

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 45 00 - Quality Control.
- .3 Section 01 74 20 - Waste Managing and Disposal.
- .4 Section 01 78 10 - Closeout Submittals.
- .5 Section 09 91 10 - Painting.
- .6 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings; submit drawings stamped and signed for approval by Contract Administrator's Representative.
- .3 Shop drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
- .4 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
- .5 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.
 - .2 Operation and maintenance manual approved by, and final copies deposited with, Contract Administrator's Representative before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

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- .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .6 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Contract Administrator's Representative for approval. Submission of individual data will not be accepted unless directed by Contract Administrator's Representative.
 - .2 Make changes as required and re-submit as directed by Contract Administrator's Representative.
 - .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
 - .8 Site records:
 - .1 Contract Administrator's Representative will provide 1 set of reproducible mechanical drawings or AutoCAD files. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour for each service.
 - .4 Make available for reference purposes and inspection.
 - .9 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Contract Administrator's Representative for approval and make corrections as directed.

- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

1.3 QUALITY ASSURANCE

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

1.4 MAINTENANCE

- .1 Furnish spare parts in accordance with Section 01 78 10 - Closeout Submittals as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One glass for each gauge glass.
 - .4 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 10 - Closeout Submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 All materials used on this project shall be new and CSA approved unless noted otherwise.

Part 3 Execution

3.1 PAINTING, REPAIRS AND RESTORATION

- .1 Do painting in accordance with Section 09 91 10 - Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.2 CLEANING

- .1 Clean interior and exterior of all systems including strainers. Protect open ends of ducts, diffusers, grilles and registers during construction to prevent ingress of dust and dirt into

interior of ducts. If dust or dirt is detected prior to startup, vacuum interior of all ducts and air handling units. Prior to vacuuming use video camera to record condition of ductwork. Also use video camera to record condition of ducts after cleaning.

3.3 FIELD QUALITY CONTROL

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

3.4 DEMONSTRATION

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

3.5 PROTECTION

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Use of HVAC systems during construction.

1.2 RELATED SECTIONS

- .1 Section 01 51 00 - Temporary Utilities.

1.3 USE OF SYSTEMS

- .1 Use of new and/or existing permanent heating and/or 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 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
 - .3 There is no possibility of damage from any cause.
 - .4 Supply ventilation systems are protected by 60 % filters, which shall be inspected daily, changed every week or more frequently as required.
 - .5 Return systems have approved filters over all openings, inlets, outlets.
 - .6 All systems will be:
 - .1 operated as per manufacturer's recommendations or instructions.
 - .2 operated by Contractor.
 - .3 monitored continuously by Contractor.
 - .7 Warranties and guarantees are not thereby relaxed.
 - .8 Regular preventive and all other manufacturers recommended maintenance routines are performed by Contractor at his own expense and under supervision of Contract Administrator's Representative.
 - .9 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, and replace filters in air systems.
- .2 Filters specified in this section are over and above those specified in other sections of this project.
- .3 Exhaust systems are not included in any approvals for temporary heating ventilation.

Part 2 Products (not used)

Part 3 Execution (not used)

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 74 00 – Cleaning and Waste Processing.
- .2 Section 01 74 20 –Waste Managing and Disposal.
- .3 Section 07 84 00 – Firestopping.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20 - Waste Managing and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility approved by Contract Administrator.

1.4 QUALITY ASSURANCE

- .1 Installers to be certified to journeyperson.

Part 2 Products (NOT used)

Part 3 Execution

1.5 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.

1.6 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.

1.7 PIPEWORK INSTALLATION

- .1 Installation by certified journeyman.
- .2 Screwed fittings jointed with Teflon tape or pipe dope as recommended by manufacturer.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 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 Provide for thermal expansion as required.
- .12 Valves:
 - .1 Install in accessible locations.
 - .2 Install with stems above horizontal position unless otherwise indicated.
 - .3 Valves accessible for maintenance without removing adjacent piping.

1.8 SLEEVES

- .1 General: Install where pipes pass building envelope and floors.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.

- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.
 - .2 Other floors: Terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.

1.9 PREPARATION FOR FIRESTOPPING

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 - Firestopping.
- .2 Uninsulated unheated pipes not subject to movement: No special preparation.

1.10 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Contract Administrator's Representative, 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: Test as specified in relevant sections of other sections or Divisions.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of other Divisions.
- .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 Contract Administrator's Representative. Work to be carried out in off hours after 5 p.m., weekends or holidays.
- .6 Pay costs for repairs or replacement, retesting, and making good. Contract Administrator's Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Contract Administrator's Representative.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Electrical motors, drives and guards for mechanical equipment and systems.
 - .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
 - .3 Control wiring and conduit specified in Division 26. Control wiring 50V or less for systems specified in Division 21, 22, 23 and 25 is by Division 25.

1.2 RELATED SECTIONS:

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 45 00 - Quality Control.
- .3 Section 01 61 00 - Product Requirements.
- .4 Section 01 74 00 - Cleaning and Waste Processing.
- .5 Section 01 74 20 –Waste Managing and Disposal.
- .6 Section 01 78 10 - Closeout Submittals.

1.3 REFERENCES

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

1.4 SUBMITTALS

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

- .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures
- .2 Shop Drawings: Submit drawings stamped and signed for approval by Contract Administrator's Representative.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Contract Administrator's Representative will make available 1 (one) copy of systems supplier's installation instructions.
- .4 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with Canadian Environmental Protection Act (CEPA), Canadian Environmental Assessment Agency (CEAA), Transportation of Dangerous Goods Act (TDGA) and applicable Provincial regulations.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.

Part 2 Products

2.1 GENERAL

- .1 Motors to be premium efficiency, in accordance with local hydro company standards and the requirements of ASHRAE 90.1 and Manitoba Energy Code for Buildings.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 1/2 HP : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.

- .3 Motors 1/2 HP and larger: NEMA, Class B, squirrel cage induction, premium efficiency, speed as indicated, continuous duty, enclosure as indicated, ball bearing, maximum temperature rise 40 °C, 3 phase, 575 V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

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

2.4 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.
- .3 For motors under 10 HP : standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 Correct size of sheave to be determined during commissioning.
- .5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .6 Motor slide rail adjustment plates to allow for centre line adjustment.
- .7 Supply one set of spare belts for each set installed in accordance with Section 01 78 10 – Closeout Submittals.

2.5 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives:
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6 mm thick 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.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

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

3.3 FIELD QUALITY CONTROL

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

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning and Waste Processing.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 General

1.1 SECTION INCLUDES

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 74 20 –Waste Managing and Disposal
- .3 Section 23 05 23.01 – Valves - Bronze
- .4 Section 23 05 53.01 – Mechanical Identification

1.3 REFERENCES

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

1.4 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit shop drawings and product data.
- .3 Submit manufacturer's product data for following items:
 - .1 Thermometers
 - .2 Ball Valves
 - .3 Wells

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20 – Waste Managing and Disposal.
- .2 Collect, separate and place in designated containers for reuse and recycling, paper, plastic, polystyrene, corrugated cardboard packaging, steel, metal, in accordance with Waste Management Plan.

- .3 Fold up metal banding, flatten and place in designated area for recycling.
- .4 Place materials defined as hazardous or toxic waste in designated containers.
- .5 Ensure emptied containers are sealed, labelled and stored safely for disposal away from children.

PART 2 Products

2.1 GENERAL

- .1 Design point to be at mid point of scale or range.
- .2 Ranges: dual imperial and metric.

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, liquid filled, accuracy ± 1 scale division, 175 mm scale length: to CAN/CGSB14.4.
 - .1 Acceptable Product: Terrice, Ashcroft, Wika, Winters, Marsh.

2.3 REMOTE READING THERMOMETERS

- .1 100 mm diameter liquid filled or vapor activated dial type: to CAN/CGSB-14.5, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass or stainless steel case for wall mounting.
 - .1 Acceptable Product: Terrice, Ashcroft, Wika, Winters, Marsh.

2.4 THERMOMETER WELLS

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass or stainless steel.

PART 3 Execution

3.1 GENERAL

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

3.2 THERMOMETERS

- .1 Install in wells on piping. Provide heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:

- .1 DHW tanks.
- .3 Install wells.
- .4 Use extensions where thermometers are installed through insulation.

3.3 NAMEPLATES

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

END OF SECTION

PART 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Bronze – valves.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 74 20 –Waste Managing and Disposal.
- .3 Section 01 78 10 – Closeout Submittals.
- .4 Section 02 81 01 - Hazardous Materials.
- .5 Section 23 05 05 – Installation of Pipework

1.3 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch.)
 - .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings
 - .3 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A 276, Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM A536, Specification for Ductile Iron Castings.
 - .3 ASTM B 16, Specification for Free-Cutting Brass Rod Bar and Shapes for Use in Screw Machines.
 - .4 ASTM B 62, Specification for Composition Bronze or Ounce Metal Castings.
 - .5 ASTM B 283, Specification for Copper and Copper Alloy Die Forgings (Hot Pressed)
 - .6 ASTM B 505/B505M, Specification for Copper-Base Alloy Continuous Castings.
 - .7 ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B242, Groove and Solder Type Mechanical Pipe Couplings.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-80, Bronze Gate, Globe, Angle and Check Valves.

- .3 MSS SP-110, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS – Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .2 Submit data for valves specified this section.
 - .3 Grooved joint couplings and fittings to be indicated on product submittals and to be specifically identified with the applicable style or series designation.
- .3 Closeout Submittals
 - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 10 – Closeout Submittals.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE AND DISPOSAL

- .1 Waste Management and Disposal
 - .1 Separate and recycle waste materials in accordance with Section 01 74 20 – Waste Managing and Disposal.
 - .2 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

1.7 MAINTENANCE

- .1 Extra Materials
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size. Minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.
 - .6 Grooved couplings: IPS and copper-tube dimensioned, one for every 10 (ten) grooved joints.

PART 2 Products

2.1 MATERIALS

- .1 Except for specialty valves, to be single manufacturer.
- .2 All products to have Canadian registration numbers (CRN).
- .3 End Connections
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems.
 - .1 Solder ends ANSI/ASME B16.18.
 - .2 Grooved ends to copper tube dimensions and CSA B242.
 - .3 Push-to-connect ends to ANSI/ASME B16.22 and manufacturer's standards.
- .4 Lockshield Keys
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.

2.2 GATE VALVES

- .1 Requirements common to all gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: with hex. shoulders.
 - .3 Connections: with hex. shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .8 Glass 125, WP=860 kPa steam, 1.4 mPa WOG
 - .9 Class 150 WP=1.03 mPa steam, 2.07 mPa WOG.
- .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel
- .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel
- .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: Handwheel
- .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:

- .1 Body: with long disc guides, screwed bonnet.
- .2 Operator: Handwheel
- .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: Handwheel

2.3 CHECK VALVES

- .1 Requirements common to all check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: with hex agonal shoulders.
 - .3 Class 125, WP=860 kPa steam, 1.4 mPa WOG
 - .4 Class 150 WP=1.03 mPa steam, 2.07 mPa WOG
 - .5 Class 200 1.4 mPa CWP
- .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45°, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .3 NPS 2 and under, swing type, bronze disc:
 - .1 Body: Y-pattern with integral seat at 45°, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45°, screw-in cap with hex. head.
 - .2 Disc: renewable rotating disc, of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
- .5 NPS 2 and under, horizontal lift type, composition disc, Class150:
 - .1 Body: with integral seat, union bonnetring with hex. shoulders, cap.
 - .2 Disc: renewable PTFE for steam, #6 composition rotating disc for water, oil or gas service in disc holder having guides top and bottom, of bronze to ASTM B62.
- .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .7 NPS 2 and under, vertical or horizontal, lift type, 1380 kPa CWP.
 - .1 Disc: 301 stainless steel, center guided.

2.4 SILENT CHECK VALVES

- .1 NPS 2 and under:
 - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.

- .4 Disc and seat: renewable rotating disc.
- .5 Stainless steel spring, heavy duty.
- .6 Seat: regrindable.

2.5 BALL VALVES

- .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B16 or ASTM B62.
 - .2 Pressure rating: Class 125, 860 MPa steam.
 - .3 Connections: Screwed ends to ANSI B1.20.1 and with hex. shoulders. Push-to-connect, Pressfit ends.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel or hard chrome, plated brass solid ball and teflon seats.
 - .7 Stem seal: TFE, EPDM, Nitrile, Fluoroelastomer with with external packing nut.
 - .8 Operator: removable lever handle with extension for insulated pipe.
 - .9 Cap and drain for drain service.
- .2 Acceptable Product: Jenkins, Crane, Watts, Newman Hattersley, Milwaukee, Conbraco, Kitz, Red White, M.A. Stewart, Nibco, Victaulic.

PART 3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Adjoining tube, couplings, and fittings with grooved joint valves shall be copper-tube dimensioned. Flaring tube or fitting ends to accommodate IPS sized valves is not permitted.
- .4 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.
 - .1 Unions are not required in installations using grooved mechanical couplings. The couplings shall serve as unions.

3.2 COMMISSIONING

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

END OF SECTION

Part 1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 61 00 –Product Requirements.
- .3 Section 01 74 20 – Waste Managing and Disposal
- .4 Section 09 91 10 - Painting.

1.3 REFERENCES

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3, Identification of Piping Systems.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with Section 01 61 00 –Product Requirements.
- .2 Deliver, store and handle materials in accordance with manufacturer’s written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.
 - .2 Dispose of unused paint coating material at official hazardous material collections site approved by Contract Administrator.
 - .3 Do not dispose of unused paint coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

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

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Equipment in Mechanical Rooms: Use size # 9.

2.3 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Natural gas: to CSA/CGA B149.1, authority having jurisdiction.

2.4 IDENTIFICATION OF PIPING SYSTEMS

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

.2 Pictograms:

.1 Where required, 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 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.6 Materials for background colour marking, legend, arrows:

.1 Pipes and tubing 20 mm and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 All other pipes: Pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100%RH and continuous operating temperature of 150°C and intermittent temperature of 200°C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from Contract Administrator's Representative.

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

Background colour	Legend, arrows
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Domestic hot water supply	Green	DOM. HW SUPPLY
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Natural gas	to Codes	

2.5 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: Black, or co-ordinated with base colour to ensure strong contrast.
- .3 Identify system : e.g. Supply AHU-1,Exhaust F-7.

2.6 VALVES

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

2.7 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates. If no EMCS included in project, identification as per this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position, component ID name.

2.8 LANGUAGE

- .1 Identification to be in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

- .1 Provide identification only after all painting specified in Section 09 91 10 - Painting has been completed.

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and/or CSA registration plates as required by respective agency.

3.4 NAMEPLATES

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

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

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

3.6 VALVES

- .1 Valves, except at plumbing fixtures or where in plain sight of equipment they serve:
Secure tags with non-ferrous chains or closed "S"hooks.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 00 – Cleaning and Waste Processing.
- .2 Upon completion and verification of performance of installation, remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

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

1.2 QUALIFICATIONS OF TAB PERSONNEL

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

1.3 PURPOSE OF TAB

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

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

- .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.

1.6 PRE-TAB REVIEW

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

1.7 START-UP

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

1.8 OPERATION OF SYSTEMS DURING TAB

- .1 Operate systems for length of time required for TAB and as required by Contract Administrator's Representative for verification of TAB reports.

1.9 START OF TAB

- .1 Notify Contract Administrator's Representative 7 days prior to start of TAB.

-
- .2 Start TAB 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 in other Divisions.
 - .4 All provisions for TAB installed and operational.
 - .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.

1.10 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 HVAC systems: plus 5 %, minus 5 %.

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

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

1.13 SUBMITTALS

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

1.14 PRELIMINARY TAB REPORT

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

1.15 TAB REPORT

- .1 Format to be in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit 3 copies of TAB Report to Contract Administrator's Representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 VERIFICATION

- .1 Reported results subject to verification by Contract Administrator's Representative.
- .2 Provide manpower and instrumentation to verify up to 30 % of reported results.
- .3 Number and location of verified results to be at discretion of Contract Administrator's Representative.
- .4 Bear costs to repeat TAB as required to satisfaction of Contract Administrator's Representative.

1.17 SETTINGS

- .1 After TAB is completed to satisfaction of Contract Administrator's Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

1.18 COMPLETION OF TAB

- .1 TAB to be considered complete when final TAB Report received and approved by Contract Administrator's Representative.

1.19 AIR SYSTEMS

- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC or NEBB.
- .2 Do TAB of systems, equipment, components, controls specified in other Divisions.

- .3 Qualifications: personnel performing TAB to be qualified to standards of AABC or NEBB.
- .4 Quality assurance: Perform TAB under direction of supervisor qualified to standards of AABC or NEBB.
- .5 Measurements: to include, but not limited to, 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, amperage and volts for each stage of electrical heating coils.
- .6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 OTHER SYSTEMS

- .1 Plumbing systems:
 - .1 Standard: National Plumbing Code.
 - .2 TAB procedures:
 - .1 Flush valves: adjust to suit project pressure conditions.
 - .2 Pumped storm water systems: test for proper operation at all possible flow rates.

1.21 OTHER TAB REQUIREMENTS

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

1.22 POST- OCCUPANCY TAB

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, NC levels, in occupied zone of areas designated by Contract Administrator's Representative.
- .2 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 3 months of termination of Warranty Period.

Part 2 Products (NOT applicable)

Part 3 Execution (NOT applicable)

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and methods for pressure testing ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.

1.2 RELATED SECTIONS:

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 45 00 - Quality Control.
- .3 Section 01 74 20 - Waste Managing and Disposal.
- .4 Section 01 78 10 - Closeout Submittals.
- .5 Section 01 91 00 - Commissioning.

