon communication failure and restoration.

.4 The AN shall provide the functionality to download and upload configuration data

.5 The AN shall perform the functional monitoring of all Controls Application variables, both from real hardware points, software variables, and controller parameters such as setpoints.

.6 The AN shall be designed, packaged, installed, programmed and commissioned in consideration of their specific service and prevailing operating conditions. They shall be proven standard product of their original manufacturer and not a custom product for this project.

.7 HVAC Systems

.1 Central HVAC Systems

.1 Standalone AN(s) shall be provided and programmed to control the Central Air Handlers, Heating and Cooling Plants as described in the sequence of operation

.2 Terminal HVAC Systems

.1 A dedicated AN shall be provided and configured for each Terminal HVAC Unit (CV and VAV Boxes, Dual Duct Boxes, Fan Coil Unit, Heat Pump, Unit Ventilator, packaged RTU, etc.)

.2 The Zone Temperature sensor associated with each AN controlling a CV, VAV or Dual Duct Box shall provide the ability (password protected access) to setup the box operating parameters (min/max flows, flow pickup Area, flow pickup K factor, etc.) or shall support the plug-in (at the sensor) of a portable service tool to do the same,

.3 Standalone AN(s) shall be provided and configured to control heating and cooling elements such as Wall Fin Radiation, Ceiling Radiant Heating and or Cooling, In-floor radiant Heating, Unit Heaters and Force Flows as called for in the sequences of operation.

.3 Mechanical Equipment with Microprocessor based Controls

.1 Controls Contractor shall integrate real-time data from building systems supplied by other trades and databases originating from other trades as called for in the sequences of operation.

.2 The Controls Systems shall include necessary hardware, equipment and software to allow data communications between the Controls Systems and building systems supplied by other trades.

.3 The trade contractors supplying other associated systems and equipment shall provide their necessary hardware and software at their cost and shall cooperate fully with the Controls Contractor in a timely manner and at their cost to ensure complete functional integration.

.4 Software:

.1 The Application and/or Network Nodes shall support the following standard programming capabilities as required to achieve the specified sequences of operation.

.1 Execute custom, job-specific processes defined by the user to automatically perform calculations and special control routines using:

.1 System measured point data

.2 Calculated data

.3 The results from other processes

.4 User defined constants

.5 Arithmetic functions

.6 Boolean Logic Operators

.7 Proportional plus Integral plus Derivative Control Algorithms as required.

.2 The Application and/or Network Nodes shall support the following software features:

.1 Event Messaging: Provide for the automatic execution of user-defined messages on the occurrence of each predefined real-time event including equipment/point status change, approaching limit or alarm, time of day and the like.

.2 Optimum Start/Stop: Provide software to start equipment on a sliding schedule based upon indoor and outdoor conditions. Determine the minimum time of HVAC system operation needed to satisfy the space environmental requirements. The program shall also determine the earliest possible time to stop the mechanical systems. The optimum start/stop program shall operate in conjunction with, and be coordinated with, the scheduled start/stop and night setback programs.

.3 Auto Alarm Lockout: Provide for scheduled and automatic lockout of alarm annunciation from equipment during non-normal operating conditions including shutdown, emergency power operation, filter alarm and the like.

.4 Energy Metering: Provide software to monitor and totalize consumption as measured by the defined pulse meters.

.5 Event Initiated Programs and Custom Logic: Provide software to define custom logic sequences that reside in the Application and/or Network Nodes.

.6 Heavy Load Delays: Provide software to achieve protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical or other defined loads.

.7 Runtime Totalization: Automatically sample, calculate and store runtime hours for binary input and output points as listed in the point schedule of this specification.

.8 Analog/Pulse Totalization: Sample, calculate and store consumption totals on a daily, weekly or monthly basis for user-selected analog and 2 binary pulse input-type points.

.9 Binary Totalization: Provide totalization for binary event counters.