1.3 REFERENCES

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

1.4 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:
 - .1 Submit proposed report form and test report format to Contract Administrator's Representative for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Contract Administrator's Representative.
 - .2 Prepare report of results and submit to Contract Administrator's Representative within 24 hours of completion of tests. Include:
 - .1 Schematic of entire system.
 - .2 Schematic of section under test showing test site.
 - .3 Required and achieved static pressures.
 - .4 Orifice differential pressure at test sites.
 - .5 Permissible and actual leakage flow rate (L/s) for test sites.
 - .6 Witnessed certification of results.

- .3 Include test reports in final TAB report.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Manufacturer's field reports specified.

1.5 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

Part 2 Products

2.1 TEST INSTRUMENTS

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

2.2 EQUIPMENT LEAKAGE TOLERANCES

- .1 Equipment and system components duct heating leakage: 2%.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TEST PROCEDURES

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

3.3 SITE TOLERANCES

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

3.4 TESTING

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

3.5 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services.
 - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.

- .2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of the Work, after cleaning is carried out.
 - .4 Obtain reports, within 3 days of review, and submit, immediately, to Contract Administrator's Representative.
- .2 Performance Verification:
- .1 Contract Administrator's Representative to witness tests and to verify reported results.
 - .2 To be certified by same TAB agency approved by Contract Administrator's Representative to undertake TAB on this project.

3.6 CLEANING

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

END OF SECTION

PART 1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 20 - Waste Managing and Disposal
- .3 Section 23 05 53.01 – Mechanical Identification.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547, Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .9 ASTM C921, Standard Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701, Thermal Insulation Polystyrene, Boards and Pipe Covering.
- .6 Manitoba Energy Code for Buildings.

1.3 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
- .2 TIAC Codes:
 - .1 CRD: Commercial Round Ductwork,
 - .2 CRF: Commercial Rectangular Finish.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

1.5 MANUFACTURERS' INSTRUCTIONS

- .1 Submit manufacturer's installation instructions in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Installation instructions to include procedures used and installation standards achieved.

1.6 QUALIFICATIONS

- .1 Installer: certified in performing work of this section, and have at least 5 years successful experience in this size and type of project, qualified to standards of TIAC.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather and construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions recommended by manufacturer.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility approved by Contract Administrator's Representative.
- .5 Divert unused adhesive material from landfill to official hazardous material collections site approved by Contract Administrator's Representative.
- .6 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

PART 2 Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.
 - .1 Maximum "k" factor of outside duct insulation: 0.032 (W/m°C)

2.3 JACKETS

- .1 Aluminum:
 - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Stucco embossed or corrugated.
 - .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.
- .2 Stainless steel:
 - .1 Type: 304 or 316 where additional corrosion protection is required.

- .2 Thickness: 0.25 mm sheet.
- .3 Finish: Corrugated or stucco embossed.
- .4 Jacket banding and mechanical seals: 12mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
- .5 Contact adhesive: quick-setting
- .6 Tie wire: 1.5 mm stainless steel.
- .7 Banding: 12 mm wide, 0.5 mm thick stainless steel.
- .8 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.
- .9 Fasteners: 4 mm diameter pins with 35 mm diameter or square clips, length to suit thickness of insulation.

PART 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

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

3.2 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and as indicated.
- .3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers: apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side.

3.3 DUCTWORK INSULATION SCHEDULE

.1 Insulation types and thicknesses: Conform to following Table:

.2

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts (exposed)	C-1	yes	50
Round cold and dual temperature supply air ducts (concealed)	C-2	yes	50
Rectangular warm air ducts (exposed)	C-1	no	38
Round warm air ducts (exposed)	C-1	no	38
Rectangular cold and dual temperature supply air ducts (concealed)	C-2	Yes	50
Round cold and dual temperature supply air ducts (exposed)	C-1	yes	50
Rectangular warm air ducts (concealed)	C-2	No	38
Round warm air ducts (concealed)	C-2	No	38
Return and exhaust ducts exposed in space being served			none
Outside air ducts to mixing plenum	C-1	yes	50
Mixing plenums	C-1	yes	25
Exhaust duct between dampers and louvers	C-1	no	50
Rectangular ducts outside	C-1	special	150
Acoustically lined ducts	See Section 23 33 53- Duct Liners		

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

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

.2 Finishes: Conform to following table:

	TIAC Code	Round
Indoor, concealed	None	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

END OF SECTION

Part 1 General

1.1 GENERAL AND RELATED WORK

- .1 All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Subcontractor
- .2 If the Controls Subcontractor believes there are conflicts or missing information in the Contract Documents then the Contractor shall promptly request clarification and instruction from the Contract Administrator before proceeding.
- .3 The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Mechanical Division Sections for details.
- .4 The Controls Subcontractor 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.
- .5 The City of Winnipeg has existing Johnson Controls Metasys based central monitoring systems in place. These systems are located at City Hall, 510 Main St, Winnipeg, MB. Where points are identified as being centrally monitored points, the Controls Subcontractor shall be required to provide and install any required hardware and/or software to interface to the Contract Administrator's Johnson Controls Metasys ADX server.

1.2 CONTROL SYSTEMS DESCRIPTION

- .1 The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems in place at the City of Winnipeg. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the Contract Administrator's IT staff to ensure that the FMS will perform in the Contract Administrator's environment without disruption to any of the other activities taking place on that LAN.
- .2 All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
- .3 Where necessary and as dictated elsewhere in these Specifications, the City of Winnipeg's existing ADX Server shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions.
- .4 The work of the single BMS Subcontractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.

- .5 The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.
- .6 Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
- .7 Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- .8 The Controls System as provided shall comprise, at a minimum, the following primary elements:
 - .9 NCE Web server(s).
 - .10 Network and application nodes.
 - .11 Field devices.
 - .12 Control wiring.

1.3 QUALITY ASSURANCE

- .1 General
 - .1 The following companies are approved Controls Subcontractors:
 - .1 Johnson Controls Branch Office
- .2 Workplace Safety And Hazardous Materials
 - .1 Provide a safety program in compliance with the Contract Documents.
 - .2 The FMS Subcontractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.
 - .3 The Contractor and its employees and subtrades comply with federal, state and local safety regulations.
 - .4 The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA have jurisdiction for at least each topic listed in the Safety Certification Manual.
 - .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 Contract Administrator within the

same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.

- .7 The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractors' company is in full compliance with the Project safety requirements.
- .8 The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the AHJ at the Project site.
- .9 The Contractor's employees and Subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

1.4 SUBMITTALS

- .1 Shop Drawings, Product Data, and Samples
 - .1 The BMS Subcontractor shall submit a list of all shop drawings with submittals dates within 30 days of Contract award.
 - .2 Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Contract Administrator for Contract compliance.
 - .3 Allow 15 working days for the review of each package by the Contract Administrator in the scheduling of the total BMS work.
 - .4 Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Subcontractor where filing is necessary. Provide a copy of all related correspondence and permits to the Contract Administrator.
 - .5 Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
 - .6 The BMS Subcontractor shall correct any errors or omissions noted in the first review.
 - .7 At a minimum, submit the following:
 - .1 BMS network architecture diagrams including all nodes and interconnections.
 - .2 Systems schematics, sequences and flow diagrams.
 - .3 Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
 - .4 Samples of Graphic Display screen types and associated menus.
 - .5 Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
 - .6 Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
 - .7 Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.

- .8 Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address
- .9 Details of all BMS interfaces and connections to the work of other trades.
- .10 Product data sheets or marked catalog pages including part number, photo and description for all products including software.

1.5 RECORD DOCUMENTATION

- .1 Operation and Maintenance Manuals
 - .1 Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Contract Administrator 's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:
 - .1 Table of contents.
 - .2 As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
 - .3 Manufacturers product data sheets or catalog pages for all products including software.
 - .4 System Operator's manuals.
 - .5 Archive copy of all site-specific databases and sequences.
 - .6 BMS network diagrams.
 - .7 Interfaces to all third-party products and work by other trades.
 - .2 The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

1.6 WARRANTY

- .1 Standard Material and Labor Warranty:
 - .1 Provide a one-year labor and material warranty on the BMS.
 - .2 If within twelve (12) months from the date of acceptance of product, upon written notice from the Contract Administrator, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Subcontractor at the cost of the BMS Subcontractor.

Part 2 Products

2.1 CONTROL SYSTEM ARCHITECTURE

- .1 The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other Contract Administrator provided networks.
- .2 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- .3 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- .4 Acceptable Manufacturers
 - .1 Johnson Controls Metasys

2.2 BMS ARCHITECTURE

- .1 Automation Network
 - .1 The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.
 - .2 The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
 - .3 The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
 - .4 Network Control Engines (NCE) shall reside on the automation network.
 - .5 The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
 - .6 The Contract Administrator shall provide all private and public telephones lines, ISDN lines and Internet Service Provider services and connections as necessary for the Controls Subcontractor to complete the work as contracted at the Contract Administrator’s direct cost. The Controls Subcontractor shall identify the specific requirements in their shop drawing submittal.
- .2 Control Network
 - .1 NCE(s) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:

- .1 BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
- .2 LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
- .3 The Johnson Controls N2 Field Bus.
- .2 Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
- .3 DDC Controllers shall reside on the control network.
- .4 Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, or Johnson Controls N2 Field Bus.
- .5 A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
- .3 Integration (if required)
 - .1 Hardwired
 - .1 Analog and digital signal values shall be passed from one system to another via hardwired connections.
 - .2 There will be one separate physical point on each system for each point to be integrated between the systems.
 - .2 Direct Protocol (Integrator Panel)
 - .1 The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers' control panels. The BMS shall receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, power monitoring system, and medical gas.
 - .2 All data required by the application shall be mapped into the Automation Engine's database, and shall be transparent to the operator.
 - .3 Point inputs and outputs from the third-party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.
 - .3 BACnet Protocol Integration - BACnet
 - .1 The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.
 - .2 A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
 - .3 The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.3 USER INTERFACE

- .1 Operator Interface
 - .1 Use the building LAN for communications with Building Controller/Web Server, and the Operator Workstation. Controllers shall communicate using BACnet

protocol. Control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specific in ASHRAE/ANSI 135-2004, BACnet Annex J.

- .2 Connection to ISP for Web Access is Contract Administrator's responsibility.
- .3 Provide a new OWS in the mechanical room for connection of control systems within the building. The new OWS shall consist of a Dell OptiPlex PC, c/w Windows 7 Professional, and a minimum 22 inch monitor

2.4 NETWORK CONTROL ENGINE (NCE 25XX)

- .1 The Network Control Engine (NCE) shall be a fully user-programmable, supervisory controller. The NCE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
- .2 The Network Control Engine (NCE) shall be a fully user-programmable, digital controller that includes a minimum of 33 I/O points.
- .3 Automation Network – The NCE shall reside on the automation network and shall support a subnet of 32 Field controllers.
- .4 User Interface – Each NCE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - .1 The web based UI software shall be imbedded in the NCE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
 - .2 The NCE shall support a minimum of two (2) concurrent users.
 - .3 The NCE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NCE.
 - .4 Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
 - .5 The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
 - .1 Configuration
 - .2 Commissioning
 - .3 Data Archiving
 - .4 Monitoring
 - .5 Commanding
 - .6 System Diagnostics
 - .6 Systems that require workstation software or modified web browsers are not acceptable.
 - .7 The NCE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
- .5 The NCE shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

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- .6 The NCE shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
 - .7 The NCE shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
 - .8 The NCE shall support the following number and types of inputs and outputs:
 - .1 Ten Universal Inputs - shall be configured to monitor any of the following:
 - .1 Analog Input, Voltage Mode
 - .2 Analog Input, Current Mode
 - .3 Analog Input, Resistive Mode
 - .4 Binary Input, Dry Contact Maintained Mode
 - .5 Binary Input, Pulse Counter Mode
 - .2 Eight Binary Inputs - shall be configured to monitor either of the following:
 - .1 Dry Contact Maintained Mode
 - .2 Pulse Counter Mode
 - .3 Four Analog Outputs - shall be configured to output either of the following:
 - .1 Analog Output, Voltage Mode
 - .2 Analog Output, Current Mode
 - .4 Seven Binary Outputs - shall output the following:
 - .1 24 VAC Triac
 - .5 Four Configurable Outputs - shall be configured to output either of the following:
 - .1 Analog Output, Voltage Mode
 - .2 Binary Output, 24 VAC Triac Mode
 - .9 The NCE shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
 - .1 The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - .2 The SA Bus shall support a minimum of 10 devices.
 - .3 The SA Bus shall operate at a maximum distance of 1,200 Ft. between the NCE and the furthest connected device.
 - .10 The NCE shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the Field Trunk or the SA Bus.
 - .11 The NCE shall support, but not be limited to, the following applications:
 - .1 Central Equipment including chillers and boilers
 - .2 Lighting and electrical distribution
 - .3 Built-up air handling units for special applications
 - .4 Power generation and energy monitoring equipment
 - .5 Interfaces to security and fire detection systems

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- .12 The NCE shall support a Local Controller Display (DIS1710) either as an integral part of the NCE or as a remote device communicating over the SA Bus.
 - .1 The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.
 - .2 The Display shall allow the user to view monitored points without logging into the system.
 - .3 The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
 - .4 The Display shall provide password protection with user adjustable password timeout.
 - .5 The Display shall be menu driven with separate paths for:
 - .1 Input/Output
 - .2 Parameter/Setpoint
 - .3 Overrides
 - .6 The Display shall use easy-to-read English text messages.
 - .7 The Display shall allow the user to select the points to be shown and in what order.
 - .8 The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.
 - .9 The display shall be a minimum of 4 lines and a minimum of 20 characters per line
 - .10 The Display shall have a keypad with no more than 6 keys.
 - .11 The Display shall be panel mountable.
 - .13 The NCE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NCE size and capability shall be sufficient to fully meet the requirements of this Specification.
 - .14 The NCE shall employ an industrial single board computer.
 - .15 Each NCE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
 - .16 The NCE shall include an integrated, hardware-based, real-time clock.
 - .17 The NCE shall employ nonvolatile Flash memory to store all programs and data. The NCE shall employ a data protection battery to save data and power the real time clock when primary power is interrupted.
 - .18 The NCE shall provide removable, color coded, screw terminal blocks for 24 VAC power, communication bus and I/O point field wiring.
 - .19 The NCE shall include troubleshooting LED indicators to identify the following conditions:
 - .1 Power
 - .2 Fault
 - .3 SA Bus

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- .4 FC Bus
 - .5 Modem TX
 - .6 Modem RX
 - .7 Battery Fault
 - .8 Ethernet
 - .9 10 LNK
 - .10 100 LNK
 - .11 Run
 - .12 Peer Com
- .20 Communications Ports – The NCE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
- .1 USB port
 - .2 RS-232 serial data communication port
 - .3 RS-485 port
 - .4 RJ-45 Ethernet port
 - .5 RJ-12 jack
- .21 The NCE shall support an optional internal modem with RJ-12 6-pin telephone line connector.
- .22 Diagnostics – The NCE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Control Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
- .23 Power Failure – In the event of the loss of normal power, The NCE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
- .1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - .2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
- .24 Certification – The NCE shall be listed by Underwriters Laboratories (UL). File E107041, CCN PAZX, UL 916, Energy Management Equipment. FCC Compliant to CFR47, Part 15, Subpart B, Class A
- .25 Field Controller Bus – The NCE shall support the following communication protocols on the Field Controller Bus:
- .1 The NCE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - .1 The NCE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

- .2 The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
- .3 A BACnet Protocol Implementation Conformance Statement shall be provided for the NCE.
- .4 The Conformance Statements shall be submitted 10 days prior to bidding.
- .5 The NCE shall support a minimum of 32 control devices.
- .2 The NCE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10 on the Field Controller Bus (LonWorks Network).
 - .1 All LonWorks controls devices shall be LonMark certified.
 - .2 The NCE shall support a minimum of 32 LonWorks enabled control devices.
- .3 The NCE shall support the N2 devices on the Field Controller Bus (Johnson Controls N2 Bus).
 - .1 The NCE shall support a minimum of 32 N2 control devices.
 - .2 The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
 - .3 The Bus shall employ a master/slave protocol where the NCE is the master.
 - .4 The Bus shall employ a four (4) level priority system for polling frequency.
 - .5 The Bus shall be optically isolated from the NCE.
 - .6 The Bus shall support the Metasys Integrator System.

2.5 BACNET DDC SYSTEM CONTROLLERS

- .1 Field Equipment Controller (**FEC**)
 - .1 The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
 - .2 The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
 - .3 Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
 - .4 The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
 - .5 The FEC shall include a removable base to allow pre-wiring without the controller.
 - .6 The FEC shall include troubleshooting LED indicators to identify the following conditions:
 - .1 Power On
 - .2 Power Off
 - .3 Download or Startup in progress, not ready for normal operation
 - .4 No Faults

-
- .5 Device Fault
 - .6 Field Controller Bus - Normal Data Transmission
 - .7 Field Controller Bus - No Data Transmission
 - .8 Field Controller Bus - No Communication
 - .9 Sensor-Actuator Bus - Normal Data Transmission
 - .10 Sensor-Actuator Bus - No Data Transmission
 - .11 Sensor-Actuator Bus - No Communication
 - .7 The FEC shall accommodate the direct wiring of analog and binary I/O field points.
 - .8 The FEC shall support the following types of inputs and outputs:
 - .1 Universal Inputs - shall be configured to monitor any of the following:
 - ◇ Analog Input, Voltage Mode
 - ◇ Analog Input, Current Mode
 - ◇ Analog Input, Resistive Mode
 - ◇ Binary Input, Dry Contact Maintained Mode
 - ◇ Binary Input, Pulse Counter Mode
 - .2 Binary Inputs - shall be configured to monitor either of the following:
 - ◇ Dry Contact Maintained Mode
 - ◇ Pulse Counter Mode
 - .3 Analog Outputs - shall be configured to output either of the following
 - ◇ Analog Output, Voltage Mode
 - ◇ Analog Output, current Mode
 - .4 Binary Outputs - shall output the following:
 - ◇ 24 VAC Triac
 - .5 Configurable Outputs - shall be capable of the following:
 - ◇ Analog Output, Voltage Mode
 - ◇ Binary Output Mode
 - .9 The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
 - .1 The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - .2 The FC Bus shall support communications between the FECs and the NAE.
 - .3 The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
 - .4 The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.
 - .5 The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
 - .10 The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
 - .1 The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - .2 The SA Bus shall support a minimum of 10 devices per trunk.
 - .3 The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.

- .11 The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
- .12 The FEC shall support, but not be limited to, the following:
 - .1 Hot water, chilled water/central plant applications
 - .2 Built-up air handling units for special applications
 - .3 Terminal units
 - .4 Special programs as required for systems control

2.6 FIELD DEVICES

- .1 Input/Output Module (IOM)
 - .1 The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
 - .2 The IOM shall communicate with the FEC over either the FC Bus or the SA Bus using BACnet Standard protocol SSPC-135, Clause 9.
 - .3 The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
 - .4 The IOM shall have a minimum of 4 points to a maximum of 17 points.
 - .5 The IOM shall support the following types of inputs and outputs:
 - .1 Universal Inputs - shall be configured to monitor any of the following:
 - ◇ Analog Input, Voltage Mode
 - ◇ Analog Input, Current Mode
 - ◇ Analog Input, Resistive Mode
 - ◇ Binary Input, Dry Contact Maintained Mode
 - ◇ Binary Input, Pulse Counter Mode
 - .2 Binary Inputs - shall be configured to monitor either of the following:
 - ◇ Dry Contact Maintained Mode
 - ◇ Pulse Counter Mode
 - .3 Analog Outputs - shall be configured to output either of the following:
 - ◇ Analog Output, Voltage Mode
 - ◇ Analog Output, current Mode
 - .4 Binary Outputs - shall output the following:
 - ◇ 24 VAC Triac
 - .5 Configurable Outputs - shall be capable of the following:
 - ◇ Analog Output, Voltage Mode
 - ◇ Binary Output Mode
 - .6 The IOM shall include troubleshooting LED indicators to identify the following conditions:
 - .1 Power On
 - .2 Power Off
 - .3 Download or Startup in progress, not ready for normal operation
 - .4 No Faults
 - .5 Device Fault
 - .6 Normal Data Transmission
 - .7 No Data Transmission

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- .8 No Communication
 - .2 Networked Thermostat (**TEC**)
 - .1 The Networked Thermostats shall be capable of controlling the following:
 - .1 A four pipe fan coil system with multi-speed fan control.
 - .2 A pressure dependant Variable Air Volume System or similar zoning type system using reheat.
 - .3 A two pipe fan coil with a single speed fan.
 - .2 The Networked Thermostat shall communicate over the Field Controller Bus using BACnet Standard protocol SSPC-135, Clause 9.
 - .1 The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.
 - .3 The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
 - .1 Two line, 8 character backlit display
 - .2 LED indicators for Fan, Heat, and Cool status
 - .3 Five (5) User Interface Keys
 - ◇ Mode
 - ◇ Fan
 - ◇ Override
 - ◇ Degrees C/F
 - ◇ Up/Down
 - .4 The display shall continuously scroll through the following parameters:
 - ◇ Room Temperature
 - ◇ System Mode
 - ◇ Schedule Status – Occupied/Unoccupied/Override
 - ◇ Applicable Alarms
 - .4 The Networked Thermostats shall provide the flexibility to support the following inputs:
 - .1 Integral Indoor Air Temperature Sensor
 - .2 Duct Mount Air Temperature Sensor
 - .3 Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator.
 - .4 Two configurable binary inputs
 - .5 The Networked Thermostats shall provide the flexibility to support the following outputs:
 - .1 Three Speed Fan Control
 - .2 On/Off Control
 - .3 Floating Control
 - .4 Proportional (0 to 10V) Control
 - .6 The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
 - .7 The Networked Thermostat shall provide the flexibility to adjust the following parameters:
 - .1 Adjustable Temporary Occupancy from 0 to 24 hours

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- .2 Adjustable heating/cooling deadband from 2° F to 5° F
 - .3 Adjustable heating/cooling cycles per hour from 4 to 8
 - .8 The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.
- .3 Wireless Thermostats
- .1 The Many-To-One System Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRS Sensors).
 - .1 The WRS Receiver shall use direct sequence spread spectrum RF technology.
 - .2 The WRS Receiver shall operate on the 2.4 GHZ ISM Band.
 - .3 The WRS Receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - .2 Many-To-One Wireless Room Temperature Sensor System (WRS-XTX-0000)
 - .1 The WRS Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.
 - .2 The WRS Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
 - .3 The WRS Receiver shall be capable of communication with WRS Sensors up to a distance of 200 Feet.
 - .4 The WRS Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - .5 The WRS Receiver shall have LED indicators to provide information regarding the following conditions:
 - ◇ Power On/Off
 - ◇ Ethernet – Receiver Activity/No Activity
 - ◇ Wireless Normal Mode – Transmission from sensors/No Transmission
 - ◇ Wireless Rapid Transmit Mode – No transmission/ weak signal/Adequate signal/Excellent signal
 - ◇ Ethernet Connection – No connection/10Mbps connection/100Mbps connection
 - ◇ Network Activity – No Network Activity/Half-Duplex Communication/Full-Duplex Communication
 - .3 The WRS Sensors shall sense and report room temperatures to the WRS Receiver.
 - .1 The WRS Sensors shall use direct sequence spread spectrum RF technology.
 - .2 The WRS Sensors shall operate on the 2.4 GHZ ISM Band.
 - .3 The WRS Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - .4 The WRS sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
 - .5 The WRS sensors shall be available with

- ◇ Warmer/Cooler Set Point Adjustment
 - ◇ No Set Point Adjustment
 - ◇ Set Point Adjustment Scale – 55 to 85° F.
- .6 The WRS sensors shall be assembled in NEMA 1 plastic housings.
- .4 ZFR1800 Series Wireless Field Bus System
- .1 The ZFR1800 Series System shall employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for Metasys BACnet devices at multiple system levels. This includes communications from FEC and VMA field controllers to sensors and from engines to these field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.
- .2 The ZFR1810 Wireless Field Bus Coordinator shall provide a wireless interface between supported field controllers and an NAE35/45/55, NIE29/39/49/59, or NCE25 supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a ZFR1810 Coordinator for initiation and formation of the network
- ◇ The ZFR Coordinator shall use direct sequence spread spectrum RF technology.
 - ◇ The ZFR Coordinator shall operate on the 2.4 GHZ ISM Band.
 - ◇ The ZFR Coordinator shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - ◇ The ZFR Coordinator shall be FCC compliant to CFR Part 15 subpart B Class A.
 - ◇ The ZFR Coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.
 - ◇ The ZFR Coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (line of sight).
 - ◇ The ZFR Coordinator shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - ◇ The ZFR Coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.
- .3 The ZFR1811 Wireless Field Bus Router shall be used with any model Field Equipment Controller (FEC) or VMA1600 series VAV Modular Assembly to provide a wireless interface to supervisory engines, via the ZFR1810 Coordinator, and associated WRZ Wireless Mesh Room Temperature Sensors. The ZFR1811 is an alternative mechanical packaging design to the ZFR1812.
- ◇ The ZFR1811 Router shall use direct sequence spread spectrum RF technology.
 - ◇ The ZFR1811 Router shall operate on the 2.4 GHZ ISM Band.
 - ◇ The ZFR1811 Router shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - ◇ The ZFR1811 Router shall be FCC compliant to CFR Part 15 subpart B Class A.

- ◇ The ZFR1811 Router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
 - ◇ The ZFR1811 Router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).
 - ◇ The ZFR1811 Router shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - ◇ The ZFR1811 Router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.
 - ◇ The ZFR1811 router shall support the ability to be used alternatively as a wireless repeater should the network design require it.
- .4 The ZFR1812 Wireless Field Bus Router shall be used with any model Field Equipment Controller (FEC) or VMA1600 series VAV Modular Assembly to provide a wireless interface to supervisory engines, via the ZFR1810 Coordinator, and associated WRZ Wireless Mesh Room Temperature Sensors. The ZFR1812 is an alternative mechanical packaging design to the ZFR1811 and provides flexible mounting options where needed.
- ◇ The ZFR1812 Router shall use direct sequence spread spectrum RF technology.
 - ◇ The ZFR1812 Router shall operate on the 2.4 GHZ ISM Band.
 - ◇ The ZFR1812 Router shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - ◇ The ZFR1812 Router shall be FCC compliant to CFR Part 15 subpart B Class A.
 - ◇ The ZFR1812 Router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
 - ◇ The ZFR1812 Router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).
 - ◇ The ZFR1812 Router shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - ◇ The ZFR1812 Router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.
 - ◇ The ZFR1812 Router shall be available in either surface mount, wall mount, or ceiling mount.
 - ◇ The ZFR1812 router shall support the ability to be used alternatively as a wireless repeater should the network design require it.
- .4 One-to-One Wireless Room Temperature Sensor System (WRZ)
- .1 The One-To-One Wireless Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRZ Sensors) and communicate this information to either FEC or VMA controllers via the Sensor/Actuator (SA) Bus.
 - .1 The WRZ Receiver shall use direct sequence spread spectrum RF technology.

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- .2 The WRZ Receiver shall operate on the 2.4 GHZ ISM Band.
 - .3 The WRZ Receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - .4 The WRZ Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.
 - .5 The WRZ Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
 - .6 The WRZ Receiver shall be capable of communication with from one to five WRZ Sensors up to a distance of 200 Feet.
 - .7 The WRZ Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - .8 The WRZ Receiver shall have LED indicators to provide information regarding the following conditions:
 - ◇ Power
 - ◇ SA Bus – Receiver Activity/No Activity
 - ◇ Wireless RF – Transmission from sensors/No Transmission
 - ◇ Wireless Rapid Transmit Mode – No transmission/ weak signal/Adequate signal/Excellent signal
- .2 The WRZ Sensors shall sense and report room temperatures to the WRZ Receiver.
- .1 The WRZ Sensors shall use direct sequence spread spectrum RF technology.
 - .2 The WRZ Sensors shall operate on the 2.4 GHZ ISM Band.
 - .3 The WRZ Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - .4 The WRZ sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
 - .5 The WRZ sensors shall be available with
 - ◇ Warmer/Cooler Set Point Adjustment
 - ◇ No Set Point Adjustment
 - ◇ Set Point Adjustment Scale – 55 to 85° F.
 - .6 The WRZ sensors shall be assembled in NEMA 1 plastic housings.
- .5 Network Sensors (NS)
- .1 The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
 - .1 Zone Temperature
 - .2 Zone humidity
 - .3 Zone setpoint
 - .2 The NS shall transmit the zone information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
 - .3 The Network Sensors shall include the following items:
 - .1 A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint.
 - .2 An LED to indicate the status of the Override feature.

- .3 A button to toggle the temperature display between Fahrenheit and Celsius.
- .4 A button to initiate a timed override command
- .4 The NS shall be available with either screw terminals or phone jack.
- .5 The NS shall be available in either surface mount or wall mount styles.

2.7 INPUT DEVICES

- .1 General Requirements
 - .1 Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.
- .2 Temperature Sensors
 - .1 General Requirements:
 - .1 Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
 - .2 The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
 - .3 The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Chilled Water	± .5°F.
Room Temp	± .5°F.
Duct Temperature	± .5°F.
All Others	± .75°F.

- .2 Room Temperature Sensors
 - .1 Room sensors shall be constructed for either surface or wall box mounting.
 - .2 Room sensors shall have the following options when specified:
 - ◇ Setpoint reset slide switch providing a ±3 degree (adjustable) range.
 - ◇ Individual heating/cooling setpoint slide switches.
 - ◇ A momentary override request push button for activation of after-hours operation.
 - ◇ Analog thermometer.
- .3 Room Temperature Sensors with Integral Display
 - .1 Room sensors shall be constructed for either surface or wall box mounting.
 - .2 Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
 - ◇ Display room and outside air temperatures.

- ◇ Display and adjust room comfort setpoint.
 - ◇ Display and adjust fan operation status.
 - ◇ Timed override request push button with LED status for activation of after-hours operation.
 - ◇ Display controller mode.
 - ◇ Password selectable adjustment of setpoint and override modes.
- .4 Thermo wells
- .1 When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
 - .2 Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
 - .3 Thermo wells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
 - .4 Thermo wells shall be constructed of 316 stainless steel.
- .5 Outside Air Sensors
- .1 Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - .2 Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - .3 Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
- .6 Duct Mount Sensors
- .1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
 - .2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
- .7 Averaging Sensors
- .1 For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
 - .2 For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
 - .3 Capillary supports at the sides of the duct shall be provided to support the sensing string.
- .8 Acceptable Manufacturers: Johnson Controls, Setra.
- .3 Humidity Sensors
- .1 The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
 - .2 The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

- .3 The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
 - .4 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealite fittings and stainless steel bushings.
 - .5 A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
 - .6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
 - .7 Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.
- .4 Differential Pressure Transmitters
- .1 General Air and Water Pressure Transmitter Requirements:
 - .1 Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - .2 Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - .3 Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the Balancing Subcontractor and Contract Administrator permanent, easy-to-use connection.
 - .4 A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
 - .2 Low Differential Water Pressure Applications (0" - 20" w.c.)
 - .1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
 - .2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - ◇ .01-20" w.c. input differential pressure range.
 - ◇ 4-20 mA output.
 - ◇ Maintain accuracy up to 20 to 1 ratio turndown.
 - ◇ Reference Accuracy: +0.2% of full span.
 - .3 Acceptable Manufacturers: Setra and Mamac.
 - .3 Medium to High Differential Water Pressure Applications (Over 21" w.c.)
 - .1 The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:
 - ◇ Differential pressure range 10" w.c. to 300 PSI.
 - ◇ Reference Accuracy: $\pm 1\%$ of full span (includes non-linearity, hysteresis, and repeatability).
 - .2 Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low

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- connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
- .3 Acceptable Manufacturers: Setra and Mamac.
 - .4 Building Differential Air Pressure Applications (-1" to +1" w.c.)
 - .1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - .2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - ◇ -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)
 - ◇ 4-20 mA output.
 - ◇ Maintain accuracy up to 20 to 1 ratio turndown.
 - ◇ Reference Accuracy: +0.2% of full span.
 - .3 Acceptable Manufacturers: Johnson Controls and Setra.
 - .5 Low Differential Air Pressure Applications (0" to 5" w.c.)
 - .1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - .2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - ◇ (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)
 - ◇ 4-20 mA output.
 - ◇ Maintain accuracy up to 20 to 1 ratio turndown.
 - ◇ Reference Accuracy: +0.2% of full span.
 - .3 Acceptable Manufacturers: Johnson Controls and Setra.
 - .6 Medium Differential Air Pressure Applications (5" to 21" w.c.)
 - .1 The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
 - ◇ Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
 - ◇ Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
 - ◇ Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).
 - .2 Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
 - .3 Acceptable manufacturers: Johnson Controls and Setra.

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- .5 Status and Safety Switches
 - .1 General Requirements
 - .1 Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
 - .2 Current Sensing Switches
 - .1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
 - .2 Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
 - .3 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
 - .4 Acceptable manufacturers: Veris Industries
 - .3 Air Filter Status Switches
 - .1 Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
 - .2 A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
 - .3 Provide appropriate scale range and differential adjustment for intended service.
 - .4 Acceptable manufacturers: Johnson Controls, Cleveland Controls
 - .4 Air Flow Switches
 - .1 Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
 - .2 Acceptable manufacturers: Johnson Controls, Cleveland Controls
 - .5 Air Pressure Safety Switches
 - .1 Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
 - .2 Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
 - .3 Acceptable manufacturers: Johnson Controls, Cleveland Controls
 - .6 Water Flow Switches
 - .1 Water flow switches shall be approved equal in accordance with B6 to the Johnson Controls P74.
 - .7 Low Temperature Limit Switches

- .1 The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
- .2 The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
- .3 For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
- .4 The low temperature limit switch shall be approved equal in accordance with B6 to Johnson Controls A70.

2.8 OUTPUT DEVICES

- .1 Actuators
 - .1 General Requirements
 - .1 Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.
 - .2 Electronic Damper Actuators
 - .1 Electronic damper actuators shall be direct shaft mount.
 - .2 Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
 - .3 Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
 - .4 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
 - .5 Acceptable manufacturers: Johnson Controls, Mamac.
 - .2 Control Dampers

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- .1 The BMS Subcontractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Subcontractor or as specifically indicated on the Drawings.
 - .2 All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
 - .3 All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
 - .4 Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500. All dampers to be insulated, both blade and frame.
 - .5 One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Johnson Controls VD-1252 series insulated damper.
 - .6 Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist
- .3 Control Relays
- .1 Control Pilot Relays
 - .1 Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
 - .2 Mounting Bases shall be snap-mount.
 - .3 DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
 - .4 Contacts shall be rated for 10 amps at 120VAC.
 - .5 Relays shall have an integral indicator light and check button.
 - .6 Acceptable manufacturers: Johnson Controls, Lectro
- .4 Electronic Signal Isolation Transducers
- .1 A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
 - .2 The signal isolation transducer shall provide ground plane isolation between systems.
 - .3 Signals shall provide optical isolation between systems.

- .4 Acceptable manufacturers: Advanced Control Technologies
- .5 External Manual Override Stations
 - .1 External manual override stations shall provide the following:
 - .1 An integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.
 - .2 A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.
 - .3 A Status LED shall illuminate whenever the output is ON.
 - .4 An Override LED shall illuminate whenever the HOA switch is in either the HAND or OFF position.
 - .5 Contacts shall be rated for a minimum of 1 amp at 24 VAC.