**2.6 Controls Systems Field Devices**

.1 Input Devices:

.1 Temperature Sensors

.1 Outdoor Air Temperature Transmitter shall contain an RTD sensing element mounting in an enclosure rated for outdoor use. The output shall be compatible with the panel it serves. Transmitter shall be factory calibrated to an accuracy of + 1% over the full range.

.2 Pipe Temperature Transmitter shall contain an RTD sensing element to monitor water temperature. The Contractor shall provide brass wells of sufficient size for the pipe to be installed. The output shall be compatible with the panel it serves. Transmitter shall be factory calibrated to an accuracy of + 1% over the full range.

.3 Duct Type Temperature Transmitter shall be a general purpose RTD sensing element, moisture resistant transmitter for mounting into a duct. The operating range shall be as indicated with an accuracy of + 1% over the full range. The output shall be compatible with the panel it serves.

.4 Duct Averaging Type Temperature Transmitter shall be a general purpose RTD sensing element, moisture resistant transmitter for mounting into a duct. The operating range shall be as indicated with an accuracy of + 1% over the full range. The output shall be compatible with the panel it serves. The sensing element shall be of sufficient length to provide a minimum of one (1) foot of element for every two (2) square feet of coil area.

.5 Space Temperature Transmitter shall contain an RTD sensing element to monitor room air temperatures in the range of 30 degrees F to 90 degrees F, unless indicated otherwise. The transmitter shall be factory calibrated to an accuracy of + 1%. The output shall be compatible with the panel it serves. Transmitter shall be factory calibrated to an accuracy of + 1% over the full range.

.2 Humidity Sensors

.1 Humidity Transmitter Outside Air shall be capable of providing continuous measurement of percent relative humidity with an accuracy of + 2% over the range 20 to 90% RH. The output shall be a proportional 4

– 20 mA or VDC signal. Transmitter shall have outside weather enclosure. Transmitter shall be General Eastern RH-1 or equal.

.2 Humidity Transmitter Duct shall be capable of providing continuous measurement of percent relative humidity with an accuracy of + 4% over the range of 10 to 80% RH. The output shall be a proportional 4 – 20 mA or VDC signal.

.3 Humidity Transmitter Space shall be capable of providing continuous measurement of percent relative humidity with an accuracy of + 3% over the range of 20 to 60% RH. The output shall be a proportional 4 – 20 mA or VDC signal.

.3 Pressure Sensors

.1 Pressure Transducers for steam service shall utilize a stainless steel sensor. The device shall output a 4-20 mA or VDC signal which is linear in relation to the sensed pressure. Accuracy shall be + 0.5% of the full scale. Power shall be from the controller and range from 22-26 volts DC. The unit shall have temperature compensation so that thermal effects are no more than + .05% of the full scale from 0-175 DEGF. The unit shall be suitable for the media and pressure measured.

.2 Differential Pressure Transducer shall be for air or water service. The device shall output a 4-20 mA or VDC signal which is linear in relation to the sensed pressure. Accuracy shall be + 0.5% of full scale. The power shall be from the controller and shall be in the range of 22-26 volts DC. The unit shall have temperature compensation so that thermal effects are no more than + .05% of the full scale from 32-100 DEGF. The transducer shall be suitable for the media and pressure measured.

.4 Safeties and Alarms

.1 Low Limit Thermostats shall be of manual reset type, with setpoint adjustment. The sensing element shall be of sufficient length to provide a minimum of one (1) foot of element for every two (2) square feet of coil area. The element shall run fully across the coil on each pass. When any one foot of the element senses a temperature as low as the setpoint, the thermostat contacts shall open. These shall contain double pole switches for simultaneous remote alarms or as desired.

.2 Differential Pressure Switch for water shall have a single-pole, single-throw (SPST) contact, adjustable setpoint, UL rated 6 amperes at 120 volts, 100 psig design.