2.9 MISCELLANEOUS DEVICES

- .1 Local Control Panels
 - .1 All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be CSA inspected and listed as an assembly and carry a CSA label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
 - .2 In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
 - .3 All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
 - .4 Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
 - .5 All wiring shall be neatly installed in plastic trays or tie-wrapped.
 - .6 A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.
- .2 Power Supplies
 - .1 DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
 - .2 Input: 120 VAC +10%, 60Hz.
 - .3 Output: 24 VDC.
 - .4 Line Regulation: +0.05% for 10% line change.
 - .5 Load Regulation: +0.05% for 50% load change.
 - .6 Ripple and Noise: 1 mV rms, 5 mV peak to peak.
 - .7 An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
 - .8 A power disconnect switch shall be provided next to the power supply.
- .3 Thermostats

- .1 Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

Part 3 Performance / Execution

3.1 BMS SPECIFIC REQUIREMENTS

- .1 Graphic Displays
 - .1 Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All graphic displays shall be per City of Winnipeg's standards.
 - .2 Custom Reports:
 1. Provide custom reports as required for this project:
- .3 Actuation / Control Type
 - .1 Primary Equipment
 - .1 Controls shall be provided by equipment manufacturer as specified herein.
 - .2 All dampers shall be electric.
 - .2 Rooftop Equipment
 - .1 All RTU's/AHU's shall be controlled with a HVAC-DDC Controller
 - .2 All damper actuation shall be electric.
 - .3 Terminal Equipment:
 - .1 Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.
 - .2 All Terminal Units shall be controlled with HVAC-DDC Controller)

3.2 INSTALLATION PRACTICES

- .1 BMS Wiring
 - .1 All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Subcontractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.
 - .2 All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.
 - .3 The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Subcontractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Subcontractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
 - .4 Class 2 Wiring

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- .1 All Class 2 (24VAC 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' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
 - .5 Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
 - .6 Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.
- .2 BMS Line Voltage Power Source
- .1 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.
 - .2 Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.
 - .3 DDC terminal unit controllers may use AC power from motor power circuits.
- .3 BMS Raceway
- .1 All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
 - .2 Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Contract Administrator.
 - .3 All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
 - .4 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. Flexible Metal Conduit shall be UL listed.
- .4 Penetrations
- .1 Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.
 - .2 All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
 - .3 All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
 - .4 Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.
 - .5
- .5 BMS Identification Standards
- .1 Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.

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- .1 Cable types specified in Item A shall be color coded for easy identification and troubleshooting.
- .6 BMS Panel Installation
- .1 The BMS panels and cabinets shall be located as indicated 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 The BMS Subcontractor shall be responsible for coordinating panel locations with other trades and Electrical and Mechanical Subcontractors.
- .7 Input Devices
- .1 All Input devices shall be installed per the manufacturer recommendation
 - .2 Locate components of the BMS in accessible local control panels wherever possible.
- .8 HVAC Input Devices – Genera1
- .1 All Input devices shall be installed per the manufacturer recommendation
 - .2 Locate components of the BMS in accessible local control panels wherever possible.
 - .3 The Mechanical Subcontractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
 - .4 Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
 - .5 Outside Air Sensors
 - .1 Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
 - .2 Sensors shall be installed with a rain proof, perforated cover.
 - .6 Water Differential Pressure Sensors
 - .1 Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
 - .2 Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
 - .3 The transmitters shall be installed in an accessible location wherever possible.
 - .7 Medium to High Differential Water Pressure Applications (Over 21" w.c.):
 - .1 Air bleed units, bypass valves and compression fittings shall be provided.
 - .8 Building Differential Air Pressure Applications (-1" to +1" w.c.):
 - .1 Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
 - .2 The interior tip shall be inconspicuous and located as shown on the drawings.
 - .9 Air Flow Measuring Stations:
 - .1 Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.

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- .2 Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
 - .10 Duct Temperature Sensors:
 - .1 Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
 - .2 The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
 - .3 For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
 - .4 The sensor shall be mounted to suitable supports using factory approved element holders.
 - .11 Space Sensors:
 - .1 Shall be mounted per ADA requirements.
 - .2 Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
 - .12 Low Temperature Limit Switches:
 - .1 Install on the discharge side of the first water or steam coil in the air stream.
 - .2 Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
 - .3 For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
 - .13 Air Differential Pressure Status Switches:
 - .1 Install with static pressure tips, tubing, fittings, and air filter.
 - .14 Water Differential Pressure Status Switches:
 - .1 Install with shut off valves for isolation.
 - .9 HVAC Output Devices
 - .1 All output devices shall be installed per the manufacturers recommendation. The Mechanical Subcontractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
 - .2 Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
 - .3 Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
 - .4 Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
 - .5 Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal

isolation transducer shall provide ground plane isolation between systems.
Signals shall provide optical isolation between systems

3.3 TRAINING

- .1 The BMS Subcontractor shall provide the following training services:
 - .1 One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.4 COMMISSIONING

- .1 Fully commission all aspects of the Building Management System work.
- .2 Acceptance Check Sheet
 - .1 Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.
 - .2 Submit the check sheet to the Contract Administrator for approval
 - .3 The Contract Administrator will use the check sheet as the basis for acceptance with the BMS Subcontractor.
- .3 Promptly rectify all listed deficiencies and submit to the Contract Administrator that this has been done.

Part 4 Sequence of Operations - Controls

4.1 FAN SYSTEM CONTROLS – GENERAL

- .1 Following control sequences shall apply to all supply fan systems whether specifically noted in sequence of operation or not.
- .2 Where fan systems have outdoor and return air dampers modulated to maintain mixed air, discharge air, or room temperature, provide adjustable (0 - 1 min.) restriction feature to retard opening of O.A. damper on system start up and enable heating source controls to come into control and prevent nuisance tripping of low limit protection controls.
- .3 Provide interlocks to ensure system controls energize and associated return and/or exhaust fans run when supply fan runs.
- .4 Provide interlocks to ensure auxiliary equipment such as humidifiers, humidifier valves, outdoor air dampers, relief air dampers, etc. are shut off and/or closed when supply fan is off.
- .5 Where hot water or glycol heating coils are utilized, the mixed air controller shall modulate media flow through coil when supply fan is off in order to prevent overheating condition within system plenum and/or ductwork.

- .6 Where heating coils have coil circulating pumps and 3-way valves associated with them, provide interlocks to ensure that circ. pump shall run when central glycol heating pumps run.
- .7 Provide all fan systems that introduce O.A. with low limit control in discharge air to shut down supply fan and activate local alarm when discharge air temperature drops below 3°C(37 °F). Locate low limit in manner that shall protect heating and cooling coils, and at same time not be subject to nuisance tripping.
- .8 Where relief air dampers are not directly ducted to supply/return fans, provide backdraft temp. controller to prevent backdraft condition from occurring.
- .9 Provide differential pressure switches across each filter bank to indicate "filter dirty" notification at DDC user workstation.
- .10 On 100% O.A. systems, provide end switch on O.A. damper to ensure O.A. damper is fully open prior to starting fan.

4.2 ROOFTOP RTU-1 CONTROL

- .1 RTU supply fan shall operate on an occupied/unoccupied schedule as programmed into the dedicated DDC controller.
- .2 Provide night setback during unoccupied mode. In unoccupied mode, supply fan shall be cycled with 100% return air to maintain setback space temperature.
- .3 In the occupied mode, RTU fan will operate continuous, with the outside air damper positioned for a minimum outdoor air percentage.
- .4 RTU controls shall take advantage of free cooling with economizer control:
 - .1 On a call for cooling, with outdoor air temperature below the economizer lockout, outside dampers shall be modulated with return air damper to maintain mixed air temperature.
 - .2 With the outside temperature above the return air temperature, the dampers will revert to a minimum outdoor air setting to provide ventilation to the space.
- .5 If more fresh air is required based on feedback from the return air CO2 sensor, economizer damper shall modulate open from normal minimum position to maintain CO2 set point of 800 ppm. Economizer damper adjustment shall be limited such that RTU discharge air temperature is maintained.
- .6 Provide discharge air reset to optimize supply air temperature. Reset based on the space temperature sensor. DDC output from FEC controller will provide a 0-10 vdc output to the gas valve supplied as part of the RTU package. With the outside temperature above set point and the space requiring cooling, the FEC controller will provide the required stages of D/X cooling to maintain set point. With the space requiring heat, the FEC controller will provide an output to the electric perimeter baseboards to act as the first stage of heat.
- .7 Provide a return air mounted humidity sensor to control the humidifier. Provide a humidity sensor in the supply air duct of RTU to act as a high limit to shut down the humidifier

when the high limit setting is reached. Interlock the humidifier to be off during the unoccupied mode or be de-energized when the RTU fan fails during the occupied mode.

- .8 Each filter bank shall have a differential pressure switch to monitor pressure across each bank for filter status.
- .9 The following lists the minimum I/O points to be sensed/controlled by the BAS:
 - .1 Analogue Inputs
 - .1 Discharge air temperature
 - .2 Mixed air temperature
 - .3 Return air temperature
 - .4 Outside air temperature (Global point)
 - .5 Return air CO2 level
 - .6 Return air humidity
 - .7 Supply air humidity (2)
 - .8 Space Temperature (Wireless Model)
 - .2 Analogue Outputs
 - .1 Outdoor/return damper signal (0-10)
 - .2 Heating signal (0-10)
 - .3 Humidifier command (0-10vdc)
 - .3 Binary Inputs
 - .1 Low temperature limit switch
 - .2 Filter status
 - .3 Supply fan status
 - .4 Binary Outputs
 - .1 Supply fan start/stop
 - .2 Humidifier enable
 - .3 Baseboard heat enable

4.3 ROOFTOP RTU-2 CONTROL

- .1 RTU supply fan shall operate on an occupied/unoccupied schedule as programmed into the dedicated DDC controller.
- .2 Provide night setback during unoccupied mode. In unoccupied mode, supply fan shall be cycled with 100% return air to maintain setback space temperature.
- .3 In the occupied mode, RTU fan will operate continuous, with the outside air damper positioned for a minimum outdoor air percentage.
- .4 RTU controls shall take advantage of free cooling with economizer control:
 - .1 On a call for cooling, with outdoor air temperature below the economizer lockout, outside dampers shall be modulated with return air damper to maintain mixed air temperature.
 - .2 With the outside temperature above the return air temperature, the dampers will revert to a minimum outdoor air setting to provide ventilation to the space.

- .5 If more fresh air is required based on feedback from the return air CO₂ sensor, economizer damper shall modulate open from normal minimum position to maintain CO₂ set point of 800 ppm. Economizer damper adjustment shall be limited such that RTU discharge air temperature is maintained.
- .6 Provide discharge air reset to optimize supply air temperature. Reset based on the space temperature sensor. DDC output from FEC controller will provide a 0-10 vdc output to the gas valve supplied as part of the RTU package. With the outside temperature above set point and the space requiring cooling, the FEC controller will provide the required stages of D/X cooling to maintain set point. With the space requiring heat, the FEC controller will provide an output to the electric perimeter baseboards to act as the first stage of heat.
- .7 Provide a return air mounted humidity sensor to control the humidifier. Provide a humidity sensor in the supply air duct of RTU to act as a high limit to shut down the humidifier when the high limit setting is reached. Interlock the humidifier to be off during the unoccupied mode or be de-energized when the RTU fan fails during the occupied mode.
- .8 Each filter bank shall have a differential pressure switch to monitor pressure across each bank for filter status.
- .9 The following lists the minimum I/O points to be sensed/controlled by the BAS:
 - .1 Analogue Inputs
 - .1 Discharge air temperature
 - .2 Mixed air temperature
 - .3 Return air temperature
 - .4 Outside air temperature (Global point)
 - .5 Return air CO₂ level
 - .6 Return air humidity
 - .7 Supply air humidity (2)
 - .8 Space Temperature (Wireless Model)
 - .2 Analogue Outputs
 - .1 Outdoor/return damper signal (0-10)
 - .2 Heating signal (0-10)
 - .3 Humidifier command (0-10vdc)
 - .3 Binary Inputs
 - .1 Low temperature limit switch
 - .2 Filter status
 - .3 Supply fan status
 - .4 Binary Outputs
 - .1 Supply fan start/stop
 - .2 Humidifier enable
 - .3 Baseboard heat enable

4.4 ROOFTOP RTU-3 CONTROL

- .1 RTU supply fan shall operate on an occupied/unoccupied schedule as programmed into the dedicated DDC controller.

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- .2 Provide night setback during unoccupied mode. In unoccupied mode, supply fan shall be cycled with 100% return air to maintain setback space temperature.
 - .3 In the occupied mode, RTU fan will operate continuous, with the outside air damper positioned for a minimum outdoor air percentage.
 - .4 RTU controls shall take advantage of free cooling with economizer control:
 - .1 On a call for cooling, with outdoor air temperature below the economizer lockout, outside dampers shall be modulated with return air damper to maintain mixed air temperature.
 - .2 With the outside temperature above the return air temperature, the dampers will revert to a minimum outdoor air setting to provide ventilation to the space.
 - .5 If more fresh air is required based on feedback from the return air CO2 sensor, economizer damper shall modulate open from normal minimum position to maintain CO2 set point of 800 ppm. Economizer damper adjustment shall be limited such that RTU discharge air temperature is maintained.
 - .6 Provide discharge air reset to optimize supply air temperature. Reset based on the space temperature sensor. DDC output from FEC controller will provide a 0-10 vdc output to the gas valve supplied as part of the RTU package. With the outside temperature above set point and the space requiring cooling, the FEC controller will provide the required stages of D/X cooling to maintain set point. With the space requiring heat, the FEC controller will provide an output to the electric perimeter baseboards to act as the first stage of heat.
 - .7 Each filter bank shall have a differential pressure switch to monitor pressure across each bank for filter status.
 - .8 The following lists the minimum I/O points to be sensed/controlled by the BAS:
 - .1 Analogue Inputs
 - .1 Discharge air temperature
 - .2 Mixed air temperature
 - .3 Return air temperature
 - .4 Outside air temperature (Global point)
 - .5 Return air CO2 level
 - .6 Space Temperature (Wireless Model)
 - .2 Analogue Outputs
 - .1 Outdoor/return damper signal (0-10)
 - .2 Heating signal (0-10)
 - .3 Humidifier command (0-10vdc)
 - .3 Binary Inputs
 - .1 Low temperature limit switch
 - .2 Filter status
 - .3 Supply fan status
 - .4 Binary Outputs
 - .1 Supply fan start/stop
 - .2 Humidifier enable
 - .3 Baseboard heat enable

4.5 AHU-1/CU-1 CONTROL

- .1 AHU supply fan shall operate on an occupied/unoccupied schedule as programmed into the dedicated DDC controller.
- .2 Provide night setback during unoccupied mode. In unoccupied mode, supply fan shall be cycled with 100% return air to maintain setback space temperature.
- .3 In the occupied mode, AHU fan will operate continuous. Minimum 2-position outside will open when the system is in the occupied mode.
- .4 Space temperature sensors located in rooms 109 and 110 will monitor the average space temperature. On a call for heating, the stages of heat will cycle to maintain space set point. With the space requiring cooling and with the outdoor temperature above set point, the heating will be locked out and the stages of D/X cooling will cycle to maintain the cooling set point.
- .5 Each filter bank shall have a differential pressure switch to monitor pressure across each bank for filter status.
- .6 The following lists the minimum I/O points to be sensed/controlled by the BAS:
 - .1 Analogue Inputs
 - .1 Discharge air temperature
 - .2 Return air temperature
 - .3 Outside air temperature (Global point)
 - .4 Space Temperature - Room 109 (Wireless)
 - .5 Space Temperature - Room 110 (Wireless)
 - .2 Binary Inputs
 - .1 Low temperature limit switch
 - .2 Filter status
 - .3 Supply fan status
 - .4 Intake damper status
 - .3 Binary Outputs
 - .1 Supply fan start/stop
 - .2 Heating stage
 - .3 Cooling stage
 - .4 Intake damper command

4.6 CRAWLSPACE EF-3 CONTROL

- .1 Crawlspace ventilation system will consist of exhaust fan EF-3, one exhaust air damper and on intake damper
- .2 Provide space mounted humidity/temperature sensors in each of the three crawlspace compartments. on a rise in the humidity in any one of the three compartments, the DDC controller will send a command to the motorized intake damper to open. When the end

switch on the intake damper indicates to the DDC controller that the damper is 100% open, the exhaust damper will be commanded open. With the exhaust damper open as sensed by the actuator end switch, the exhaust fan will start.

- .3 The temperature inputs from each space will be used to cycle the respective electric unit heater on.
- .4 Provide an outdoor sensor, which will lock out the ventilation system when the outside temperature is below its programmed set point.
- .5 The following lists the minimum I/O points to be sensed/controlled by the BAS:
 - .1 Analog Inputs
 - .1 Space temperature (Typical of 3)
 - .2 Space humidity (Typical of 3)
 - .3 Outside air temperature (Global point)
 - .2 Binary Inputs
 - .1 Intake damper status
 - .2 Exhaust damper status
 - .3 Exhaust fan status
 - .3 Binary Outputs
 - .1 Exhaust fan start/stop
 - .2 Intake damper - open/close
 - .3 Exhaust damper - open/close
 - .4 Unit heater - on/off (Typical of 3)

4.7 VESTIBULE SF-1 CONTROL

- .1 Supply fan SF-1 will activate on a heating call from the space temperature thermostat, which will be BACnet MS/TP to allow monitoring from the central system.
- .2 With the operation of the supply fan confirmed, the electric duct coil EHC-1 will be enabled to operate on a call for heat from the space thermostat. The thermostat will provide a 0-10 Vdc signal to the packaged SCR controller on the duct coil to maintain space set point.
- .3 Provide a locking guard for the space thermostat
- .4 The operation of EHC-1 will be locked out with the outdoor temperature above set point.
- .5 The following lists the minimum I/O points to be sensed/controlled by the BAS:
 - .1 Analogue Inputs
 - .1 Space Temperature
 - .2 Outside air temperature (Global)
 - .2 Binary Inputs

- .1 Supply fan status
- .3 Analog Outputs
 - .1 Duct Coil SCR
- .4 Binary Outputs
 - .1 Supply fan start/stop

4.8 WASHROOM EXHAUST EF-1

- .1 Washroom exhaust fan will operate on a occupied/unoccupied schedule.
- .2 In the occupied mode, the DDC controller will send a command to open the motorized exhaust air damper. With the damper open, as sensed by the end switch, the exhaust fan will operate on a continuous basis.
- .3 In the unoccupied mode, the exhaust fan will be off
- .4 Provide an override where shown on the drawings, which when activated, will operate the fan for a programmed time period during the unoccupied schedule.
- .5 The following lists the minimum I/O points to be sensed/controlled by the BAS:
 - .1 Binary Inputs
 - .1 Override
 - .2 Exhaust fan status
 - .2 Binary Outputs
 - .1 Exhaust fan start/stop
 - .2 Exhaust damper - open/close

4.9 WASHROOM EXHAUST EF-2

- .1 Washroom exhaust fan will operate on a occupied/unoccupied schedule.
- .2 In the occupied mode, the DDC controller will send a command to open the motorized exhaust air damper. With the damper open, as sensed by the end switch, the exhaust fan will operate on a continuous basis.
- .3 In the unoccupied mode, the exhaust fan will be off
- .4 The following lists the minimum I/O points to be sensed/controlled by the BAS:
 - .1 Binary Inputs
 - .1 Exhaust fan status
 - .2 Binary Outputs
 - .1 Exhaust fan start/stop
 - .2 Exhaust damper - open/close

4.10 ELECTRIC BASEBOARD CONTROL (TYPICAL FOR ROOMS 103,105,111,115/117, JANITOR ROOM)

- .1 Baseboard heater will activate on a heating call from the space temperature thermostat, which will be BACnet MS/TP to allow monitoring from the central system.
- .2 Thermostats will be programmed to operate in an occupied/night set back mode.
- .3 Provide a locking guard for any space thermostats in public areas.

4.11 SUMP PUMP MONITORING SP-1A/1B CONTROL

- .1 Duplex sump pump package will be c/w remote panel located in the mechanical room. The Electrical Subcontractor will provide the wiring between the sump pumps and the remote panels.
- .2 The remote panels will be c/w aux contacts to pick up both pump operation and sump high level alarm.
- .3 The following lists the minimum I/O points to be sensed/controlled by the BAS:
 - .1 Binary Inputs
 - .1 Pump SP-1A status
 - .2 Pump SP-1B status
 - .3 High level alarm

4.12 SUMP PUMP MONITORING SP-2A/2B CONTROL

- .1 Duplex sump pump package will be c/w remote panel located in the mechanical room. The Electrical Subcontractor will provide the wiring between the sump pumps and the remote panels.
- .2 The remote panels will be c/w aux contacts to pick up both pump operation and sump high level alarm.
- .3 The following lists the minimum I/O points to be sensed/controlled by the BAS:
 - .1 Binary Inputs
 - .1 Pump SP-2A status
 - .2 Pump SP-2B status
 - .3 High level alarm

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation procedures wireless communication link and space sensors.

Part 2 PRODUCTS

2.1 SECTION INCLUDES

- .1 Architecture/Communication
- .2 Operator Interface
- .3 Auxiliary Control Devices

2.2 ARCHITECTURE/COMMUNICATION

- .1 Wireless equipment controllers and auxiliary control devices shall conform to:
 - .1 IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.
 - .2 Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.
 - .3 Operating range shall be a minimum of 200 feet; open range shall be 2,500 ft. (762 m) with less than 2% packet error rate to ensure reliable operation.
 - .4 To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.
 - .5 Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.
 - .6 Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E

2.3 OPERATOR INTERFACE

- .1 Wireless Space Sensors
 - .1 Battery life shall be 15 years or greater to minimize the need for battery replacement in typical operating conditions.
 - .2 To check for proper operation, wireless space temperature sensors shall include a signal strength on the space sensor display.
 - .3 To allow local troubleshooting without specialized tools, error codes shall be displayed on the digital display. Error codes shall include: not associated, address to 000, improper software configuration, input voltage too high, or general sensor failure. Codes shall be indicated on inside of sensor back cover.

- .4 To support use by the physically impaired, the wireless space sensor shall be a minimum font size of 12 points, and the LCD model shall be readable in low light conditions.
- .5 A 2% relative humidity sensors module shall be available for humidity control applications to minimize the need for wires sensors, and shall not shorten typical battery life to less than 15 years.

2.4 AUXILIARY CONTROL DEVICES

- .1 Wireless space sensors for use in Heating, Ventilating, and Air Conditioning (HVAC) systems
 - .1 Temperature and Humidity Range
 - .1 The ambient operating temperature range for the wireless space sensor shall be 32 to 122°F (0 to 50°C).
 - .2 The ambient storage temperature range for the wireless space sensor shall be -40 to 185°F (-40 to 85°C).C.
 - .3 The ambient operating and storage humidity range for the wireless space sensor shall be 5 to 95%, non-condensing.
 - .2 Components
 - .1 Wireless space sensors shall be available as: temperature only, field configurable model with digital display, a 2% humidity module for use in either model above. The field configurable model shall allow field configuration without a field service tool. Configuration options include: setpoint, override pushbuttons, fan speed, and system mode switches. System mode, fan speed and setpoint shall include a lock option. The digital display shall also be field configurable to display in Fahrenheit or Celsius units of measure, and can also be configured to display setpoint only.
 - .2 The wireless space sensor addresses shall be held in non-volatile memory to ensure operation through system voltage disturbances and to minimize the risk of incorrect association.
 - .3 The wireless space sensor shall be addressed using pushbuttons and display with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing. Two position DIP switches are not acceptable.
 - .4 Installation and replacement of failed sensors shall be accomplished automatically after power up.
 - .5 The wireless space sensor shall include security screws to protect against theft.
 - .6 Wireless space sensor component certifications shall include:
 - .1 TFP-13651127 - Canada Compliance
 - .2 UL 916 - Energy Management Equipment
 - .3 UL 94 - The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances: 5 VA flammability rating
 - .4 UL 873 - Temperature regulating and indicating equipment
 - .3 Accuracy
 - .1 To ensure proper system performance, the wireless space sensors shall automatically determine when the space temperature is rapidly changing.

When the space temperature is readily changing, the space temperature shall be transmitted at least once each 30 seconds. The maximum time between transmissions shall be 15 minutes. Space temperature sensing accuracy shall be +/- 0.5F (+/- 0.28C).

- .4 Power Requirements
 - .1 The wireless space sensor battery life shall provide at least 15 years life under normal operating conditions and must be readily available size AA, 1.5V.
- .2 Wireless Communications Interface for use in Heating, Ventilating, and Air Conditioning (HVAC) systems
 - .1 Temperature and Humidity Range
 - .1 The ambient storage temperature range for the wireless communications interface shall be -40 to 185°F (-40 to 85°C).C.
 - .2 The ambient operating and storage humidity range for the wireless communications interface shall be 5 to 95%, non-condensing.
 - .2 Components
 - .1 The wireless communications interface shall be addressed using rotary switches with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing. Two position DIP switches are not acceptable.
 - .2 Wireless Comm Interface certifications shall include:
 - 1) TFP-13651127 - Canada Compliance
 - .1 UL 916 - Energy Management Equipment
 - .2 UL 94 - The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances: 5 VA flammability rating
 - .3 UL 873 - Temperature regulating and indicating equipment
 - .4 ZigBee Building Automation, BACnet Tunnelling Device

Part 3 EXECUTION

END OF SECTION

PART 1 General

1.1 SUMMARY

- .1 Section Includes
 - .1 Materials and installation for piping, valves and fittings for gas fired equipment.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 74 00 – Cleaning and Waste Processing.
- .3 Section 01 74 20 – Waste Managing and Disposal.
- .4 Section 01 78 10 – Closeout Submittals.
- .5 Section 01 45 00 – Quality Control.
- .6 Section 01 91 00 – Commissioning.
- .7 Section 02 81 01 – Hazardous Materials.
- .8 Section 23 05 05 – Installation of Pipework.

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5, Pipe Flanges and Flanged Fittings
 - .2 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings
 - .3 ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
 - .4 ASME B18.2.1, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A 53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM B 75M, Standard Specification for Seamless Copper Tube (Metric).
 - .4 ASTM B 837, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .3 Canadian Standards Association (CSA International).
 - .1 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA) / Canadian Gas Association (CGA)
 - .1 CAN/CSA B149.1HB, Natural Gas and Propane Installation Code Handbook.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS)

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fitting and equipment.
 - .2 Indicate on manufacturer's catalogue literature following: valves.
 - .3 Submit WHMIS MSDS in accordance with Section 02 81 01 – Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
 - .4 Test Reports: Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .5 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .6 Instructions: Submit manufacturer's installation instructions.
 - .7 Closeout Submittals: Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 10 – Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
 - .1 Verify Project requirements.
 - .2 Review Installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Trades people to have journeyman qualifications.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20 –Waste Managing and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for reuse and recycling and place in designated containers, steel, metal , plastic waste in accordance with WMP.
 - .5 Divert unused metal materials from landfill to metal recycling facility as approved by Contract Administrator's Representative.

PART 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A 53/A53M, Schedule 40, seamless as follows:
 - .1 NPS ½ to 2, screwed.
 - .2 NPS2 ½ and over, plain end.

2.2 JOINTING MATERIAL

- .1 Screwed fittings: pulverized lead paste
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: non-metallic flat.
- .4 Brazing: to ASTM B 75M.

2.3 FITTINGS

- .1 Steel pipe fittings, screwed:
 - .1 Malleable iron: screwed to ANSI B16.3, Class 150 for service pressures up to and including 861 kPa.
 - .2 Unions: malleable iron, brass to iron, ground seat, to ASTM A47M.
 - .3 Nipples: schedule 40, to ASTM A53.

2.4 MANUAL SHUT-OFF VALVES

- .1 NPS 4 and under, full port, forged brass ball valve for two piece body construction complete with the following:
 - .1 Blowout-proof stem.
 - .2 Adjustable packing gland.
 - .3 Chrome-plated ball.
 - .4 Class 150 WSP, 600 WOG.
 - .5 CGA 3.16 approved.
 - .6 Provide complete with CRN.
 - .7 Lever handle.
 - .8 ANSI B1.20.1 NPT end connections

PART 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

- .1 Install piping in accordance Section 23 05 05 – Installation of Pipework, applicable Provincial Codes, CAN/CSA-B149.1, supplemented as specified.
- .2 Slope piping down in direction to flow to low points.
- .3 Install drip points:
 - .1 At low points in piping system and where indicated.
 - .2 Provide complete with blowdown valve i.e. manual shut-off valve as specified above.
 - .3 Minimum 75 mm in length from tee connection in riser to top of valve. Size to be minimum NPS ¾. Provide complete with threaded end cap.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage.
- .5 Provide clearance for access and for maintenance.
- .6 Ream pipes, clean scale and dirt, inside and out.
- .7 Install piping to minimize pipe dismantling for equipment removal.
- .8 Field ending of piping to be prohibited.
- .9 Nesting of bushings to be prohibited. Utilize properly sized reducing fittings.
- .10 Do not utilize propane piping as an electrical ground.

3.3 VALVES

- .1 Install valves with stems upright or horizontal unless approved otherwise by Contract Administrator's Representative.
- .2 Install valves as indicated.

3.4 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
 - .1 Test system in accordance with CAN/CSA B149.1 and CAN/CSAB149.2 and requirements of authorities having jurisdiction.
- .2 Manufacturer's Field Services:
 - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.
 - .2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
 - .3 Schedule site visits to review work at stages listed:

- .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
- .2 Twice during progress of work at 25% and 60% complete.
- .3 Upon completion of work, after cleaning is carried out.
- .3 Obtain reports within 3 days of review and submit immediately to Contract Administrator's Representative
- .4 PV procedures:
 - .1 Test performance of components.

3.5 ADJUSTING

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

3.6 CLEANING

- .1 Cleaning: in accordance with CAN/CSA B149.1, supplemented as specified.
- .2 Perform cleaning operations as specified in Section 01 74 00 – Cleaning and Waste Processing, and in accordance with manufacturer's recommendations.
- .3 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.7 PURGING

- .1 Purge after pressure test in accordance with CSA-B149.1.

3.8 IDENTIFICATION

- .1 Identify new propane piping systems in accordance with requirements for CSA-B149.1.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 74 20 –Waste Managing and Disposal.
- .3 Section 01 91 00 –Commissioning.
- .4 Section 02 81 01 - Hazardous Materials.
- .5 Section 07 84 00 – Firestopping
- .6 Section 23 05 94 – Pressure Testing of Ducted Air Systems.
- .7 Section 23 44 00 – HVAC Air Filtration

1.3 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A 480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A 635/A635M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A 653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA).
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual.
 - .3 IAQ Guideline for Occupied Buildings Under Construction, 1st Edition.
- .7 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA).

1.4 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials for the following:
 - .1 Sealants.
 - .2 Tape.
 - .3 Proprietary Joints.

1.5 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
 - .1 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Separate for reuse and recycling and place in designated containers steel, metal, plastic waste in accordance with Waste Management Plan.
 - .5 Place materials defined as hazardous or toxic in designated containers.
 - .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
 - .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

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

.2 Seal classification:

.1 Class C: transverse joints and connections made air tight with gaskets, sealant tape or combination thereof. Longitudinal seams unsealed.

2.2 SEALANT

.1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30°C to plus 93°C.

2.3 TAPE

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

2.4 DUCT LEAKAGE

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

2.5 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows:

.1 Rectangular: Centreline radius: 1.5 times width of duct.

.2 Round: smooth radius or five piece. Centreline radius: 1.5 times diameter.

.3 Branches:

.1 Rectangular main and branch: with radius on branch 1.5 times width of duct or 45° entry on branch.

.2 Round main and branch: enter main duct at 45° with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.4 Main duct branches: with volume control damper.

.4 Transitions:

.1 Diverging: 20° maximum included angle.

.2 Converging: 30° maximum included angle.

.5 Offsets:

.1 Full short radiused elbows as indicated.

.6 Obstruction deflectors: maintain full cross-sectional area. Maximum included angles: as for transitions.

2.6 FIRESTOPPING

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

2.7 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653, G90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

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: 500 mm.
- .2 Hanger configuration: to SMACNA.
- .3 Hangers: galvanized steel angle with black steel rods to ASHRAE or SMACNA following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25x25x3	6
751 to 1050	40x40x3	6
- .4 Upper hanger attachments:
 - .1 For steel joist: manufactured joist clamp steel plate washer.
 - .1 Acceptable Product: Myatt, Grinnell, Hunt.
 - .2 For steel beams: manufactured beam clamps:
 - .1 Acceptable Product: Myatt, Grinnell, Hunt.

Part 3 Execution

3.1 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B, and SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation. Do not place fire stopping material in expansion space between damper sleeve and fire partition.

- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.2 HANGERS

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

Duct Size (mm)	Spacing (mm)
to 1500	3000

3.3 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Fresh air intake.
 - .2 Minimum 3000 mm from duct mounted humidifier in all directions.
 - .3 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams. Solder or weld joints of bottom and side sheets. Seal other joints with duct sealer.

3.4 SEALING AND TAPING

- .1 Apply sealant to outside of joint to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations. Sealant and tape to be applied to full perimeter of duct.

3.5 LEAKAGE TESTS/COMMISSIONING

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Do leakage tests in sections.
- .4 Make trial leakage tests as instructed to demonstrate workmanship.
- .5 Install no additional ductwork until trial test has been passed.
- .6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90° elbows.
- .7 Complete test before insulation or concealment.

END OF SECTION

PART 1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 45 00 – Quality Control.
- .3 Section 01 74 00 – Cleaning and Waste Processing.
- .4 Section 01 74 20 –Waste Managing and Disposal.
- .5 Section 01 78 10 – Closeout Submittals.
- .6 Section 02 81 01 – Hazardous Materials.

1.3 REFERENCES

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

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
 - .1 Flexible connections
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.
 - .2 Submit WHMIS MSDS in accordance with Section 02 81 01 – Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

- .1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Manufacturer's Field Reports: manufacturer's field reports specified.
- .7 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 10 – Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20 –Waste Managing and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, and corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for reuse and recycling and place in designated containers steel, metal, and plastic waste in accordance with Waste Management Plan (WMP).
 - .5 Divert unused metal materials from landfill to metal recycling facility as approved by Contract Administrator's Representative.

PART 2 Products

2.1 GENERAL

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

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame 0.66 mm thick with fabric clenched by means of double locked seams.

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

2.3 ACCESS DOORS IN DUCTS

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

2.4 TURNING VANES

- .1 Factory or shop fabricated double thickness with trailing edge, to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST PORTS

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

2.6 SPIN-IN COLLARS

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

PART 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Flexible connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
 - .2 Length of connection: 100 mm.
 - .3 Minimum distance between metal parts when system in operation: 75 mm.
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
- .2 Access doors and viewing panels:
 - .1 Size:
 - .1 450 x 450 mm for servicing entry.
 - .2 300 x 300 mm for viewing.
 - .3 As indicated.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 Instrument test ports.
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations.
 - .1 For traverse readings:
 - .1 Inlets and outlets of fan systems.
 - .2 Main and sub-main ducts.
 - .3 And as indicated.