.3 Differential Pressure Switch for air shall have a single-pole, single-throw (SPST) contact, adjustable setpoint, UL rated 9.8 amperes at 120 volts

.4 Current Sensing Transducers shall be self-powered, solid state with adjustable trip current. Each transducer shall be selected to match the current and voltage of the application. The output shall be compatible with the panel it serves. Each transducer shall include an LED to indicate output status.

.5 Specialty Sensors

.1 Carbon Dioxide Transmitter shall be capable of providing continuous measurement of Carbon Dioxide levels with an accuracy of + 50 ppm over the normal operating range of 400 – 1000 ppm. Transmitter shall utilize microprocessor based temperature compensated infrared sensing technology.

.2 Output Devices:

.1 Control Dampers:

.1 Dampers required in the temperature and smoke control functions of the automatic control system shall be sized as shown on drawings or as specified.

.2 All damper frames shall be constructed of 13 gauge galvanized sheet metal or extruded aluminum of 12 gauge thickness, and shall have a flange or duct mounting. The blades shall be parallel or opposed, as required, and suitable for the air velocities to be encountered in the system. Replaceable Butyl rubber seals are to be provided on damper blades and installed along with the top and bottom of the frame. Stainless steel damper blades and seals shall be installed inside the frame sides. Seals and bearings shall be able to withstand temperatures ranging from - 40°C to 93°C (- 40°F to 200°F).

.3 Dampers shall be leak rated for 15.2 lps/$m^2$ ( 3 cfm/$ft.^2$) at 250 kPa (1" WC) and 20 CFM/foot. squared at 1000 kPa (4" WC) or less in full closed position at 1000 kPa (4" WC) pressure differential across damper.

.4 Damper blades shall not exceed 150 mm (6") in width. All blades are to be corrugated type construction, fabricated from two sheets of #22 gauge galvanized sheet steel, spot welded together. Blades are to be suitable for high velocity performance.

.5 Dampers shall be Ruskin CD-60 or equivalent.

.6 All smoke control dampers must conform to UL5555 and be Ruskin SD-60 or equivalent.

.2 Control Valves:

.1 Valves shall be sized by the control manufacturer to produce the required capacity at a pressure loss not exceeding the allowable pressure drop indicated on the drawing.

.2 Nominal body rating shall be not less than 860 kPa (125 PSI). However, the valve body and packing selected shall be sized to withstand the system static head plus the maximum pump head and the maximum temperature of the control medium, chilled water, steam, and/or hot water.

.3 Two-way modulating valves shall have close-off ratings exceeding the maximum pressure difference, at any load condition, between the outlet

and inlet. Each valve shall be equipped with proper packing to assure there will be no leakage at the valve stem.

.4 Terminal unit two-way control valves shall have equal percentage characteristics. Terminal unit three-way control valves shall have linear flow characteristics.

.5 Valve sizes 12 mm to 50 mm (½" to 2") shall have screwed connections. Valve sizes 63 mm (2-1/2") and larger shall have flanged connections.

.3 Damper and Valve Operators:

.1 Damper and valve operator shall be electric and be provided for each automatic damper or valve and shall be of sufficient capacity to operate the damper or valve under all conditions and to guarantee tight close-off of valves, as specified, against system pressure encountered.

.2 Damper operators shall be direct drive and equal to those manufactured by Belimo. Provide sufficient quantity of damper operators to provide a minimum of _____ 5 in-lbs of torque for every square foot of damper area.

.3 Each central system damper or valve operator shall be provided with spring-return for normally closed or normally open position for fail safe operation to account for fire, low temperatures, or power interruption as indicated or as appropriate.

.4 Electric to Pressure Transducers:

.1 Electric to pressure transducers shall be used to interface to pneumatically actuated field devices.

.2 Transducers shall produce a high volume pneumatic output.

.3 Transducers shall include both zero and span adjustment capabilities.