- .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 At inlet and outlet of coils.
 - .3 And as indicated.
- .4 Turning vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Have manufacturer's representative of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of the Work, after cleaning is carried out.
 - .4 Obtain reports, within 3 days of review, and submit, immediately, to Contract Administrator's Representative.

3.4 CLEANING

- .1 Perform cleaning operations as specified in Section 01 74 00 – Cleaning and Waste Processing, and in accordance with Manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS:

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 45 00 – Quality Control.
- .3 Section 01 61 00 – Product Requirements.
- .4 Section 01 74 20 –Waste Managing and Disposal.
- .5 Section 01 78 10 – Closeout Submittals.

1.3 REFERENCES

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

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 – Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 – Submittal Procedures.
 - .2 Indicate the following:
 - .1 Specifications.
 - .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: Submit manufacturer's installation instructions.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with Section 01 61 00 – Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 –Waste Managing and Disposal.

PART 2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

- .1 Fabricate from same material as duct, 0.8 mm up to 450 mm wide, 1.6 mm maximum up to 1200 mm wide, V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon or bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.3 MULTI-BLADED DAMPERS

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

PART 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 For supply and exhaust systems, locate balancing dampers in each branch duct.
- .4 Runouts to registers and diffusers: located as close as possible to main ducts.
- .5 All dampers to be vibration free.
- .6 Ensure damper operators are observable and accessible.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning and Waste Processing.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 45 00 – Quality Control.
- .3 Section 01 61 00 - Product Requirements.
- .4 Section 01 74 00 - Cleaning and Waste Processing.
- .5 Section 01 74 20 –Waste Managing and Disposal.
- .6 Section 01 78 10 – Closeout Submittals.
- .7 Section 23 33 00 – Air Duct Accessories.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate the following:
 - .1 Performance data.
 - .2 Specifications
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals

1.5 QUALITY ASSURANCE

- .1 Certificates:
 - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.

PART 2 Products

2.1 MULTI-LEAF DAMPERS

- .1 Opposed or parallel blade type as indicated.
- .2 Structurally formed steel or extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel or extruded aluminum frame.
- .3 Pressure fit self-lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5 Performance:
 - .1 Leakage: in closed position to be less than 2% of rated air flow at 500 Pa differential across damper.
 - .2 Pressure drop: at full open position to be less than 25 Pa differential across damper at 10 m/s.
- .6 Insulated aluminum dampers:
 - .1 Frames: insulated with extruded polystyrene foam with RSI factor of 5.0.

- .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI factor of 5.0.

2.2 DISC TYPE DAMPERS

- .1 Frame: insulated brake formed, welded, 1.6 mm thick, galvanized steel to ASTM A 653M.
- .2 Disc: insulated spin formed, 1.6 mm thick, galvanized steel to ASTM A 653M.
- .3 Gasket: extruded neoprene, field replaceable, with 10-year warranty.
- .4 Bearings: roller self lubricated and sealed.
- .5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.
- .6 Performance:
 - .1 Leakage: in closed position to be less than 2 % of rated air flow at 500 Pa pressure differential across damper.
 - .2 Pressure drop: at full open position to be less than 25 Pa differential across damper at 10 m/s.

2.3 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi leaf, aluminum or steel construction with nylon bearings, centre pivoted, spring assisted or counterweighted.
- .2 counter-weights set to open as indicated.

PART 3 Execution

3.1 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00 – Air Duct Accessories.
- .5 Ensure dampers are observable and accessible.

3.2 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning and Waste Processing.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 61 00 - Product Requirements.
- .3 Section 01 74 00 - Cleaning and Waste Processing.
- .4 Section 01 74 20 –Waste Managing and Disposal.
- .5 Section 01 78 10 - Closeout Submittals.
- .6 Section 01 91 00 – Commissioning.
- .7 Section 23 31 13.01 – Metal Ducts – Low Pressure to 500 Pa.

1.3 REFERENCES

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

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate the following:
 - .1 Fire dampers.

- .2 Smoke dampers.
- .3 Operators.
- .4 Fusible links.
- .5 Design details of break-away joints.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.5 QUALITY ASSURANCE

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

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 10 – Closeout Submittals.
 - .2 Provide the following:
 - .1 6 fusible links of each type.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.

PART 2 Products

2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type B or C, blades out of air stream listed and bear label of ULC, meet requirements of provincial fire authority and ANSI/NFPA 90A. Fire damper

- assemblies to be fire tested in accordance with CAN4-S112. Minimum rating 1 ½ hours, dynamically rated.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
 - .3 Top hinged: offset, round or square; multi-blade hinged or interlocking type; roll door type; or guillotine type; sized to maintain full duct cross section.
 - .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 Retaining angle iron frame, 40 x 40 x 3 mm, on full perimeter of fire damper, on both sides of fire separation being pierced.
 - .6 Equip fire dampers with steel sleeve or frame installed to prevent disruption of ductwork or impair damper operation.
 - .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
 - .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
 - .9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
 - .10 Unless otherwise indicated, the installation details given in SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.2 SMOKE DAMPERS

- .1 To be ULC or UL listed and labelled.
- .2 Normally closed reverse action smoke vent (S/D-RASV): folding blade type, opening by gravity upon detection of smoke, and/or from remote alarm signalling device actuated by an electro thermal link. Two flexible stainless steel blade edge seals to provide required constant sealing pressure.
- .3 Normally open smoke/seal (S/D-SSSD): folding blade type, closing when actuated by means of electro thermal link and/or from remote alarm signalling device. Blade edge seals of flexible stainless steel shall provide required constant sealing pressure. Stainless steel negator springs with locking devices shall ensure positive closure for units mounted horizontally in vertical ducts.
- .4 Motorized (S/D-M): folding blade type, normally open with power on. When power is interrupted damper shall close automatically. Both damper and damper operator shall be ULC listed and labelled.

- .5 Electro thermal link (S/D-ETL): dual responsive fusible link which melts when subjected to local heat of 74 °C and from external electrical impulse of low power and short duration; ULC or UL listed and labelled.

2.3 COMBINATION FIRE AND SMOKE DAMPERS

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

PART 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00 – Air Duct Accessories.
- .5 Coordinate with installer of firestopping to Section 07 84 00 – Firestopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning and Waste Processing.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.4 COMMISSIONING

- .1 Commission in accordance with Section 01 91 00 – Commissioning.

END OF SECTION

PART 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation of flexible ductwork, joints and accessories.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 74 20 –Waste Managing and Disposal.
- .3 Section 01 91 00 –Commissioning.
- .4 Section 02 81 00 - Hazardous Materials.
- .5 Section 23 05 94 - Pressure Testing of Ducted Air System.

1.3 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA).
 - .2 Transportation of Dangerous Goods Act, (TDGA).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction.
- .6 Underwriters' Laboratories Inc. (UL).
 - .1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.
- .7 Underwriters' Laboratories of Canada (ULC).
 - .1 CAN/ULC-S110, Fire Tests for Air Ducts.

1.4 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS in accordance with Section 02 81 00 - Hazardous Materials for the following:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .3 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures.

1.5 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Place materials defined as hazardous or toxic in designated containers.
 - .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
 - .6 Ensure emptied containers are sealed and stored safely.
 - .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

1.7 INDOOR AIR QUALITY (IAQ)

- .1 During construction, meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

PART 2 Products

2.1 GENERAL

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

2.2 METALLIC - UNINSULATED

- .1 Type 1: spiral wound flexible aluminum.
- .2 Performance:
 - .1 Factory tested to 1000 Pa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.3 METALLIC - INSULATED

- .1 Type 2: spiral wound flexible aluminum with factory applied, 25 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl or reinforced mylar/neoprene laminate jacket.
- .2 Performance:
 - .1 Factory tested to 1000 Pa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Thermal loss/gain: 1.3 W/m².°C. mean.

2.4 NON-METALLIC - UNINSULATED

- .1 Type 3: non-collapsible, coated mineral base fabric or aluminum foil mylar type, mechanically bonded to, and helically supported by, external steel wire.
- .2 Performance:
 - .1 Factory tested to 1000 Pa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.5 NON-METALLIC - INSULATED

- .1 Type 4: non-collapsible, coated mineral base fabric or aluminum foil mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, 25 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl or reinforced mylar/neoprene laminate jacket.
- .2 Performance:
 - .1 Factory tested to 1000 Pa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Thermal loss/gain: 1.3 W/m².°C mean.

2.6 METALLIC ACOUSTIC INSULATED MEDIUM PRESSURE

.1 Type 5: Spiral wound, flexible perforated aluminum with factory applied 25 mm thick flexible glass fibre thermal insulation and sleeved by aluminum foil and mylar laminate vapour barrier.

.2 Performance:

.1 Factory tested to 3 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

.3 Acoustical performance: Minimum attenuation (dB/m) to following table:

	Frequency (Hz)					
Duct Diam:	125	250	500	1000	2000	
100	0.6	3	12	27	0	
150	1.2	3	12	22	27	
200	2.0	5	12	19	20	
300	2.4	5	12	16	15	

2.7 NON-METALLIC - ACOUSTIC INSULATED

.1 Type 6: Non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to steel wire with factory applied flexible glass fibre acoustic insulation and encased in aluminum foil and mylar laminate vapour barrier.

.2 Performance:

.1 Factory tested to 3 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

.3 Acoustical performance: Minimum attenuation (dB/m) to following table:

	Frequency (Hz)					
Duct Diam:	125	250	500	1000	2000	
100	0.6	3	12	27	0	
150	1.2	3	12	22	27	
200	2.0	5	12	19	20	
300	2.4	5	12	16	15	

PART 3 Execution

3.1 DUCT INSTALLATION

.1 Install in accordance with: NFPA 90A and NFPA 90B SMACNA.

.2 Do leakage test in accordance with Section 23 05 94 - Pressure Testing of Ducted Air System.

.3 Do trial test to demonstrate workmanship.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for acoustic duct lining.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 20 - Waste Managing and Disposal.
- .3 Section 02 81 01 - Hazardous Materials.

1.3 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM C 423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM C 916, Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C 1071, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .4 ASTM C 1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .5 ASTM G 21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .5 Thermal Insulation Association of Canada(TIAC).
 - .1 National Insulation Standards.
- .6 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).
 - .1 SMACNA, HVAC DCS HVAC, Duct Construction Standards, Metal and Flexible.
 - .2 SMACNA IAQ Guideline for Occupied Buildings 95.
- .7 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

- .8 Underwriter's Laboratories of Canada (ULC).
 - .1 CAN/ULC-S102, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Store and manage hazardous materials in accordance with Section 02 81 01 - Hazardous Materials.
- .2 Protect on site stored or installed absorptive material from moisture damage.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
- .6 Ensure emptied containers are sealed and stored safely.
- .7 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 DUCT LINER

- .1 General:
 - .1 Mineral Fibre duct liner: air surface coated mat facing.
 - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102, NFPA 90A and NFPA 90B.
 - .3 Fungi resistance: to ASTM C 1338, ASTM G 21.
- .2 Rigid:

- .1 Use on flat surfaces where indicated
 - .2 25 mm thick, to ASTM C 1071, Type 2, fibrous glass rigid board duct liner.
 - .3 Density: 48 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.76 (m².degrees C)/W for 25 mm thickness, 1.15 (m².degrees C)/W for 38 mm thickness, 1.53 (m².degrees C)/W for 50 mm thickness when tested in accordance with ASTM C 177, at 24 degrees C mean temperature.
 - .5 Maximum velocity on faced air side: 20.3 m/sec.
 - .6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C 423.
- .3 Flexible:
- .1 Use on round or oval surfaces.
 - .2 25 mm thick, to ASTM C 1071 Type 1, fibrous glass blanket duct liner.
 - .3 Density: 24 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.37 (m².degrees C)/W for 12 mm thickness, 0.74 (m².degrees C)/W for 25 mm thickness, 1.11 (m².degrees C)/W for 38 mm thickness, 1.41 (m².degrees C)/W to 50 mm thickness when tested in accordance with ASTM C 177, at 24 degrees C mean temperature.
 - .5 Maximum velocity on coated air side: 25.4 m/sec.
 - .6 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C 423.

2.2 ADHESIVE

- .1 Adhesive: to NFPA 90A and NFPA 90B, ASTM C916.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degrees C to plus 93 degrees C.
- .3 Water-based fire retardant type.

2.3 FASTENERS

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.

2.4 JOINT TAPE

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.5 SEALER

- .1 Meet requirements of NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

Part 3 Execution

3.1 GENERAL

- .1 Do work in accordance with SMACNA HVAC DCS, NIAC, FGDLs and as indicated except as specified otherwise.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.

3.2 DUCT LINER

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100 % coverage of adhesive to ASTM C 916
 - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.
 - .1 Spacing of mechanical fasteners in accordance with SMACNA HVAC, DCS, TIAC.
 - .2 In systems, where air velocities exceed 20.3 m/sec, install galvanized sheet metal nosing to leading edges of duct liner.

3.3 JOINTS

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply two coats of sealer over tape.
- .2 Replace damaged areas of liner at discretion of Contract Administrator's Representative.
- .3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

END OF SECTION

PART 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Fans, motors, accessories, and hardware for commercial use.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures
- .2 Section 01 61 00 - Product Requirements.
- .3 Section 01 74 00 - Cleaning and Waste Processing.
- .4 Section 01 74 20 – Waste Managing and Disposal.
- .5 Section 01 78 10 – Closeout Submittals.
- .6 Section 01 91 00 – Commissioning.
- .7 Section 09 91 10 – Painting.
- .8 Section 23 05 13 – Common Motor Requirements for HVAC Equipment.
- .9 Section 23 33 00 – Air Duct Accessories.

1.3 REFERENCES

- .1 Air Conditioning and Mechanical Contractors (AMCA)
 - .1 AMCA Publication, Standards Handbook.
 - .2 AMCA 300, Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA MG 1 Motors and Generators

- .2 NEMA ICS 7.1 Safety Standard for Construction and Guide for Selection, Installation and Operation of Adjustable Drive Systems.

1.4 SYSTEM DESCRIPTION

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

1.5 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Provide:
 - .1 Fan performance curves showing point of operation, BHP kW and efficiency.
 - .2 Sound rating data at point of operation.
 - .3 Dimensional data.
 - .4 Installation procedures.
- .4 Indicate:
 - .1 Motors, sheaves, bearings, shaft details
 - .2 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.

- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.
 - .1 Spare parts to include:
 - .1 Matched sets of belts.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals.
 - .2 Belts
 - .3 Addresses of suppliers.
 - .4 List of specialized tools necessary for adjusting, repairing or replacing.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.

PART 2 Products

2.1 FANS GENERAL

- .1 Capacity: flow rate, static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data 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. Unit shall bear AMCA certified sound rating seal.
- .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 diameter.
- .5 Motors:

- .1 Open drip proof outside of air stream, TEFC when in air stream, explosion proof as indicated in accordance with NEMA MG1.
- .2 In accordance with Section 23 05 13 – Common Motor Requirements for HVAC Equipment supplemented as specified herein.
- .3 For use with variable speed controllers where specified.
- .4 Sizes as specified.
- .5 Two speed with two windings and speeds of approximately 1200 or 900 r/min low and 1800 r/min high as indicated.
- .6 Two speeds with split winding, constant horsepower or constant or variable torque as specified and speeds 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 and as specified in Section 23 05 13 – Common Motor Requirements for HVAC Equipment, 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 Finish on fume hood exhaust fans: heresite coated
- .10 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .11 Flexible connections: to Section 23 33 00 – Air Duct Accessories.

2.2 CENTRIFUGAL FANS

- .1 Fan wheels:
 - .1 Welded steel or aluminum construction.
 - .2 Maximum operating speed of centrifugal fans not more than 40 % of first critical speed.
 - .3 Air foil or backward inclined blades, as indicated.
- .2 Bearings: air handling quality, heavy duty, split pillow-block, flange mounted grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life to ABMA L10 of 100,000 hours. Shaft seals on laboratory fume hood and biological safety cabinet exhaust fans:
 - .1 Single disc or stuffing box seals.
- .3 Housings:
 - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, cast iron, or steel, for smaller wheels, braced, and with welded supports.
 - .2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.
 - .3 Provide bolted latched airtight access doors with handles.
 - .4 Spark resistant construction Type B minimum where indicated.
- .4 Variable volume control devices:

- .1 Mounted by fan manufacturer.
- .2 Adjustable inlet vanes: operated from a centre mechanism linked to each damper vane. Support each vane at ends in bronze bearings. On DWDI fans interconnect vanes to operate in unison. Provide locking devices for manual operation.
- .3 Variable Speed Drives: to NEMA ICS 7.1.

2.3 CABINET FANS - GENERAL PURPOSE

- .1 Fan characteristics and construction: as centrifugal fans.
- .2 Cabinet hung single or multiple wheels with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, direct drive or V-belt drive and guard outside casing.
- .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 to CGSB 1.181. Finish inside and out, over prime coat, with rust resistant enamel to Section 09 91 10 – Painting. Internally line cabinet with 12-25 mm thick rigid acoustic insulation, pinned and cemented, complete with metal nosings on all exposed edges.

2.4 IN-LINE CENTRIFUGAL FANS

- .1 Characteristics and construction: as for centrifugal fan wheels, with axial flow construction and direct or belt drive as indicated.
- .2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.
- .3 Acceptable Product: Trane, Sheldons, Barry Blower, Cook, Penn, Woods, Greenheck.

PART 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 FAN INSTALLATION

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

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning and Waste Processing.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.4 COMMISSIONING

- .1 Commissioning in accordance with Section 01 91 00 –Commissioning.