## Part 3 3.0 Execution

### 3.1 Installation Practices:

.1 Controls Systems Wiring

.1 All conduit raceways, wiring, accessories and wiring connections required for the installation of the Controls Systems shall be provided by the Controls Contractor except as shown on the Electrical Trade documents. All wiring shall comply with the requirements of applicable portions of the Electrical Trade work and all local and national electric codes and the requirements of the AHJ.

.2 All Controls Systems wiring materials and installation methods shall comply with the original equipment manufacturer recommendations and standards.

.3 The sizing type and provision of cable, conduit, cable trays and raceways shall be the design responsibility of the Controls Contractor.

.4 Class 2 Wiring

.1 All Class 2 (30VAC or less) wiring shall be installed in conduit unless otherwise specified.

.2 Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5 ft. from the building structure. Wiring shall be installed parallel to the building structural lines.

.5 Class 2 signal wiring and 24VAC power may be run in the same conduit. Power wiring 120VAC and greater shall not share the same conduit with Class 2 signal wiring.

.2 Line Voltage Power Sources

.1 120-volt AC circuits for the Controls Systems shall be taken by the Controls Contractor from electrical trade panelboards and circuit breakers as designated on the electrical drawings.

.2 Circuits used for the Controls Systems shall be dedicated to these Controls systems and shall not be used for any other services.

.3 Controllers for powered terminal units may use 120-volt AC power from motor power circuits.

.3 Controls Systems Raceways

.1 All wiring shall be installed in conduit or raceway except as noted elsewhere in the Specification.

.2 Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.

.3 All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the supporting surface.

.4 UL/ULC Listed Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls and for final connection to equipment.

.4 Field Panel Installation And Location

.1 The Controls Systems panels, enclosures and cabinets shall be located as coordinated with the Architect at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.

.2 All field devices shall be installed per the manufacturer recommendation and in accessible locations as coordinated with the Architect.

.3 Panels to be located in damp areas or areas subject to condensation shall be mounted with wall standoffs.

.4 Conduit configurations entering or leaving panels and devices shall be such as to preclude condensation traps.

.5 Identification

.1 All control components and services shall be identified with appropriately sized lamecoid labels with a unique name/number referencing item back to the shop drawings and or maintenance manuals.

.2 All control wiring conduits shall be color-coded and identified so as to be distinguishable from standard electric conduiting.

.3 Clearly identify all controls LAN hubs and racks.

.4 All control wiring terminations shall be taqgged and referenced.

**3.2 Verification:**

.1 Fully test and verify all aspects of the Controls Systems Contract work on a point/system/integrated operational basis for all points, features and functions specified.

.1 Test each digital output for proper results from the Operator Workstation.

.2 Test each analog output by sending commands from the Operators Workstation to stroke an actuator throughout its range.

.3 Test each digital input for proper verification at the Operators Workstation. Jumper digital alarm inputs as required.

.4 Calibrate all temperature, humidity and pressure sensors with a hand held digital meter with equal or better accuracy.

.5 All software programs shall be fully tested to eliminate any glitches and to ensure conformance with the specifications. A system shall be considered commissioned when all alarms and system values are appropriate for the control sequence defined. Submit history logs for approval.

.2 Provide all necessary specialist labor, materials and tools to demonstrate to the Architect that the Controls Systems have been verified and are operating in compliance with the Controls Systems Contract.

.3 Promptly rectify all deficiencies and submit in writing to the Architect a signed report that this has been done.

.4 The Architect will retest the deficiencies in conjunction with the Controls Contractor at the Architect's option.

**3.3 Training:**

.1 The Controls Contactor shall provide the following training services for up to three (3) Owner's Representatives at common sessions:

.1 Provide two (2) full days of on-site training by a Field Technician who is fully knowledgeable of the specific installation details of the Project. This training shall, at a minimum, consist the following:

.1 Review of project documentation control system software layout and naming conventions

.2 Basic Controls System operation.

.3 System reporting and alarm management.

.4 Scheduling and point trending.

.5 Setup of Paging feature.

.2 Should the Web based user interface differ from the Operator Interface provide an additional two (2) full days of on-site training consisting of the following:

.1 Basic User Interface operation.

.2 System reporting and alarm management.

.3 Scheduling and point trending.

**3.4 Schedule of Workstations and Web Servers.**

.1 Provide a new OWS in _____.

.2 Provide a new CWS in _____.

.3 The Controls Contractor shall utilize their own CWS to setup and verify the complete installation.

.4 Provide a new Web Server located as suitable for this installation. The Owner shall supply Personal Computers to be used for remote access to the Controls Systems through the Web Server.

**3.5 System Graphics**

.1 Provide Home Navigation graphics complete with links to each central system graphic and one or more floorplan graphics

.2 Provide individual Color Graphics for each central Air Handler, Heating and Cooling System

.3 Provide one or more floorplan graphics with indication of each measured space temperature.

.1 Include a link on the floorplan graphic from each space temperature indicator to its associated terminal unit control graphic.

**3.6 Sequences of Operation:**

**END OF SECTION**

## Part 1 General

### 1.1 General

.1 Mechanical General Conditions, Section 15010, shall be part of this Section.

.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do all other work as specified in this Section.

### 1.2 Qualifications of TAB Personnel

.1 Names of all personnel proposed to perform TAB to be submitted to and approved by the Contract Administrator within 90 days of award of contract.

.2 Provide documentation confirming qualifications and successful experience when requested.

.3 Personnel performing TAB to be current member(s) in good standing of Associated Air Balance Council (AABC) and qualified to standards of AABC.

.4 Quality assurance: perform TAB under direction of superior qualified to AABC standards.

### 1.3 Purpose of TAB

.1 Testing to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, peak loads and as otherwise detailed.

.2 Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with all other related systems under all normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges where described.

### 1.4 Exceptions

.1 TAB of systems and equipment regulated by codes, standards to be 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 so as 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. Interlocks as defined in system controls and/or electrical sections.

**1.6 Pre-TAB Review**

.1 Review contract documents before project construction is started and confirm in writing to Contract Administrator adequacy of provisions for TAB and all other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Contract Administrator in writing all proposed procedures which vary from standard.

.3 During construction, coordinate location and installation of all TAB devices, equipment, accessories, measurement ports and fittings.

**1.7 Start-Up**

.1 Perform TAB after equipment start-up has been performed by Mechanical Contractor or other authorized parties.

**1.8 Operation of Systems During TAB**

.1 Operate systems for length of time required for TAB and as required by Contract Administrator for verification of TAB reports.

**1.9 Start of TAB**

.1 Notify Contract Administrator 7 days prior to start of TAB.

.2 Start TAB only when building is essentially completed, including:

.1 Installation of ceilings, doors, windows, other construction affecting TAB.
.2 Application of weatherstripping, sealing, caulking.
.3 All pressure, leakage, other tests specified elsewhere Division 15.
.4 All provisions for TAB installed and operational.
.5 Start-up, verification for proper, normal and safe operation of all 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 All 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 All HVAC systems: plus 10%, minus 5%.

.2 Hydronic systems: plus or minus 10%.

**1.11 Instruments**

.1 Submit to Contract Administrator a list of instruments used together with serial numbers as part of TAB report.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate mechanical and electromechanical within 3 months of TAB. Provide letter of certification that electronic devices are operating within tolerance under bench test conditions. Include certificate of calibration and certification letter(s) in TAB report.

.4 Measured values to be accurate to within plus or minus 2% of actual values.

**1.12 Submittals**

.1 Submit, prior to commencement of TAB:

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

**1.13 TAB Report**

.1 Format to be in accordance with AABC.

.2 Provide draft report, prior to submission of final TAB report, with all field test results.

.3 TAB report to show all results to match construction drawings or use dual units (metric/imperial)

.4 Submit 6 copies of TAB report to Contract Administrator for approval, in English, in D-ring binders, complete with index tabs.

.5 Revise and resubmit TAB reports to include any comments or clarifications requested following Contract Administrator's review.

.6 Base building plans in AutoCad format will be made available to TAB for use in report preparation.

**1.14 Verification**

.1 All reported results subject to verification by Contract Administrator.

.2 Provide manpower and instrumentation to verify up to 10% of all reported results.

.3 Number and location of verified results to be at discretion of Contract Administrator.

.4 Bear costs to repeat TAB as required to satisfaction of Contract Administrator.

**1.15 Settings**

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

.2 Permanently mark all settings to allow restoration of any time during life of facility. Markings not to be eradicated or covered in any way.

**1.16 Completion of TAB**

.1 TAB to be considered complete only when final TAB report received and approved by Contract Administrator.

**1.17 Air Systems**

.1 Standard: TAB to be to most stringent of this section and TAB standards of AABC.

.2 Do TAB of all ventilation systems shown on drawings.

.3 Measurements: to include, but not limited to, the following 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, vibration.

.4 Locations of equipment measurements: To include, but not be limited to, the following as appropriate:

.1 Inlet and outlet of each damper, filter, coil, humidifier, fan, other equipment causing changes in conditions.

.2 At each controller, controlled device.

.5 Locations of systems measurements to include, but not be limited to, the following as appropriate: Each main duct, main branch, sub-branch, run-out (or grille, register or diffuser).

.6 Assist in calibration of control system end devices and thermostats by making comparative measurements.

**1.18 Hydronic Systems**

.1 Definitions: for purposes of this section, to include low pressure hot water heating, chilled water, condenser water, glycol systems.

.2 Standard: TAB to be to most stringent of this section and TAB standards of AABC.

.3 Do TAB of all hydronic systems shown on drawings.

.4 Measurements: to include, but not be limited to, the following as appropriate for systems, equipment, components, controls: flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power voltage, noise, vibration.

.5 Locations of equipment measurement: to include, but not be limited to, the following as appropriate:

.1 Inlet and outlet of each heat exchanger (primary and secondary sides), boiler, chiller, coil, humidifier, cooling tower, condenser, pump, PRV, control valve, other equipment causing changes in conditions.

.2 At each controller, controlled device.

.6 Locations of systems measurements to include, but not be limited to, the following as appropriate: supply and return of each primary and secondary loop (main, main branch, branch, sub-branch) of all hydronic systems, inlet connection of make-up water.

.7 Assist in calibration of control system and thermostats by making comparative measurements.

**1.19 Other TAB Requirements**

.1 Direct natural gas fired make-up air units:

.1 Standard: CGAB149.1 Natural Gas Installation Code.

.2 Provide correction of air flow for outdoor air temperature.

.3 Interlocked exhaust fan(s) operation to be minimum 95% of make-up air unit supply air volume.

**1.20 Fire Dampers**

.1 Provide inspection and verification of access and movement (by removing fusible link) of all fire dampers and fire stop flaps indicated in the design documents.

.2 Provide a detailed drawing(s) to indicate location of fire damper. Where design documents do not indicate a numbering system, number all fire dampers for ease of reference.

**1.21 Duct Leakage**

.1 Provide services to ventilation trades for pressure testing of ductwork.

.2 Provide report on results of testing and pass/no pass compliance with SMACNA standards for duct leakage.

**1.22 Drive Adjustment**

.1 TAB personnel are to identify revised drive requirements where the factory or existing drive is no longer applicable to the required operating conditions.

.2 Drive components and their selection criteria are covered under other sections of this specification. Replacement drives will be provided as required to achieve the specified performance.

.3 Drive replacement, tensioning, alignment, adjustment and retesting is included in the scope of this section.

**Part 2 Products**

.1 Not Used.

**Part 3 Execution**

.1 Not Used.

**END OF SECTION**