END OF SECTION

PART 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Fans, window ventilators, exterior, wall and ceiling mounted discharge fans for domestic use.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 61 00 - Product Requirements.
- .3 Section 01 74 00 - Cleaning and Waste Processing.
- .4 Section 01 74 20 –Waste Managing and Disposal.
- .5 Section 01 78 10 – Closeout Submittals.
- .6 01 91 00 – Commissioning.
- .7 Section 23 05 13 – Common Motor Requirements for HVAC Equipment.
- .8 Section 23 33 00 – Air Duct Accessories.

1.3 REFERENCES

- .1 Air Conditioning and Mechanical Contractors Association (AMCA)
 - .1 AMCA 201, Fans and Systems.
 - .2 AMCA 300, Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
 - .4 AMCA 302, Application of Sone Ratings for Non-Ducted Air Moving Devices.
 - .5 AMCA 303, Application of Sound Power Level Ratings for Fans.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.4 SYSTEM DESCRIPTION

.1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

1.5 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures
 - .2 Indicate following: dimensions, performance, sound rating, and installation procedure.
 - .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .4 Closeout Submittals
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals.
 - .2 Belts
 - .3 Addresses of suppliers.
 - .4 List of specialized tools necessary for adjusting, repairing or replacing.

1.7 DELIVERY, STORAGE, AND HANDLING

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

- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.

PART 2 Products

2.1 FANS GENERAL

- .1 Standard of rating:
 - .1 AMCA 201 for fan application.
 - .2 AMCA 302 for application of some loudness ratings for non-ducted air moving devices.
 - .3 AMCA 303 for application of sound power ratings for ducted air moving devices.
 - .4 Performance: to ANSI/AMCA 210 and ANSI/ASHRAE 51.
- .2 Pwl sound ratings to comply with AMCA 301, tested to AMCA 300
- .3 Maximum loudness: 5 sones.

2.2 WALL AND CEILING DISCHARGE FANS

- .1 Centrifugal direct drive, with plug-in type electric motor suitable for ceiling or wall installation, zinc coated rectangular metal housing.
- .2 Sizes and capacity: see schedule.
- .3 Toggle switch or timer operated complete with integral electrical outlet box with plug-in type receptacle.
- .4 Top or side 80 mm x 250 mm rectangular duct outlet with integral backdraft damper.
- .5 Roof jack or wall cap complete with spring loaded backdraft damper with neoprene gasket.
- .6 White polymeric or silver anodized aluminum grille.

PART 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations.

3.3 ANCHOR BOLTS AND TEMPLATES

- .1 Supply for installation by other divisions.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning and Waste Processing.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.5 COMMISSIONING

- .1 Commission in accordance with Section 01 91 00 –Commissioning.

END OF SECTION

PART 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Supply, return and exhaust grilles and registers, diffusers and linear grilles, for commercial use.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 61 00 - Product Requirements.
- .3 Section 01 74 20 –Waste Managing and Disposal.
- .4 Section 01 78 10 - Closeout Submittals.

1.3 REFERENCES

- .1 American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE).
 - .1 ASHRAE 70, Method of Testing for Rating the Performance of Air Ducts and Outlets.

1.4 SYSTEM DESCRIPTION

- .1 Performance requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.5 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate following:
 - .1 Capacity
 - .2 Throw and terminal velocity
 - .3 Noise criteria
 - .4 Pressure drop
 - .5 Neck velocity
 - .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: submit manufacturer's installation instructions.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.

1.7 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.
 - .2 Include:
 - .1 Keys for volume control adjustment
 - .2 Keys for air flow pattern adjustment.

PART 2 Products

2.1 GENERAL

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity.
- .2 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames where set into plaster or gypsum board.
 - .3 Concealed fasteners.
- .3 Concealed manual volume control damper operators as indicated.
- .4 Colour: standard or as directed by Contract Administrator's Representative.
- .5 Acceptable Product: E. H. Price, Titus, Nailor, Carnes, Airvector, Anemostat, Kruger.

2.2 MANUFACTURED UNITS

- .1 Grilles, registers and diffusers of same generic type to be product of one manufacturer.

2.3 SUPPLY GRILLES AND REGISTERS

- .1 See Schedule.

2.4 RETURN AND EXHAUST GRILLES AND REGISTERS

.1 See Schedule.

2.5 DIFFUSERS

.1 See Schedule.

2.6 LINEAR GRILLES

.1 See Schedule.

PART 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturers instructions.
- .2 Install with flat head stainless steel or cadmium plated screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.
- .4 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms and elsewhere.

3.3 CLEANING

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

END OF SECTION

PART 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Mechanical louvers; intakes; vents; and reinforcement and bracing for air vents, intakes and gooseneck hoods.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 10 - Cleaning and Waste Processing.
- .3 Section 01 74 20 –Waste Managing and Disposal.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E 90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .4 Society of Automotive Engineers (SAE)

1.4 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.5 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate following:
 - .1 Pressure drop.
 - .2 Face area.

- .3 Free area.
- .4 Dimensions
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .3 Test Reports:
 - .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E 90.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Managing and Disposal.

PART 2 Products

2.1 FIXED LOUVRES - ALUMINUM

- .1 Refer to schedules and drawings for sizes and types.
- .2 Construction: welded with exposed joints ground flush and smooth.
- .3 Material: extruded aluminum alloy 6063-T5.
- .4 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.
- .5 Frame, head, sill and jamb: 100 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit. Flanged frame or flush frame as indicated.
- .6 Mullions: at 1500 mm maximum centres.
- .7 Fastenings: stainless steel with nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .8 Screen: 12 mm on exhaust and intake mesh, 2 mm diam wire aluminum birdscreen on inside face of louvres in formed U-frame.

- .9 Finish: factory applied enamel, or anodized as indicated. Colour: to Contract Administrator's Representative's approval.

PART 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking around to ensure weather tightness.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 10 - Cleaning and Waste Processing.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Filters and filter gauges for various types of mechanical air handling equipment.

1.2 RELATED SECTIONS:

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 61 00 - Product Requirements.
- .3 Section 01 74 00 - Cleaning and Waste Processing.
- .4 Section 01 74 20 –Waste Managing and Disposal.
- .5 Section 01 78 10 - Closeout Submittals.
- .6 Section 23 74 00 – Packaged Outdoor HVAC Equipment.

1.3 REFERENCES

- .1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)
 - .1 ANSI/NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 52.1, Gravimetric And Dust Spot for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter (ANSI Approved).
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-115.10, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.
 - .2 CAN/CGSB-115.11, Filters, Air, High Efficiency, Disposable, Bag Type.
 - .3 CAN/CGSB-115.12, Filters, Air, Medium Efficiency, Disposable, Bag Type.
 - .4 CAN/CGSB-115.13, Filter Media, Automatic Roll.
 - .5 CAN/CGSB-115.14, High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems.
 - .6 CAN/CGSB-115.15, High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
 - .7 CAN/CGSB-115.16, Activated Carbon for Odor Removal from Ventilating Systems.
 - .8 CAN/CGSB-115.18, Filter, Air, Extended Area Panel Type, Medium Efficiency.
 - .9 CAN/CGSB-115.20, Polarized Media Air Filter.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 ULC-S111, Standard Method of Fire Tests for Air Filter Units.
 - .2 ULC-S649, Exhaust Hoods and Related Controls for Commercial and Institutional Kitchens.

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Indicate following:
 - .1 Pressure drop.
 - .2 Installation procedures.
 - .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .4 Closeout Submittals
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.

1.6 MAINTENANCE

- .1 Extra Materials:

- .1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.
- .3 Spare filters: in addition to filters installed immediately prior to acceptance by Contract Administrator's Representative, supply one (1) complete set of filters for each filter unit or filter bank in accordance with Section 01 78 10 - Closeout Submittals

PART 2 Products

2.1 GENERAL

- .1 Media: suitable for air at 100% RH and air temperatures between minus 40°C and plus 50°C.
- .2 Number of units, size as recommended by manufacturer and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated.
- .3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.
- .4 Acceptable Product: Farr, Cambridge, American Air Filter.

2.2 ACCESSORIES

- .1 Holding frames: permanent "T" section or channel section construction of galvanized steel or same material as casing/hood, 1.6 mm thick, except where specified otherwise.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: through doors/panels on each side and/or from upstream face of filter bank.

2.3 FIBROUS GLASS PANEL FILTERS

- .1 Disposable fibrous glass media: to CAN/CGSB-115.10 with adhesive.
- .2 Holding frame: 1.2 mm minimum thick galvanized steel with 3 mm diam hinged wire mesh screen.
- .3 Performance: minimum average synthetic dust weight arrestance 70 %.
- .4 Fire rated: to ULC -S111.
- .5 Nominal thickness: 50 mm.

2.4 FILTER GAUGES - DIAL TYPE

- .1 Housing: Die cast aluminum case and bezel, with acrylic cover. Exterior finish coated to withstand 168 hour salt spray corrosion test. Diaphragm actuated, direct reading.
- .2 Accuracy: $\pm 2\%$ of full scale ($\pm 3\%$ on 0-125 PA, and $\pm 4\%$ on 0-60PA.), throughout range at 21.1°C.
- .3 Pressure Limits: 500 mm Hg to 100 kPa.
- .4 Overpressure: Relief plug opens at approximately (1.72 kPa), standard.
- .5 Temperature Limits: 6.67 to 60°C.
- .6 Size: 101.6 mm diameter dial face.
- .7 Mounting Orientation. Diaphragm in vertical position.
- .8 Process Connections: 2- 1/8 female NPT duplicate high and low pressure taps one pair side and one pair back.
- .9 Standard Accessories: Two 1/8 NPT plugs for duplicate pressure taps, two 1/8 NPT pipe thread to rubber tubing adapters and three flush mounting adapters with screws.
- .10 Range: 0-250 Pa.

PART 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION GENERAL

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

3.3 REPLACEMENT MEDIA

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

3.4 FILTER GAUGES

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

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning and Waste Processing.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 General

1.1 RELATED WORK

- .1 The Contractor is to ensure that all related work is coordinated among all specification sections and that the bid price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 20 –Waste Managing and Disposal.
- .3 Section 01 78 10 - Closeout Submittals.
- .4 Section 01 91 00 - Commissioning.
- .5 Section 03 30 00 – Cast-in-Place Concrete.
- .6 Section 23 84 13 - Humidifiers.

1.3 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI Z21.64, Direct Vent Central Furnaces.
- .2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 52.1, Gravimetric and Dust Spot Procedures for Testing Air-Borne Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-B139 , Installation Code for Oil Burning Equipment.
 - .2 CSA B140.2.2, Pressure Atomizing Oil Burner Nozzles.
 - .3 CSA B140.4, Oil-Fired Warm Air Furnaces.
 - .4 CSA B140.14, Automatic Flue-Pipe Dampers for Use with Oil Fired Appliances.
 - .5 CAN/CSA-B140.2.1, Oil Burners, Atomizing Type.
 - .6 CSA C22.1 Canadian Electrical Code.
 - .7 CSA C22.2 No.24, Temperature-Indicating and Regulating Equipment.
 - .8 CSA C22.2 No.46, Electric Air-Heaters.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include following: installation instructions, capacity, dimensions, weights, wiring diagrams.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.
- .2 Include following: shop drawings, operation and maintenance manual.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20 –Waste Managing and Disposal, and with the Waste Reduction Workplan.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Contract Administrator.

1.7 EXTRA MATERIALS

- .1 Spare filters: in addition to filters installed immediately prior to acceptance by Contract Administrator's Representative, supply 1 complete set of filters for each filter unit or filter bank in accordance with Section 01 78 10 - Closeout Submittals.

PART 2 Products

2.1 GENERAL

- .1 Provide CSA approved, packaged factory assembled unit consisting of cabinet, fan, fan motor, intake/exhaust assembly, heat exchanger, combustion chamber, burner, controls, air filter, condensate drain, and humidifier to Section 23 84 13 - Humidifiers.
- .2 Mid efficiency level range: 80%.
- .3 Certification of components and construction of factory assembled oil-fired unit: to CSA B140.4.
 - .1 Acceptable Product: Trane, Carrier, Lennox.

2.2 CAPACITY

- .1 Output: as indicated.
- .2 Air flow rate: as indicated.
- .3 External static pressure: as indicated.
- .4 Input: as indicated.

- .5 Electrical characteristics: as indicated.

2.3 TYPE

- .1 Upflow with gas burner.

2.4 CABINET

- .1 1.0 mm thick minimum steel with baked enamel finish.
- .2 Welded steel base for floor type.
- .3 Easily removed and secured access doors for components requiring service.
- .4 Thermally insulated cabinet with minimum 25 mm thick insulation.
- .5 Cabinet to be equipped with brackets for floor mounting or ceiling hung.

2.5 HEAT EXCHANGER

- .1 Primary: stainless steel tube type 430 with stainless steel fins.
- .2 Secondary: stainless steel tube with stainless steel fins.
- .3 Warranty: 3 years.

2.6 COMBUSTION CHAMBER

- .1 Power vent, forced draft: to manufacturer's standard.
- .2 Exhaust stack direct drive induced draft fan.

2.7 CIRCULATION BLOWER MOTOR ASSEMBLY

- .1 Blower: centrifugal type:
 - .1 Statically and dynamically balanced.
 - .2 Rubber mounted.
 - .3 Speed adjustment: adjustable V-belt shieve.
- .2 Motor: as indicated, Hz , 1750 r/min. single speed, overload protection, adjustable mounts.

2.8 AIR FILTERS

- .1 25 mm thick, glass fiber, disposable type 35 % efficiency to ASHRAE 52.

2.9 HEATER BURNER

- .1 General: to bear CSA and ULC labels.
- .2 Oil burner:

- .1 High pressure atomizing type, certified to CAN/CSA B140.2.1.
- .2 Pressure atomizing oil burner nozzle, certified to CSA B140.2.2 and flame retention head.
- .3 Two stage fuel pump.
- .4 Burner shall be equipped for controlled modulated firing, including modulating damper motor, proportioning air damper, fuel metering valves, end switch, solenoid valves and necessary linkage to assure proper air/fuel ratio at all firing rates. The burner shall be factory tested and adjusted for a high/low fire turndown ratio of 10 to 1.

2.10 INTAKE AND VENT ASSEMBLY

- .1 Provide barometric damper.

PART 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions, regulations of authorities having jurisdiction and to CAN/CSA-B139 and/or Canadian Electric Code.
- .2 Co-ordinate with Section 03 30 00 – Cast-in-Place Concrete regarding concrete bases as indicated on drawings.
- .3 Provide Contract Administrator's Representative written report of test results.

3.2 COMMISSIONING

- .1 Manufacturer to:
 - .1 Certify installation.
 - .2 Start up and commission installation.
 - .3 Carry out on-site performance verification tests.
 - .4 Demonstrate operation and maintenance.
- .2 Provide Contract Administrator's Representative at least 72 h notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.
- .3 Commission in accordance with Section 01 91 00 - Commissioning.
- .4 Final commissioning to occur between November and March when ambient temperature is -10°C or lower.

END OF SECTION

PART 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and application of electric duct heaters.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 35 26 – Environmental Protection.
- .3 Section 01 74 20 –Waste Managing and Disposal.
- .4 Section 01 91 00 – Commissioning.
- .5 Section 26 05 00 – Common Work Results - Electrical.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No. 46, Electric Air-Heaters.
- .2 Department of Justice Canada (Jus.)
 - .1 Canadian Environmental Protection Act (CEPA)
- .3 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act (TDGA)

1.4 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit product data and include:
 - .1 Element support details.
 - .2 Heater: total kW rating, voltage, phase.
 - .3 Number of stages.
 - .4 Rating of stage: rating, voltage, phase.
 - .5 Heater element watt/density and maximum sheath temperature.
 - .6 Maximum discharge temperature.
 - .7 Physical size.
 - .8 Unit support.
 - .9 Performance limitations.
 - .10 Clearance from combustible materials.
 - .11 Internal components wiring diagrams.
 - .12 Minimum operating airflow.

- .13 Pressure drop, operating and minimum airflow.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Place materials defined as hazardous or toxic in designated containers in accordance with Section 01 35 26 – Environmental Protection.
 - .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
 - .6 Ensure emptied containers are sealed and stored safely.
 - .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

PART 2 Products

2.1 DUCT HEATERS

- .1 Duct heaters: flange type or insert type.
- .2 To carry CSA Approval.
- .3 Elements:
 - .1 Open coil elements of nickel-chrome resistance wire.
 - .2 Coils machine crimped into stainless steel terminals extending at least 25mm into the air stream.
 - .3 All terminal hardware shall be stainless steel.
 - .4 Coils shall be supported by ceramic bushings staked into the supporting brackets.
- .4 Frames: Heater frames and boxes shall be corrosion resistant steel.
- .5 Terminal box:
 - .1 NEMA 1 general purpose enclosure.
 - .2 Hinged, latching cover.
 - .3 Multiple concentric knockouts to accept field wiring.
 - .4 Terminal blocks to accommodate field wiring.
 - .5 All internal wiring to be complete with 105°C rated insulation.
- .6 Ratings:
 - .1 Heaters to be rated for voltage, phase, and KW capacity as indicated in schedule on drawings.
 - .2 All three phase heaters to have equal, balanced, three phase stages.

- .3 Supply heaters with size and quantity of fixed and proportional heating stages as indicated in schedule.
- .7 Controls:
 - .1 Factory mounted and wired in control box. Use terminal blocks for power and control wiring.
 - .2 Controls to include:
 - .1 Magnetic contactors.
 - .2 Fixed differential pressure switch.
 - .3 Manual and automatic reset high limit.
 - .4 Control transformers.
 - .5 Solid state relays.
 - .6 HRC load fuses.
 - .7 Electronic hybrid step controller.
 - .8 Heater to be controlled by 0 – 10 VDC or 4-20mA remote control signal from the building automation system supplied and installed by the EMCS Contractor.
 - .3 Performance: see schedule.
 - .4 Provide heater complete with protective screens on inlet/outlet.
 - .5 Acceptable Product: EH Price, Thermolec, Neptronic.

PART 3 Execution

3.1 INSTALLATION

- .1 Make power and control connections in accordance with CSA C22.2 No.46. Install in accordance with manufacturer's instructions.

3.2 COMMISSIONING

- .1 Perform tests in accordance with Section 01 91 00 –Commissioning and Section 26 05 00 – Common Work Results – Electrical.

END OF SECTION

PART 1 General

1.1 SUMMARY

- .1 Materials and installation for self-contained single zone, gas, electric, refrigeration packaged rooftop HVAC units.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 45 00 – Quality Control.
- .3 Section 01 74 00 – Cleaning and Waste Processing.
- .4 Section 01 74 20 –Waste Managing and Disposal.
- .5 Section 01 78 10 – Closeout Submittals.
- .6 Section 01 91 00 – Commissioning.
- .7 Section 02 81 00 - Hazardous Materials.
- .8 Section 09 91 10 - Painting.

1.3 REFERENCES

- .1 American National Standards Institute (ANSI)/Air Conditioning and Refrigeration Institute (ARI)
 - .1 ANSI/ARI 210/240, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
 - .2 ARI 270, Sound Rating of Outdoor Unitary Equipment.
- .2 ANSI/UL 1995 B, Standard for Heating and Cooling Equipment.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B52, Mechanical Refrigeration Code.
 - .2 CSA C22.1, Canadian Electrical Code.
- .4 Health Canada / Workplace Hazardous Materials Information System (WHMIS)]
 - .1 Material Safety Data Sheets (MSDS)
- .5 National Roofing Contractors Association (NRCA)
- .6 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .7 American Bearing Manufacturer's Association (ABMA)
 - .1 ANSI/ABMA 9 Load Ratings and Fatigue Life for Ball Bearings

- .2 ANSI/ABMA 11 Load Ratings and Fatigue Life for Roller Bearings.
- .8 Air Movement and Control Association (AMCA)
 - .1 AMCA 300 Reverberant Room Method for Sound Testing of Fans.
- .9 National Electrical Manufacturer's Association (NEMA)
 - .1 NEMA MG1 Motors and Generators
 - .2 NEMA ICS 7-1 Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- .10 Provincial Boiler, Pressure Vessel and Compressed Gas Regulations.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for packaged rooftop HVAC units.
- .3 Submit WHMIS MSDS in accordance with Section 02 81 00 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
- .4 Shop Drawings:
 - .1 Submit shop drawings to indicate project layout and dimensions; indicate:
 - .1 Equipment, piping, and connections, together with control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
 - .2 Control equipment shipped loose, showing final location in assembly.
 - .3 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
 - .4 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.
 - .5 Fan performance curves.
 - .6 Details of vibration isolation.
 - .7 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.
 - .8 Type of refrigerant used.
- .5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .6 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .7 Instructions: submit manufacturer's installation instructions.

- .8 Manufacturer's Field Reports: manufacturer's field reports specified.
- .9 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals include data as follows:
 - .1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.
 - .2 Provide for units, manufacturer's name, type, year, number of units, and capacity.

1.5 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Waste Managing and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for reuse and recycling and place in designated containers steel, metal, plastic waste in accordance with Waste Management Plan (WMP).
 - .5 Handle and dispose of hazardous materials in accordance with Canadian Environmental Protection Act (CEPA), Transportation of Dangerous Goods Act (TDGA), Regional and Municipal, regulations.
 - .6 Divert unused metal materials from landfill to metal recycling facility as approved by Contract Administrator's Representative.

1.7 WARRANTY

- .1 Contractor hereby warrants that packaged rooftop HVAC units and refrigeration compressors will function and operate in accordance with GC 31.1, but for 24 months.

PART 2 Products

2.1 GENERAL

- .1 Grade-mounted, self-contained single zone unit with gas heating coil and DX refrigeration and bear label of CSA.

- .2 Units to consist of cabinet and frame, supply fan, control, air filter, refrigerant cooling coil, compressor, condenser coil and fans, motorized outside air damper, return damper.
- .3 Conform to ANSI/ARI 210/240, rating for unit larger than 40 kW nominal.

2.2 CABINET

- .1 Cabinets: weatherproofing tested and soundproofing tested to ARI 270, dbA at 3 m free field.
- .2 Framing and supports: 2 mm thick welded steel, galvanized after manufacture, with lifting lugs at top of unit and/or fork lift slots at bottom.
- .3 Outer casing: weathertight galvanized steel with baked enamel finish, to Section 09 91 10 - Painting.
- .4 Access: removable gasketed hinged doors or panels with locking door handle type or screwdriver operated flush cam type fasteners.
- .5 Insulation: neoprene coated glass fiber on surfaces, 50 mm thick, 32 kg/m³density.

2.3 FANS

- .1 Centrifugal, forward curved impellers, backward inclined, or airfoil, statically and dynamically balanced. Rubber spring isolated hinge mounted motor fan, and motor integrally mounted on isolation base, separated from unit casing with flexible connections and spring isolators. Vibration isolators: 95% efficiency.

2.4 AIR FILTERS

- .1 50 mm thick, 30 % efficiency, metal framed, replaceable media or throwaway.
- .2 To meet NFPA 90A, air filter requirements type Class 1 or type Class 2.

2.5 REFRIGERATION

- .1 Conform to CSA B52 and ANSI/UL 465 requirements.
- .2 Compressor/condenser section:
 - .1 Semi-hermetic or hermetic compressors, vibration isolated with flexible suction and discharge connections, oil sight glass, oil pressure switch, crankcase heater, and automatic pump down system with control to liquid line solenoid valve.
 - .2 Fans: propeller type with single piece spun venturi outlets and zinc plated guards. Motors shall be sequenced for head pressure control.
 - .3 Electrical system shall have operating controls, oil and refrigerant pressure protection, motor overload protection, weatherproof electrical wiring with weatherproof, rain tight disconnect.
 - .4 Include refrigerant piping with, sight glass, filter drier and valves.
 - .5 Condenser: staggered copper tube, aluminum fin coil assembly with sub-cooling rows to provide 6 °C sub-cooling.

- .6 Capacity reduction: cylinder unloading. Provide flooding for head pressure control for low ambient operation down to 0 °C ambient temperature.
- .7 Refrigerant: R 134a.
- .3 Evaporator:
 - .1 Rated to ANSI/ARI 210/240.
 - .2 Thermostatic expansion valve, with adjustable super heat and external equalizer.
 - .3 Coil: NPS 1/2 or NPS 5/8 od staggered seamless copper tubes expanded into aluminum fins and insulated condensation pan.
 - .4 Cooling coil condensate drain pans: designed to avoid standing water, to be easily cleaned or removable for cleaning. Drain connection to have deep seal trap and be complete with trap seal primer.

2.6 CONTROLS

- .1 In addition to safety controls, provide smoke sensors in return to NFPA standards, low limit on supply and freeze protection on water coils.
- .2 Single zone cooling control:
 - .1 Zone sensor or room thermostat to activate cooling relay in control circuit cycling compressor. Provide safeties and pressure controls. Condenser fans to operate in sequence.
 - .2 When call for cooling is satisfied, relay is de-energized closing liquidline solenoid valve and pumps down. On two compressor units provide separate circuits to evaporator and condenser.
- .3 Mixed air single zone unit:
 - .1 Motorized outside, return and automatic power gravity relief dampers with spring return damper operator and control package to automatically vary outside air quantity. Outside air and exhaust air dampers, normally closed.
 - .2 Tight fitting opposed blade dampers with neoprene or suitable gaskets, bronze or synthetic bushings and 1% maximum leakage.
 - .3 Damper operation: 24V, spring return motor with gear train sealed in oil, and heater for operation under minus 18°C.
 - .4 Mixed air controls: maintain 13 °C mixed air temperature, lock out compressor below 14°C ambient, restart 17°C.
- .4 Single Zone Heat-Cool Unit
 - .1 Low voltage, adjustable room thermostat controls, heater stages in sequence with delay between stages, compressor and supply fan shall maintain room temperature setting.
 - .2 Thermostat: include system selector switch day-night, heat-cool-auto-off and fan control switch (on-auto).
 - .3 Mixed air controls: maintain 13 °C mixed air temperature, lock out compressor below 14°C ambient, restart 17°C.
- .5 Night mode: unit cycles as unit heater with 100% recirculation on winter cycles.
- .6 Night set-back: 15 ° C.

2.7 REMOTE PANEL

- .1 Provide remote readout panel for each unit containing:
 - .1 Signal lights indicating system status, heating system failure cooling system failure and dirty filters.
 - .2 Check switches proving signal light operation.
 - .3 System on-off switch.
 - .4 Fan on-off switch.
 - .5 Manual 6 h timer to override night-set back control.
- .2 Provide gauges in remote panel indicating outside air, mixed air, return air and discharge air temperatures for each deck before heat exchangers.

2.8 CAPACITY

- .1 Capacity: see schedule.

PART 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install as per manufacturers' instructions on roof curbs provided by manufacturer.
- .2 Manufacturer's representative to certify installation, supervise start-up and commission unit.
- .3 Run drain line from cooling coil condensate drain pan to discharge over roof.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Have manufacturer's representative of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.
 - .2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
 - .3 Schedule site visits to review work at stages listed:
 - .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of work at 25% and 60% complete.

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- .3 Upon completion of work, after cleaning is carried out.
 - .2 Obtain reports within 3 days of review and submit immediately to Contract Administrator's Representative.
 - .3 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.
 - .4 Verify accessibility, cleanability, drainage of drain pans for coils, humidifiers.
 - .5 Performance Verification:
 - .1 Packaged Air Handling Units:
 - .1 Set zone mixing dampers for full cooling, except that where diversity factor forms part of design set that % of zone dampers to full heating.
 - .2 Set outside air and return air dampers for minimum outside air.
 - .3 Set face and bypass dampers so face dampers are fully open and bypass dampers are fully closed.
 - .4 Check for smooth, vibrationless correct rotation of supply fan impeller.
 - .5 Measure supply fan capacity.
 - .6 Adjust impeller speed as necessary and repeat measurement of fan capacity.
 - .7 Measure pressure drop for each component of air handling unit.
 - .8 Set outside air and return air dampers for the % of outside air required by design and repeat measurements of fan capacity.
 - .9 Reduce differences between fan capacity at minimum and maximum outside air less than 5 %.
 - .10 Set face and bypass dampers to full bypass and repeat measurement of fan capacity.
 - .11 Reduce difference between fan capacity with F&BPD fully closed to bypass and fully open to bypass to less than 5 %.
 - .12 Reduce difference between fan capacity at full cooling and fan capacity at full heating to less than 5 %.
 - .13 OAD: verify for proper stroking, interlock with RAD.
 - .14 Measure DBT, WBT of SA, RA, EA.
 - .15 Measure air cooled condenser discharge DBT.
 - .16 Measure flow rates (minimum and maximum) of SA, RA, EA, relief air.
 - .17 Simulate maximum cooling load and measure refrigerant hot gas and suction temperatures and pressures.
 - .18 Use smoke test to verify no short-circuiting of relief air to outside air intake or to condenser intake.
 - .19 Simulate maximum heating load and:
 - .1 Verify temperature rise across heat exchanger.
 - .2 Perform flue gas analysis. Adjust for peak efficiency.
 - .3 Verify combustion air flow to heat exchanger.
 - .4 Simulate minimum heating load and repeat measurements.
 - .20 Verify operating control strategies, including:
 - .1 Heat exchanger operating and high limit.

- .2 Early morning warm-up cycle.
- .3 Freeze protection.
- .4 Economizer cycle operation, temperature of change-over.
- .5 Alarms.
- .6 Voltage drop across thermostat wiring.
- .7 Operation of remote panel including pilot lights, failure modes.
- .21 Set zone mixing dampers for full heating and repeat measurements.
- .22 Measure leakage past zone mixing dampers by taking temperature measurements. Reduce leakage to less than 5 %.
- .23 Measure return fan capacity.
- .24 Adjust impeller speed as necessary and repeat measurement of return fan capacity.
- .25 Check capacity of heating unit.
- .26 Measure DX refrigeration system performance as specified Section.
- .27 Refer to other sections of these specifications for PV procedures for other components.
- .2 Verify accessibility, serviceability of components including motorized dampers, filters, coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.
- .3 Verify accessibility, clean ability, drainage of drain pans for coils, humidifiers.
- .6 Commissioning Reports:
 - .1 In accordance with Section 01 91 00 - Commissioning: reports supplemented as specified herein. Include:
 - .1 Report forms as specified Section 01 91 00 - Commissioning: Report Forms and Schematics.

3.4 DEMONSTRATION

- .1 Training: in accordance with Section 01 91 00- General Commissioning (Cx)
Requirements: Training of O&M Personnel, supplemented as specified.

3.5 CLEANING

- .1 Perform cleaning operations as specified in Section 01 74 00 – Cleaning and Waste Processing, and in accordance with manufacturer's recommendations.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Materials and installation for direct steam injection, packaged electrode steam generating, steam-to-steam, electric self-contained humidifiers and accessories.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 45 00 – Quality Control.
- .3 Section 01 74 00 – Cleaning and Waste Processing.
- .4 Section 01 74 20 –Waste Managing and Disposal.
- .5 Section 01 78 10 – Closeout Submittals.
- .6 Section 01 91 00 –Commissioning.
- .7 Section 23 31 13.01 – Metal Ducts – Low Pressure to 500 Pa.

1.3 REFERENCES

- .1 Health Canada / Workplace Hazardous Materials Information System (WHMIS)]
 - .1 Material Safety Data Sheets (MSDS)
- .2 Air-Conditioning and Refrigeration Institute (ARI)
 - .1 ARI 640, Performance Rating of Commercial and Industrial Humidifiers

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for heating, ventilation and air conditioning distribution piping and ductwork.
- .3 Shop drawings:
 - .1 Submit shop drawings to indicate project layout, dimensions, and extent of humidification system.
- .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .6 Instructions: submit manufacturer's installation instructions.
- .7 Manufacturer's field reports specified.
- .8 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for reuse and recycling and place in designated containers steel, metal, plastic waste in accordance with Waste Management Plan (WMP).
 - .5 Divert unused metal materials from landfill to metal recycling facility as approved by Contract Administrator's Representative.

1.7 MAINTENANCE

- .1 Extra materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 10 – Closeout Submittals.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, addresses of suppliers, and list of specialized tools necessary for adjusting, repairing or replacing, for inclusion into operating manual.
 - .3 Provide following: one complete set of renewable evaporator media.

Part 2 Products

2.1 PACKAGED ELECTRODE STEAM GENERATING TYPE

- .1 CSA certified and ULC listed.

- .2 Components housed in factory fabricated cabinet with factory enameled finish and electrically interlocked door, BACnet interface to building EMCS System.
- .3 Cleanable steam cylinder complete with factory installed electrodes to suit water condition.
- .4 Controls:
 - .1 Solid state panel.
 - .2 Solenoid valve on water and drain lines.
 - .3 Duct high limit humidistat.
 - .4 Airflow proving switch.
 - .5 Adjustable flush cycle timer.
 - .6 Amp meter.
 - .7 Cylinder replacement indicator light.
- .5 Duct distribution header complete with condensate drain and supply hose, see schedule.
- .6 Acceptable Product: Nortec, Dri Steem, Neptronic, Hygromatik.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Humidifier and evaporator media to be new and clean when project is accepted.
- .3 Install humidistat in accessible location.
- .4 Water service overflow drain: as indicated and to manufacturers' recommendation.
- .5 Install access doors or panels in adjacent ducting.
- .6 When installing in ducting, provide waterproof duct up and downstream in accordance with Section 23 31 13.01: Metal Ducts – Low Pressure to 500 Pa.
- .7 Install capped drain connection at low point in duct.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Have manufacturer's representative of products, supplied under this Section, review work involved in the handling, installation/application, protection and

-
- cleaning, of its products and submit written reports, in acceptable format, to verify compliance of work with Contract.
 - .2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review work, at stages listed:
 - .1 After delivery and storage of products, and when preparatory work, or other work, on which the work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of work at 25% and 60% complete.
 - .3 Upon completion of the work, after cleaning is carried out.
 - .4 Obtain reports, within 3 days of review, and submit, immediately, to Contract Administrator's Representative.
-
- .2 Performance Verification (PV):
 - .1 General: in accordance with Section 01 91 00 - Commissioning: General Requirements, supplemented as specified.
 - .2 Timing:
 - .1 After TAB of ducted air systems.
 - .2 At same time as PV of related air handling units.
 - .3 Start-up:
 - .1 General: in accordance with Section 01 91 00 - Commissioning: General Requirements, supplemented as specified.
 - .2 Verify:
 - .1 Steam lines are sloped to ensure steam condensate is drained away from the humidifier.
 - .2 Vapour lines and manifolds are sloped to ensure condensate is drained away from the duct system.
 - .3 Visually check distribution manifold to ensure:
 - .1 Even distribution of vapour.
 - .2 Freedom from water deposits.
 - .4 Commissioning Reports:
 - .1 General: in accordance with Section 01 91 00 - Commissioning: reports, supplemented as specified. Include:
 - .1 PV results on approved PV Report Forms.
 - .2 Product Information Report Forms.

3.4 DEMONSTRATION

- .1 Training: in accordance with Section 01 91 00 - Commissioning: Training of O&M Personnel.

3.5 CLEANING

- .1 Perform cleaning operations as specified in Section 01 74 00 – Cleaning and Waste Processing, and in accordance with manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION