

## Addendum / Addenda

Project Description / Description de projet <b>M58 Ground Floor East and West</b>		
Solicitation No./N° de sollicitation <b>16-22087</b>	Project No./N° de projet <b>5189</b>	W.O. No./N° d'ordre de travail <b>A1-009908-01-58</b>
Departmental Representative / représentant ministériel <b>Mark O'Connor</b>		Date <b>October 17, 2016</b>
<p><b>Notice:</b> This addendum shall form part of the tender documents and all conditions shall apply and be read in conjunction with the original plans and specifications.</p>		<p><b>Nota:</b> Cet addenda fait partie intégrale des dossiers d'appel; toutes les conditions énoncées doivent être lues et appliquées en conjonction avec les plans et les devis originaux.</p>

- 1 Attached to this addendum is the original as-built ductwork drawing for the ground floor (M-5, 1965) which can be used to assist with pricing the extent of the duct removal during the asbestos abatement. All ductwork is to be removed except the perimeter induction unit ductwork which feeds the heating and cooling units on the first floor. That ductwork is to be abated, cleaned and re-insulated.
- 2 On drawing 5189-A00, the photographer background support referred to in note 35 is to stay on same wall, centered within new room.
- 3 On drawing 5189-E07, the 4 receptacles on the ceiling of the photo studio are to be arranged in a 6' by 6' square, centered within the room.
- 4 On drawing 5189-A00, the storage and relocation of the work station referred to in note 37 is no longer required. NRC will remove prior to construction and install in new location after construction is complete. Power and data for this workstation in it's new location is still part of the contract.
- 5 Note that construction drawings and specifications will be issued when contract is awarded. These will incorporate any changes by addendum and will be stamped by the engineers.
- 6 Asbestos abatement in the first floor lobby is to be done on a weekend.
- 7 The intent of the abatement documents is to remove all identified materials, as well as any discovered during construction. Estimated quantities are identified in the report by Pinchin.
- 8 All existing furniture will be removed by NRC prior to construction.
- 9 All repairs required due to damage caused by the abatement is included in the scope of work.

- 10** Door operator push buttons to be 915mm tall column style. Camden CM-7536/4 or equivalent approved by NRC Departmental Representative.
- 11** Workstations are to come prewired with all electrical components attached to a "whip". The electrical contractor is to connect the "whip" to the circuit in the ceiling identified on the electrical drawings and supply and install any additional materials and labour required to complete this connection.
- 12** Specification section 12 59 13 : Remove 125913.2.3.6.5. LED lights are not required for the cubicles.
- 13** Specification section 12 50 00 : Replace 125000.2.6.2.3.1 with the following : Different fabrics for each of seat and back as selected by Departmental Representative from manufacture's full range.
- 14** Drawing 5189-A12, included with this addendum are revised 3-dimensional representations of a typical cubicle. Note that the glass topper is to be installed with the frame as a part of the top cap and not held in with clips.
- 15** Specification section 21 05 01 : Revise 210501.1.37 as follows: 1.37 BUILDING AUTOMATION SYSTEM
- .1** Mechanical contractor shall carry all base building BAS contractor "Airtron". Total cost for Airtron controls is \$117,500.00 HST Extra (one hundred seventeen thousand five hundred dollars) as outlined in the attached quotation. Contact Aaron Dobson Regional Sales Manager Tel: 613-247-7938
  - .2** Airtron shall provide all control valves, and actuators, temperature sensors, damper actuators, pressure sensors, and all other sensors outlined in the mechanical drawings. Mechanical dampers, VAVs, VAV controllers shall be by mechanical contractor. Low voltage wiring for associated controls will be by BAS contractor.
  - .3** Mechanical contractor shall review full scope of work as outlined on drawings with controls contractor during tender period and allow for installation of all BAS sensors, control valves and other coordination items. No extra will be given to mechanical contractor for EMCS items that need to be installed to control mechanical equipment.
  - .4** Refer to 25 90 01 EMCS Site Requirements, Applications and System Site Sequences of Operations added as part of this addendum.
- 16** Specification section 23 05 93 : Remove article 1.24 - Post-occupancy TAB
- 17** Specification section 23 21 13 : Delete entire section and replace with attached section 23 21 13 – Hydronic – Copper
- 18** Specification section 23 21 23 : Delete entire section and replace with attached section 23 21 23 – Hydronic pumps
- 19** Specification section 23 34 00 : Delete entire section and replace with attached section 23 34 00 – HVAC Fans
- 20** Specification section 23 36 00 : Delete entire section and replace with attached section 23 36 00 – Terminal unit
- 21** Specification section 23 73 10 : Delete entire section and replace with attached section 23 73 10 – Air Handling Built up
- 22** Specification section 23 84 13 : Delete entire section and replace with attached section 23 84 13– Humidifiers
- 23** Add attached specification section 25 90 01 - EMCS Site Requirements, Applications and System Site Sequences of Operations



**24** Specification section 23 31 13.01 : Replace Article 2.1 Classification of ducts by the following :

**Classification of ducts**

The category of static pressure (Pa) for the construction of air ducts for the system is as follows:

<b>SYSTEM No.</b>	AHU system #04
<b>OUTDOOR AIR (1)</b>	-500
<b>SUPPLY (2)</b>	+1000/+500
<b>RETURN OR EXHAUST (3)</b>	-500
<b>EXHAUST (4)</b>	+500
<b>CATEGORY OF SEAL</b>	A

Note 1: Air duct from outside air to ventilation system.

Note 2: Air duct from the ventilation system to supply diffuser. When two categories are shown, the first applies to the portion of air duct between the ventilation system and the terminal unit and the second applies to the portion of air duct between the terminal unit and the grid or diffuser.

Note 3: Air duct from return or exhaust grilles or other discharge point, to fan or ventilation system. When two categories are shown, the first applies to the portion of the air duct between the diffuser and the terminal unit and the second applies to the portion of the air duct between the terminal unit and the fan.

Note 4: Air duct from the fan or the ventilation system to outside.

**25** Specification section 09 13 00 : Replace section 2.1 with the following:

**2.1 MATERIALS**

.1 Acoustic ceiling panel for suspended ceiling system: to CAN2-92.1

.1 Flame spread rating of 25 or less.

.2 Noise reduction coefficient (NRC) designation of 0.70 to 0.75.

.3 Ceiling Attenuation Class (CAC): minimum 35.

.4 Light reflectance range: Actual LR of 0.85.

.5 Edge type: square.

.6 Colour: white.

.7 Standard size: 610 mm x 1220 mm x 19 mm thick (ACT-1) and 610 mm x 610 mm x 19 mm thick (ACT-2), as indicated.

.8 Custom size: to be field cut and edge finished as required and as indicated.

.9 Shape: flat.

.10 Acceptable products and manufacturers:

.1 Armstrong Ultima

.2 CGC Mars

.3 Certainteed Symphony M.

.2 Suspension Systems for Use with A-PNL:

.1 Acceptable products and manufacturers:

.1 Prelude XL as manufactured by Armstrong

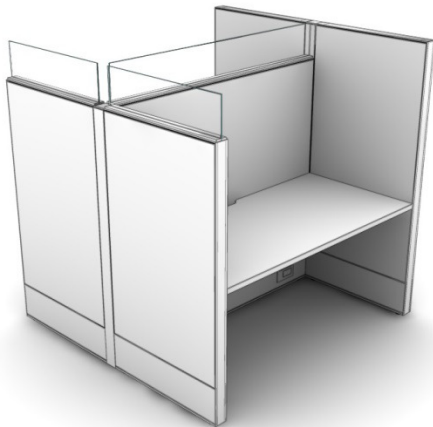
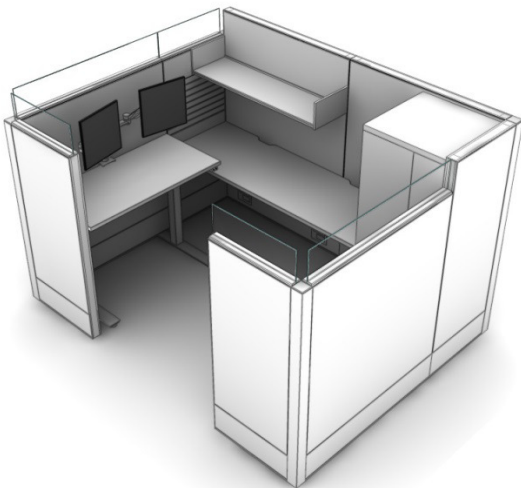
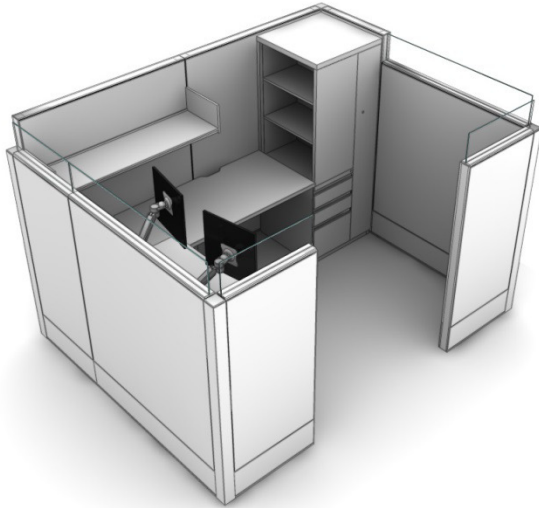
.2 Donn DX/DXL as manufactured by CGC Inc.

.3 Classic Stab as manufactured by Certainteed



Solicitation 16-22087

Addendum #1, item #14, revised 3-dimensional representations of a typical cubicle.



October 5, 2016

SNC-Lavalin  
200-100 Sparks Street  
Ottawa, Ontario  
K1P 5B7

Attention: Jayson Bowie  
Email: [Jayson.Bowie@snclavalin.com](mailto:Jayson.Bowie@snclavalin.com)

**Subject: NRC Building M-58 Ground Floor Renovation - EMCS**

We are hereby submitting our quotation to provide the EMCS for the above-mentioned project. Our quotation is based on mechanical drawings dated September 13, 2016 – issued for tender and our understanding of the scope of work and services. For a detailed scope of work, please see the following;

- Supply and install new EMCS controls for (1) new Air Handling Unit (AHU-4), (1) new humidification unit, (1) heating pump AHU-04-HCP-1
  - Supply and install all required end-devices (duct temperature, immersion temperature, pressure, humidity, transducers, freeze-stat).
  - Supply and install motorized damper actuators for outdoor air, return air and exhaust air dampers.
  - Supply heating and cooling control valves (2 in total).
  - Interface the unit contacts to the EMCS control panel for ventilation, humidification, heating and cooling control.
  - Remove existing EMCS control associated to existing AHU-4, including pneumatic interface devices associated to existing damper and control valve actuator control.
  - Supply and install the required low voltage interlocks to VFDs.
- Supply and install EMCS controls for new VAV boxes c/w reheat and perimeter heating.
  - Supply reheat control valves.
  - Supply and install reheat duct temperature sensors.
  - Supply perimeter heating control valves.
  - Supply and install space temperature sensors (standard NRC Smart Sensor).
- Supply and install new EMCS controls for (3) new cabinet unit heaters
  - Supply and install all required end-devices (space temperature, fan control relay).
- Supply (3) duct mounted airflow stations (1x outdoor air, 2x return air).
- Supply and install (1) BACnet BCX Master and associated network for integration of (3) VFDs to EMCS.
- Supply and install miscellaneous EMCS controls for the following;
  - Sanitary pump status
- Supply and install all required enclosures, power supplies for EMCS.
- Update existing Operator Workstation graphics to reflect the changes made.
- Testing and commissioning of new EMCS points.
- Coordination of final sequence of operations with NRC Staff before implementation.
- Engineering shop drawings, as-built updates, O&M manuals

**Items supplied by Airtron, installed by Mechanical Contractor**

- (4) Immersion wells.
- (68) Motorized control valves.
- (2) duct-mounted airflow stations.

**Items supplied and installed by Mechanical Contractor**

- AHU motorized dampers.
- AHU VFDs and fire alarm shutdown wiring.
- Flush valve wiring, if applicable.
- Steam control valve.

Our Scope of Work includes installation, start-up and commissioning, engineering, graphics and project management.

**Pricing;**

We have established a total project cost of **\$117,500.00 HST Extra (one hundred seventeen thousand five hundred dollars)** as per the above scope of work.

**Particular notes;**

All work to be completed during regular working hours.

Installation as per NRC/Airtron established standards.

All exposed wiring will be installed in pre-painted orange conduit.

Training is included.

Price does not include for bonding, builder's risk insurance, asbestos abatement, patching and painting.

Price is valid for a period of 30 days.

Should you have any questions or comments, please contact me.

Regards,

**Airtron Canada**



Aaron Dobson  
Regional Sales Manager

[Filename: NRC M-58 Ground Floor Renovation Airtron EMCS Quote OCT 2016.pdf](#)

**Part 1            General**

**1.1                SUMMARY**

- .1    Section Includes:
  - .1        Copper and steel piping for hydronic systems.

**1.2                RELATED SECTIONS:**

- .1    The prescriptions for the sections 21 05 01 -Mechanical- General Requirements concerning the work results and 22 05 00 -Piping- General Requirements concerning the work results, are both integral parts of this present section.

**1.3                REFERENCES**

- .1    American Society of Mechanical Engineers (ASME).
  - .1        ASME B16.1-98, *Cast Iron Pipe Flanges and Flanged Fittings*.
  - .2        ASME B16.3-98, *Malleable Iron Threaded Fittings*.
  - .3        ASME B16.5-03 *Pipe Flanges and Flanged Fittings*.
  - .4        ANSI/ASME B16.4-98, *Gray-Iron Threaded Fittings*.
  - .5        ASME B16.9-01, *Factory-Made Wrought Butt welding Fittings*.
  - .6        ANSI/ASME B16.15-1985(2004), *Cast Bronze Threaded Fittings*.
  - .7        ANSI B16.18-2001, *Cast Copper Alloy, Solder Joint Pressure Fittings*.
  - .8        ANSI/ASME B16.22-2001, *Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings*.
  - .9        ASME B18.2.1-03, *Square and Hex Bolts and Screws (Inch Series)*.
  - .10      ASME B18.2.2-87(R1999), *Square and Hex Nuts (Inch Series)*.
- .2    American Society for Testing and Materials International (ASTM)
  - .1        ASTM A47/A47M-99, *Standard Specification for Ferritic Malleable Iron Castings*.
  - .2        ASTM A53/A53M-02, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless*.
  - .3        ASTM A536-84(1999)e1, *Standard Specification for Ductile Iron Castings*.
  - .4        ASTM B32-04, *Standard Specification for Solder Metal*.
  - .5        ASTM B61-02, *Standard Specification for Steam or Valve Bronze Castings*.

- .6 ASTM B62-02, *Standard Specification for Composition Bronze or Ounce Metal Castings.*
- .7 ASTM B88M-03, *Standard Specification for Seamless Copper Water Tube Metric.*
  - .1 ASTM E202-04, *Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.*
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .4 Manufacturers Standardization Society (MSS)
  - .1 MSS SP67-2002a, *Butterfly Valves.*
  - .2 MSS SP70-1998, *Cast Iron Gate Valves, Flanged and Threaded Ends.*
  - .3 MSS SP71-1997, *Grey Iron Swing Check Valves, Flanged and Threaded Ends.*
  - .4 MSS SP80-2003, *Bronze Gate, Globe, Angle and Check Valves.*
  - .5 MSS SP85-2002, *Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.*
- .5 American Water Works Association (AWWA).
  - .1 AWWA C111-00, *Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.*
- .6 Canadian standards association (CSA)/CSA International.
  - .1 CSA B242-M1980 (R1998), *Groove and Shoulder Type Mechanical Pipe Couplings.*
  - .2 CAN/CSA W48-01, *Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).*

## **1.4 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 00 10 00 – General Instructions. Include product characteristics, performance criteria, and limitations.
  - .2 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 00 10 00 – General Instructions.



- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 00 10 00 – General Instructions.
  - .2 Indicate on manufacturer’s catalogue literature the following: VALVES.
- .3 Quality assurance submittals: submit following in accordance with Section 00 10 00 – General Instructions.
  - .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 The NRC Representative will make available 1 copy of systems supplier's installation instructions.
- .4 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 00 10 00 – General Instructions.

**1.5 QUALITY ASSURANCE**

- .1 Regulatory Requirements: ensure Work is performed in compliance with Provincial regulations.

**1.6 HEALTH AND SAFETY:**

- .1 Do construction occupational health and safety in accordance with Section 00 15 45 – General Safety Section & Fire Instructions.

**1.7 MAINTENANCE**

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

**1.8 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 00 10 00 – General Instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 00 10 00 – General Instructions.

**Part 2 Products**

- .1 Supply and install piping and fittings as specified in tables entitled "Standards of pipe" attached.

**Part 3 Execution**

**3.1 PIPING INSTALLATION**

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

**3.2 VALVE INSTALLATION**

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

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

.8 Install plug cocks or ball valves for glycol service.

### **3.3 CIRCUIT BALANCING VALVES**

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove hand wheel after installation and TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

### **3.4 FLUSHING AND CLEANING**

.1 Flush and clean piping network with Section 23 08 02.

### **3.5 FILLING OF SYSTEM**

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

### **3.6 FIELD QUALITY CONTROL**

.1 Testing:

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

.2 Balancing:

.1 Balance water systems to within plus or minus 5% of design output.

.2 Refer to Section 23 05 93 for applicable procedures.

### **3.7 CLEANING**

.1 Proceed in accordance with Section 00 10 00 – General Instructions.

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

	DIAMETER		SPECIFICATION (*)	DESCRIPTION	Materials & A.S.T.M. standards
	FROM	TO			
<b>PIPING</b>	ND ½	ND 2	Cal. 40	Continuous seal (CW) Threaded ends	Black Steel A.53
	ND 2 ½	ND 4	Cal.40	Continuous seal (CW) Chamfered ends	Black Steel A.53
	ND 5	ND 12	Cal. 40	Elect. joint (ERW), Chamfered ends	Black Steel A.53
	ND 14	ND 24	Cal. 30	Elect. joint (ERW), Chamfered ends	Black Steel A.53
<b>ASSEMBLY</b>	ND ½ ND 2 ½	ND 2 ND 24		Screwed But welded	Welding according to the section covering the welding
<b>FITTINGS</b>	ND ½	ND 2	150 psi	Screwed	Malleable cast iron A.197
	ND 2 ½	ND 24	Std.	No joint, Chamfered ends	Steel A-234-WPB
<b>FLANGES</b>	ND 2 ½	ND 24	150 psi	Collar and a) Saliend of 1/16 in or b) Surface plate (flat face)	Forged Steel A.105
<b>UNIONS</b>	ND ½	ND 2	300 psi	Bronze round joint to cast iron, screwed	Malleable cast iron A.47
<b>BOLTS</b>	Robust hex screws and nuts, semi-finished				Steel A.307
<b>PACKING FOR THE FLANGE</b>	Thickness: 1/8 in ("full face")				EPDM 150 psi
<b>FAUCET</b>	DIAMETER		SPECIFICATION (*)	DESCRIPTION	
	FROM	TO			
<b>VALVE</b>	ND ½	ND 2	Class 150	Jenkins 106BJ, Crane 7TF, Kitz 9 (AK150D), Toyo 221A, Nibco TY-235-Y	
	ND 2 ½	+	Class 200 CWP	Jenkins 2342J, Crane 351, Kitz 76 (125FCJ), Toyo 400, Nibco F718N	
<b>HOLDING VALVE</b>	ND ½	ND 2	Class 150	Jenkins 4092J, Crane 137, Kitz 29 (AK150YR), Toyo 239, Nibco T-433	
	ND 2 ½	+	Class 150	Type "wafer" ; Rite 210, Prince 810, Crane Uni-Check II	
<b>SPHERICAL PLUG VALVE (1)</b>	ND ½	ND 2	Class 600 CWP	Stainless steel rod and ball: Jenkins 201SJLD, Crane F9222-LD, Toyo 5044SLH, Nibco T-585-70-66-LL	
<b>BUTTERFLY (2)</b>	ND 2 ½	+	Class 250	"lug type" Keystone F222, Nibco LD-2000-3 et -6	
<b>SCREEN</b>	ND ½	ND 2	Class 250	Screwed cast iron. Armstrong Int., Spirax, Mueller or approved equivalent	
	ND 2 ½	+	Class 200 CWP	Flange cast iron; Armstrong Int., Spirax, Mueller or approved equivalent	
<b>FAUCET DRAIN FOR LOWER POINT</b>	ND ½	ND 2	Class 600 CWP	Welded or screwed by hose connection, bronze body, chromium-plated brass ball, safety lock with cap and chain: Kitz 68C/69C, Crane F9202, Jenkins 201J, Nibco T-585-70-HC	
<b>NOTE:</b>	(1) With latch (2) Drive member for butterfly type: DN6 and less use a lever, DN8 and greater use gear				
<b>FAUCET AND PIPING STANDARDS</b>				<b>Hydronic network</b>	

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENT**

- .1 The requirements for section 21 05 01 -Mechanical- General Requirements concerning the work results and 22 05 00 -Piping- General Requirements concerning the work results, are both an integral part of this present section.

**1.2 REFERENCES**

- .1 *American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)*
  - .1 Standard 90.1-2007, *Energy Standard for Buildings except Low-Rise Residential Buildings.*
  - .2 *Electrical Equipment Manufacturer Advisory Council (EEMAC) / Association des manufacturiers d'équipement électrique et électronique du Canada (AMEEEEC)*
  - .3 Canadian Standards Association (CSA International)
    - .1 CSA-B214-F07, *Installation Code for Hydronic Heating Systems.*
  - .4 *National Electrical Manufacturers' Association (NEMA)*
    - .1 NEMA MG 1-2006, *Motors and Generators.*

**1.3 DOCUMENTS / SAMPLES TO SUBMIT FOR APPROVAL / INFORMATION**

- .1 Provide submittals in accordance with Section 00 10 00 – General Instructions.
- .2 Product data:
  - .1 Provide manufacturer's printed product literature and datasheets for pumps, circulators, and related equipments.
  - .2 The data sheets must include:
    - .1 Equipments and their components, including connections, piping, fittings and control devices, as well as factory mounted or site mounted details.
    - .2 Size and recommended installation instructions.
    - .3 Pumps performance curves with their point of operation.
    - .4 Motor characteristics including efficiency.
  - .3 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.
- .3 The maintenance datasheets must include the following items:

- .1 Equipment description including the name of the manufacturer, the equipment type, the manufacturing date, the power or capacity and the serial number.
- .2 Maintenance and operation details data sheets.
- .3 The recommended spare parts list, the name and address of the manufacturer representatives.
- .4 Product characteristics, performance criteria, dimensions, limitation and finish.

#### **1.4 CLOSEOUT SUBMITTALS**

- .1 Provide at work completion, maintenance and operation data for incorporation into manual specified in Section 00 10 00 – General Instructions.
- .2 The maintenance and operation datasheets must include the following items:
  - .1 Equipments description including the name of the manufacturer, the equipment type, the manufacturing date, the power or capacity and the serial number.
  - .2 Maintenance and operation details data sheets.
  - .3 The recommended spare parts list, the name and address of manufacturer representatives.
  - .4 Product characteristics, performance criteria, dimensions, limitation and finish.

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

- .1 Deliver, store and handle in accordance with Section 00 10 00 – General Instructions.
- .2 Deliver materials in original factory packaging, labeled with manufacturer's name and address.
- .3 Packaging Waste Management: in accordance with Section 00 10 00 – General Instructions.

### **Part 2 Product**

#### **2.1 IN LINE VERTICAL CLOSE COUPLED CIRCULATORS**

- .1 Pumps shall be Taco, Armstrong, Bell & Gossett or approved equal. The pumps shall be single stage vertical in-line design. The seal shall be serviceable without disturbing the piping connections. The capacities and characteristics shall be as called for in the plans/schedules.
- .2 High efficiency ECM motor with integrated electronic regulation.
- .3 Pump shall be constructed of ASTM A48 class 30 cast iron. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections.
- .4 All casings shall be flanged connections.

- .5 The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 125°C.

## **2.2 CHARACTERISTICS**

- .1 See pump schedule on drawing (M-09).

## **Part 3 Execution**

### **3.1 APPLICATION**

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

### **3.2 INSTALLATION**

- .1 Install hydronic pumps in accordance to CSA-B214.
- .2 In line circulator directly mounted on pipe:
  - .1 Support at inlet and outlet flanges or unions
  - .2 Install with bearing lubrication points accessible.
- .3 Base mounted type: supply templates for anchor bolt placement
  - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
  - .2 Align coupling in accordance with manufacturer's recommended tolerance.
  - .3 Check oil level and lubricate. After run-in, tighten glands.
- .4 Ensure that pump body does not support piping or equipment.
  - .1 Provide stanchions or hangers for this purpose.
  - .2 Refer to manufacturer's installation instructions for details.
- .5 Connect a drain pipe connection to a floor drain.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.



### **3.3 START-UP**

- .1 General:
  - .1 In accordance with Section 00 10 00 – General Instructions, supplemented as specified herein.
  - .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
  - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
  - .2 After starting pump, check for proper and safe operation.
  - .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
  - .4 Check base for free-floating and no obstructions under base.
  - .5 Run-in pumps for 12 continuous hours minimum.
  - .6 Verify operation of over-temperature and other protective devices under low- and no-flow conditions.
  - .7 Eliminate air from scroll casing.
  - .8 Adjust water flow rate through water-cooled bearings.
  - .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
  - .10 Adjust alignment of piping and conduit to ensure true flexibility.
  - .11 Eliminate cavitations, flashing and air entrainment conditions.
  - .12 Adjust pump shaft seals, stuffing boxes and glands.
  - .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
  - .14 Replace seals if pump used to degrease system or if pump used for temporary heat.
  - .15 Replace seals if pump is used to degrease system or if pump is used for temporary heat.
  - .16 No pump test is allowed to the air.

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

- .1 General
  - .1 Verify performance in accordance with Section 000 10 00 – General Instructions.
- .2 Verify that manufacturer's performance curves are accurate;
- .3 Ensure valves on pump suction and discharge provide tight shut-off.
- .4 Net Positive Suction Head (NPSH)
  - .1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.
  - .2 Measure using procedures prescribed in Section 00 10 00 – General Instructions.
  - .3 Where procedures do not exist, discontinue PV, report to NRC Representative and await instructions.
- .5 Multiple Pump Installations - Series and Parallel
  - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .7 Commissioning Reports: in accordance with Section 00 10 00 – General Instructions reports supplemented as specified herein. Reports to include:
  - .1 Record of point(s) of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
  - .2 Use Report Forms specified in Section 00 10 00 – General Instructions: Report Forms and Schematics.
  - .3 Reports should indicate the characteristics of pumps curves (families of curves).

### **3.5 CLEANING**

- .1 Operational requirements in accordance with Section 00 10 00 – General Instructions.
  - .1 Remove site materials/equipment surplus, waste management, tools and equipment.
- .2 Waste Management: in accordance with Section 00 10 00 – General Instructions.

**END OF SECTION**

**Part 1 GENERAL**

**1.1 SUMMARY**

- .1 Section Includes
  - .1 Fans, motors, accessories and hardware for commercial use.
- .2 Related Sections
  - .1 The requirements of Section 21 05 01 – Common Work Results for Mechanical and 23 05 00 – Common Work Results for HVAC are an integral part of this section.
    - .1 Section 00 10 00 – General Instructions.
    - .2 Section 00 15 45 – General Safety Section & Fire Instructions.

**1.2 REFERENCES**

- .1 Air Conditioning and Mechanical Contractors (AMCA)
  - .1 AMCA Publication 99-2003, Standards Handbook.
  - .2 AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.
  - .3 AMCA 301-1990, 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 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 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 and ASHRAE 51-99. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

#### **1.4 SUBMITTALS**

- .1 Product Data
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 00 10 00 – General Instructions. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 00 10 00 – General Instructions and Section 00 15 45 – General Safety Section & Fire Instructions.
  - .2 Shop Drawings
    - .1 Submit shop drawings and product data in accordance with Section 00 10 00 – General Instructions.
  - .3 Provide:
    - .1 Fan performance curves showing point of operation, bhp kW and efficiency.
    - .2 Sound rating data at point of operation.
  - .4 Indicate:
    - .1 Motors, sheaves, bearings, shaft details;
    - .2 Minimum performance achievable with variable speed controllers.
  - .5 Quality Assurance Submittals: submit following in accordance with Section 00 10 00 – General Instructions.
    - .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 NRC Representative to make available one (1) copy of installation instructions prepared by the system supplier to intended personnel.
  - .6 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 00 10 00 – General Instructions.

## **1.5 QUALITY ASSURANCE**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 00 15 45 – General Safety Section & Fire Instructions.

## **1.6 MAINTENANCE**

- .1 Extra Materials
  - .1 Provide maintenance materials in accordance with Section 00 10 00 – General Instructions.
    - .1 Spare parts to include:
      - .1 Matched set of belts.
  - .2 Furnish:
    - .1 List of individual manufacturer’s recommended spare parts for equipment, including bearings and seals.
    - .2 Address of suppliers.
    - .3 List of specialized tools necessary for adjusting, repairing or replacing.

## **1.7 DELIVERY, STORAGE AND HANDLING**

- .1 Packing, shipping, handing and unloading:
  - .1 Deliver, store and handle in accordance with Section 00 10 00 – General Instructions.
  - .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 00 10 00 – General Instructions.

## **Part 2 Products**

### **2.1 FANS – GENERAL**

- .1 Motors
  - .1 In accordance with Section 21 05 01 – Common Work Results For Mechanical and supplemented as specified herein.

- .2 Motors selected based on variable speed drive applications, 50-hp motors and up must be in accordance with NEMA MG1, part 30.
- .3 Motors to be high efficiency and surpasses CAN/CSA-C390.
- .4 Factory installed motors.
- .5 Rating as indicated.
- .2 Accessories and hardware: matched set 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.
- .3 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 of 200 000 h to AFBMA L-50 (AntiFriction Bearing Manufacturers Association). Characteristics and specifications of bearings are to be based on fan maximum speed and capacity as illustrated in catalogue data. Bearing supports are to be single or two-row cylindrical roller bearings. Supports must be secured to fan base.
- .4 Factory primed before assembly in colour standard to manufacturer.
- .5 Scroll casing drains: as indicated.
- .6 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .7 Vibration isolation: to Section 23 05 48 – Vibration and Seismic Control for HVAC Piping and Equipment.
- .8 Flexible connections: to Section 23 33 00 – Air Duct Accessories.

## **2.2 AIR HANDLING UNIT FANS**

- .1 Refer to section 23 73 10 – Air handling unit Built-up.

### **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 Install flexible connections on fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum flex between ductwork and fan while running. Flexible connections must not be under tension when fan is operating.
- .3 Provide sheaves and belts required for final air balance.
- .4 Bearings and extension tubes to be easily accessible.
- .5 Access doors and access panels to be easily accessible.

**3.3 ANCHOR BOLTS AND MOUNTING TEMPLATES**

- .1 Properly sized anchor bolts are to be used to seismically restrain (speed and acceleration) the units as specified in the section.

**3.4 CLEANING**

- .1 Proceed in accordance with Section 00 10 00 – General Instructions.
- .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 Variable air volume units, constant air volume bypass units, mixing units with fan, and electronic mixing units.
- .2 Related Sections
  - .1 The requirements of Section 21 05 01 – Common Work Results for Mechanical and 23 05 00 – Common Work Results for HVAC are an integral part of this section.
    - .1 Section 00 10 00 – General Instructions.
    - .2 Section 00 15 45 – General Safety Section & Fire Instructions.

**1.2 REFERENCES**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - .2 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .3 International Organization of Standardization (ISO)
  - .1 ISO 3741-2001, Acoustics – Determination of Sound Power Levels of Noise Sources Using Sound Pressure – Precision Methods for Reverberation Rooms.
- .4 Underwriters' Laboratories (UL)
  - .1 UL 181-2003, Factory-Made Air Ducts and Air Connectors.

**1.3 RESPONSIBILITIES**

- .1 The Ventilation Contractor is the person ultimately in charge of providing, coordinating and installing air terminal units.
- .2 The Division 25 Contractor is the only person in charge of coordination for the design of signals between PLCs and air terminal units. The Division 25 Contractor must also coordinate his work with that of the Division 25 Ventilation Contractor for installation of these units.



## **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 recognized by the ADC (Air Diffusion Council), 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 00 10 00 – General Instructions. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS), Material Safety Data Sheets (MSDS) in accordance with Section 00 10 00 – General Instructions.
  - .2 Test Data: to ANSI/AMCA 210.
    - .1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.
    - .2 Sound power level with minimum inlet pressure of 1 kPa in accordance with ISO 3741 for 2<sup>nd</sup> through 7<sup>th</sup> octave band, also made by independent testing agency.
    - .3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.
  - .2 Shop Drawings
    - .1 Submit shop drawings and product data in accordance with Section 00 10 00 – General Instructions.
    - .2 Indicate the following:
      - .1 capacity;
      - .2 pressure drop;
      - .3 noise rating;
      - .4 leakage.
  - .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.
  - .1 NRC Representative to make available one (1) copy of installation instructions prepared by the system supplier to intended personnel.

.4 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 00 10 00 – General Instructions.

**1.6 UNIT FABRICATION**

- .1 The manufacturer of the unit must have been involved in the design and fabrication of air terminal units for more than ten (10) years. Strict adherence to dimensions and capacities to be respected, and deviation from specifications to be approved by NRC Representative ten (10) days prior to project bid, with no modifications to be taken into consideration following that date.

**1.7 QUALITY ASSURANCE**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 00 15 45 – General Safety Section & Fire Instructions.

**1.8 DELIVERY, STORAGE AND HANDLING**

- .1 Packing, shipping, handing and unloading:
  - .1 Deliver, store and handle in accordance with Section 00 10 00 – General Instructions.
  - .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 00 10 00 – General Instructions.

**1.9 MAINTENANCE**

- .1 Extra Materials
  - .1 Provide maintenance materials in accordance with Section 00 10 00 – General Instructions.
  - .2 Furnish:
    - .1 List of individual manufacturer's recommended spare parts for equipment, including bearings and seals.
    - .2 Address of suppliers.

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

**Part 2 Products**

**2.1 MANUFACTURED UNITS**

- .1 Air terminal units of the same type and product of one manufacturer.

**2.2 GENERAL**

- .1 A terminal unit to include the following:

.1 Single Duct Terminal Units

- .1 An airflow unit (variable or constant, as required), electronic digital controller, dampers and flow sensor for single duct terminal units, terminal reheat coil (if required) and sound attenuator. Assemblies must be pressure independent type.

- .2 The Contractor responsible for work described in this section must seal all joints and penetration points on the coil and attenuator.

- .3 Each terminal unit, coil and sound attenuator must be furnished with flanges minimum 14 gauge, pre-pierced, with neoprene gasket seal for connection to duct system.

- .4 Provide an access door in compliance with the description of Section 23 05 00 – Common Work Results for HVAC, upstream of coil.

- .5 Complete with reheat coil : As indicated on drawings.

- .6 Attenuators:

- .1 Provide and install, as indicated, a factory-mounted sound attenuator made of galvanized steel, 0.853 mm (22 gauge) thick, suitable for air ducts specified in other sections and in accordance with requirements of ASHRAE and SMACNA.

- .2 Acoustic quality, glass fibre, free of shot and odour; bacteria and fungus resistant; free of corrosion causing or accelerating agents; packed to minimum density of 10 to meet performance requirements; and meet NBC requirements concerning air duct liners.

- .3 Outer casing and galvanized steel inner casing with clean-cut circular perforations to enclose acoustic media.

- .4 Protect media from erosion (disintegration or friction wear) and humidity with Tedlar placed between the perforated metal casing and attenuating material.

- .7 Fabricated assembly to be delivered to the site with the following characteristics:

- .1 Pressure loss through terminal units must not exceed 125 Pa water column from one flange to another.

- .2 Terminal unit length must be such that it may be installed at any location on the duct network without affecting air terminal unit performance. Any distance required upstream or downstream of the VAV unit must be included for precision purposes.
- .3 Provide all necessary supports.
- .4 Models and capacities as indicated on schedule.

## 2.3 ELECTRONICALLY-CONTROLLED VARIABLE AIR VOLUME UNITS

- .1 General:
  - .1 Casing to be constructed of 0.853 mm galvanized steel (22 gauge).
  - .2 Panels will be sealed using clear silicone to form airtight casing. Rate of loss through the unit casing must not exceed 1% of nominal flow when subjected to a pressure of 3 in.H<sub>2</sub>O at inlet, and 0 in. H<sub>2</sub>O at outlet.
  - .3 Units must be configured (NC or NO) as indicated on drawings and/or in specifications.
  - .4 Unit control range must be at least 6 to 1 (minimum set point versus maximum set point).
  - .5 Only the unit's minimum and maximum nominal flows may be factory calibrated. The project's specific minimum and maximum values must be calibrated on site by the contractor of Section 23 05 94 – Testing, Adjusting and Balancing for HVAC.
  - .6 All moving parts shall use a ring type assembly.
  - .7 Unit performance must be in compliance with the standards of ARI-ADC Industry 880-98, ANSI/ASHRAE Standard 130-1996 and as per tests performed in an ADC-certified laboratory.
  - .8 Each VAV unit must be equipped with a nameplate installed on the outside of the casing, with the following information listed: minimum and maximum capacity, and parts identification for unit and system.
  - .9 Each VAV unit to be insulated with fibrous glass 24 kg/m<sup>3</sup> density and 13 mm thick, with 0.853 mm (22 gauge) internally-lined galvanized steel. Internal insulation flame spread rating up to 25 and smoke development rating of 50. All perimeters of penetrations must be sealed. Fibrous glass insulation to respect the following standards: NFPA 90A, UL181 (Air Erosion), UL181 (Mold Growth & Humidity), UL723 (25/50) (Flame & Smoke), ASTM E84 (25/50) (Flame & Smoke), ASTM C 665 (Fungi Resistance), ASTM C 1071 (Physical Properties).
  - .10 Dimensions and capacity: as indicated.
  - .11 Product : Price, Titus, Nailor or approved equivalent.

**2.4 CONTROLS**

- .1 Direct Digital Control – DDC (pressure independent):
  - .1 Air terminal units will be delivered to the site with pressure independent digital controls provided by the Control Contractor and factory-installed by the manufacturer. The Control Contractor must, in addition to providing controls to the Air Terminal Unit Manufacturer, provide technical data on all components including dimensions, mounting accessories and electrical diagrams for each terminal unit that appears on the schedule and mechanical drawings.
- .2 Each specialized air terminal unit is controlled by an air terminal control assembly by the Division 25 Contractor.
- .3 The unit actuator must be the same make as the air terminal unit (refer to Division 25 for specifications on actuators).

**2.5 FLOW CHARACTERISTICS**

- .1 Maximum flow of each terminal unit not to exceed 80% of maximum specified by manufacturer.

**2.6 ACOUSTICS**

- .1 Integrated sound attenuating sections described in this section must be in strict compliance with the requirements of Section 23 32 48 – Acoustical Air Plenums.
- .2 Sound attenuators to eliminate noise generated by terminal units to produce the following results:

	<u>RC (N)</u>
2.1 Offices	40

**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 terminal units in accordance with manufacturer's instructions.
- .2 Coordinate VAV unit installation with Balancing Subcontractor.
- .3 Provide complete instructions with regard to calibration to the contractor of Section 23 05 94 – Testing, Adjusting and Balancing for HVAC in order that he may perform work described in his section. Provide supervision for follow-up of methods explained.

- .4 All air terminal units must be delivered to the site with their ends covered to avoid accumulation of dust within the units. Any unit found not to comply with this requirement will be returned to the Subcontractor at his cost, or must be cleaned on site.
- .5 Support independently of ductwork.
- .6 Install flexible ducting directly upstream of each air terminal unit at least 1,000 mm long and a straight inlet duct minimum of four (4) duct diameters, same size as inlet.
- .7 Locate terminal units so that controls, dampers and access panels are easily accessible.
- .8 Duct liners must be intact, without tears or rips during installation of VAV units. Perform all necessary repairs or replace damaged liners.

**3.3****CLEANING**

- .1 Proceed in accordance with Section 00 10 00 – General Instructions.
- .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 REQUIREMENTS**

- .1 The requirements of sections 21 05 01 – Common Work Results for Mechanical and 23 05 00 – Common Work Results for HVAC are an integral part of this section.
- .2 Section 00 10 00 – General Instructions.
- .3 Section 00 15 45 – General Safety Section & Fire Instructions.

**1.2 REFERENCES**

- .1 Definitions:
  - .1 Catalogued or published ratings: ratings obtained from tests carried out by manufacturer or manufacturer’s designated independent testing agency which signify adherence to codes and standards in force.
- .2 Reference Standards:
  - .1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)
    - .1 ANSI/NFPA-90A-2009, Standard for the Installation of Air Conditioning and Ventilating Systems.
    - .2 ANSI/AMCA Standard 210-07, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
  - .2 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
    - .1 ANSI/ASHRAE 90.1-2007, (I-P) Energy Standard for Buildings Except Low-Rise Residential Buildings.
    - .2 ANSI/ASHRAE 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
    - .3 ANSI/ASHRAE 52, Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
    - .4 ASHRAE / ANSI Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
  - .3 Air Conditioning and Refrigeration Institute (AHRI)
    - .1 AHRI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil.
  - .4 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .5 Master Painters Institute (MPI)
  - .1 MPI-INT 5.3-2007, Galvanized Metal.
- .6 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
- .7 IEEE 112-B: Standard Test Procedures for Polyphase Induction Motors and Generators.
- .8 NEMA MG-1: National Electrical Manufacturers Association Motor Standards.
- .9 ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

### **1.3 SCOPE OF WORK**

- .1 Design, fabricate, factory assemble, transport and supervise installation of the required air handling units according to the specific requirements of this section.
- .2 Field fabrication of units and their components will not be accepted. Only final assembly of AHU modules shall be done on site.
- .3 Dimensions of AHUs must not exceed the dimensions available along the route for their final installation in the building.
- .4 Air handling unit shall be fully tested for air leakage before shipping by the manufacturer of the unit. Field tests to be performed on site once the unit is assembled and connected to ductwork.
- .5 Once shop-inspected, unit modules shall be engineered knock down and crated, when required, in a number of engineered sections required to suit transportation regulations and special existing site conditions for handling and assembling.
- .6 Manufacturer is fully responsible for their equipment until delivery on site and acceptance from contractor and departmental representative.
- .7 Subcontractor is responsible for receiving, hoisting, handling, installing, assembling and connecting ductwork on site.
- .8 A representative of each manufacturer to assist and supervise the Ventilation Subcontractor when unloading and handling each module of the air handling units that he has supplied up to their final location installation and assembly of the units.
- .9 Subcontractor to fully field test air handling units for leakage. Excessive leakage to be corrected.
- .10 All components required for assembly and sealing of modules must be provided with assembly drawings.



- .11 Further to assembly, Contractor to start up air handling unit with the assistance of the Manufacturer.
- .12 Each manufacturer to re-align on site each fan driving assembly (pulleys and belt drives) before any start-up of air handling units. Manufacturer to also perform vibration signature testing for each fan and motor once each AHU is ready for start-up.
- .13 Subcontractor to repaint scratches and repair all damages on the air handling unit and their components after their complete installation in the field.
- .14 Provide training for operating and maintenance personnel identified by NRC Representative (plan for a 4-hour training session for each type of air handling unit).
- .15 Standard of acceptance: Ingenia, Haakon, Venmar, Ventrol or equal approved via addendum. For approval as equal contractor must propose unit with sufficient time (minimum five (5) business days prior to closing) for review by Departmental representative.

#### **1.4 SUBMITTALS**

- .1 Provide submittals in accordance with Section 00 10 00 – General Instructions.
- .2 Product Data:
  - .1 Provide manufacturer’s printed product literature and datasheets for following and include product characteristics, performance criteria, physical size, finish and limitations:
    - .1 Overall construction.
    - .2 Dimensions.
    - .3 Component configuration.
    - .4 Coil data – size, EAT, LAT, EWT, LWT, airflow, water flow, air velocity, water velocity, air friction, water pressure drop.
    - .5 Filters and pre-filters (dimensions, velocities, initial and final pressure drops).
    - .6 Filter support data.
    - .7 Access doors.
    - .8 Motorized dampers.
    - .9 Materials of construction.
    - .10 Insulation.
    - .11 Paint.

- .12 Cross-section details of typical wall, floor and roof construction.
  - .13 Component equipment data as detailed in component specification section.
  - .14 Details of coil supports and coil banks.
  - .15 Piping connection sizes and approximate locations.
  - .16 Doors and windows.
  - .17 Drain pan details.
  - .18 VFD.
  - .19 Operating and maintenance data.
  - .20 Indications of all split points in shop drawings.
- .3 Shop Drawings:
- .1 Indicate following:
    - .1 Actual cooling and heating air and fluid entering and leaving operating conditions for stated air side requirements.
    - .2 Fan data.
    - .3 Unit and component performance data.
    - .4 Wiring diagrams.
    - .5 Sound data.
      - .1 Sound analysis consisting of inlet, outlet and radiated sound power levels per unit.
    - .6 Important construction details and dimensions.

**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 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in Section 00 10 00 – General Instructions.

- .2 Furnish list of individual manufacturer recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for incorporation into operating manual.

### **1.7 HEALTH AND SAFETY**

- .1 Complete construction occupational health and safety in accordance with Section 00 15 45 – General Safety Section & Fire Instructions.

### **1.8 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 00 10 00 – General Instructions.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer’s name and address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 00 10 00 – General Instructions.
- .4 The units shall be thoroughly cleaned and inspected before applying a shrink wrapping protective cover. The plastic cover must completely enclose all shipping modules individually.
- .5 The units must be shipped completely assembled, in modules or knock down as documented in the specifications or instructed by the contractor. The units and/or modules shall be equipped with adequately sized and removable lifting lugs for field rigging and handling.
- .6 The units must be handled carefully in the field to avoid damaging internal components, cabinet walls and the exterior finish.
- .7 Store the units in a dry, clean environment protected from the outdoor weather. Factory applied shrink wrap is intended to protect the units while in transit to the job site. The units must not be stored with the factory applied shrink wrap.
- .8 The units must not be operated, for temporary or permanent purposes, until the official start-up is completed by the mechanical contractor and witnessed by a manufacturer’s representative.

### **1.9 WARRANTY**

- .1 The Manufacturer shall furnish the following in writing:
  - .1 An unconditional warranty of all equipment, materials, and workmanship for a period of one (1) year from the date of acceptance by the NRC Representative.
  - .2 During the warranty period, the Manufacturer shall provide all labour and materials necessary to repair or replace, at his own expense and without any additional cost, any defective material, equipment or workmanship.

- .3 For the warranty period, the Manufacturer may enter into an agreement with the Contractor to provide the labour to Manufacturer as needed.

## **Part 2 Products - Air handling Unit (AHU-04)**

### **2.1 GENERAL**

- .1 Field or factory-assembled components to form units supplying air at design conditions as indicated. Air handling unit must be provided as “knock-down” corresponding to the physical limitations on site. All sections shall be able to fit through a standard 2100 x 810 door.

### **2.2 PERFORMANCE**

- .1 Provide factory fabricated air handling units having overall dimensions as shown on the construction plans. Physical dimensions and unit arrangement are critical for equipment layout and must be as shown on the drawings.
- .2 Refer to the air handler schedules to determine the performance of all internal components: Fans, coils, filters, humidifiers, acoustical performance, etc.
- .3 The indicated total static pressure for each fan must be equal to the sum of the external static and the internal static, including all internal system effects.
- .4 The fan performance characteristics must be based on the actual elevation and operating temperature.
- .5 All deviations from the specification must be clearly indicated on the submittal drawings. The contractor shall be held responsible for all additional expenses associated with the substitution of the specified product.

### **2.3 RATINGS**

- .1 Catalogued or published ratings shall be those obtained from tests carried out by Manufacturer or those ordered by him from an independent testing agency signifying adherence to codes and standards in force.

### **2.4 FANS**

- .1 In accordance with Section 23 34 00 – HVAC Fans.

### **2.5 CASING**

- .1 General
  - .1 Factory-manufactured galvanized steel casing thickness as indicated, reinforced and braced for rigidity and flanged for bolted sub-assemblies, to withstand a pressure differential as indicated.
  - .2 Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, “Standard for the Installation of Air Conditioning and Ventilating Systems.”

- .3 Provide walk-in access doors to allow access to internal parts.
  - .1 Walk-in access doors: insulated sandwich panel construction of same material and thickness as casing, of sizes as indicated and complete with three (3) hinges, two-way latches, neoprene gaskets and 300 x 300 mm Georgian wire glass ports as indicated. Hinge doors to open against air pressure complete with hold-open devices; a two-stage door-opening prevention device is considered to be an acceptable alternative.
- .4 Paint over steel, where steel is not galvanized, or where galvanized steel sheet is cut, with corrosion-resistant paint to MPI-INT 5.3A CAN/CGSB 1.181.
  - .1 Finish inside and out, over prime coat, with enamel paint to Section 09 91 23 – Interior Painting.
  - .2 Primer: maximum VOC limit 250 g/L to Standard GS-11 and SCAQMD Rule 1113.
  - .3 Enamel finish: maximum VOC limit 250 g/L to Standard GS-11 and SCAQMD Rule 1113.
- .2 Unit Base / Floor / Frame Work:
  - .1 AHU unit must be equipped with a structural perimeter made of G90 galvanized steel HSS members. Cross members are to be anticipated at regular intervals to provide rigidity to floor and support weight of heavy equipment within the unit. The perimeter must be minimum 6.0’’ (152 mm) high and maximum permissible deflection less than 1/200.
  - .2 The floor must be filled with 3’’ (76 mm) thick insulation with a hydrophobic polyurethane base having a nominal thermal resistance of R-6.5 per inch thickness.
  - .3 The unit base assembly is coated with a second epoxy primer coat and painted with polyurethane paint. The completed unit base coating must be able to sustain salt spray testing of 1,000 hours, per ASTM 117B.
  - .4 The “double bottom” base features a 75 mm thick insulated walk-on floor as specified below. Each unit must be equipped with removable lifting plates having a maximum of 10 ft (3,000 mm) centre-to-centre spacing.
  - .5 The floor’s visible internal surface must be “checkered plate” type and made of 11-ga aluminium or 304 stainless steel. Floor seam shall be sealed to create leak-free joints. The perimeter of the unit consists of a 38-mm upturned perimeter lip to create a drainable floor. The under-floor liner shall be 22-Ga, G-90 galvanized steel and recessed nominal 12.7 mm to allow for air circulation under the unit floor. The entire unit base must be polyurethane foamed in place with a minimum thickness of 75 mm and a minimum R value of 20. Insulation made of rock wool or fibreglass may be accepted as an equivalent if the thicknesses are adjusted to provide equivalent thermal resistance and designed to provide equivalent rigidity.

- .3 Wall and ceiling panels:
- .1 All panels must have a nominal thickness of 3" (76 mm). Panel interior must be filled with insulation with a hydrophobic polyurethane base having a nominal thermal resistance of R-6.5 per inch thickness.
  - .2 Insulation made of rock wool or fiberglass may be accepted as an equivalent if the thicknesses are adjusted to provide equivalent thermal resistance and designed to provide equivalent rigidity.
  - .3 Panel exterior must be made of G90 galvanized steel, 16 Ga.
  - .4 The units' exterior finish will be pre-painted Bone White (QC-16069) with granular finish. Each panel must be individually powder coated using electrostatic spray process and oven baked.
  - .5 Panel interior must be solid and made of 22-Ga stainless steel. Internal surfaces must be completely washed with isopropyl alcohol before packaging.
  - .6 As an alternative, the inner wall may be made of pre-painted galvanized steel with a smooth white coating incorporating an antibacterial agent. For this alternative, each panel must be individually powder coated with electrostatic spray process and oven baked. Coating must be able to sustain salt spray testing of 1,000 hours, per ASTM B117.
  - .7 All individual panels to be easily removable and concealed hardware must not prevent panels from being removed.
  - .8 All joints must be sealed using approved caulking bead to create an easily cleanable and smooth interior finish and prevent dust build-up.
  - .9 Casing shall incorporate insulating thermal breaks as required so that, when fully assembled, there is no path of continuous unbroken metal to metal conduction from inner to outer surfaces.
  - .10 Units shall entirely be made of double wall construction. Single wall construction with coated insulation is not acceptable. Exposed insulation edges in the air stream are not acceptable.
  - .11 Provide duplex receptacles and vapour-tight marine lights complete with gaskets and cast aluminum guards in each section in accordance with Division 26.
  - .12 Cut and frame openings or panel penetrations greater than 150 mm (diameter or length and width) at factory. Openings or penetrations less than 150 mm (pipe, conduit and instrument holes) may be field cut. Manufacturer to provide filler sheets between equipment and casing.

## **2.6 COILS**

- .1 General:
  - .1 Coil frame must be made of 16-gauge 304 stainless steel.
  - .2 Maximum tube length: 3.6 m unless specified otherwise.
  - .3 Factory tested with air under water.
  - .4 Coils shall be AHRI certified.
- .2 Capacities: as indicated.
- .3 Ratings: Submit with shop drawings actual cooling and heating fluid entering and leaving conditions for stated air side requirements.
- .4 Do not use removable headers at working gauge pressures above 0.7 MPa.
  - .1 Unless otherwise indicated, dehumidifying coils rated for 2.0  $\leq$  m/s face velocity.
  - .2 Unless otherwise indicated, preheat coils rated for less than 3.0  $\leq$  m/s.
  - .3 Water velocity: at least 1.2 m/s. For velocity between 0.6 m/s and 1.2 m/s, turbulators may be used if manufacturer's standard practice.
- .5 "WC" cooling and heating coils
  - .1 Primary Tube Surface
    - .1 Round seamless 15.9 mm O.D. copper tubes with 0.889 mm wall thickness mechanically expanded into fin collars of the secondary surface. Tubes shall be mechanically expanded to provide a permanent metal-to-metal bond for efficient heat transfer. Manufacturer may only use staggered tubes in direction of airflow and only return bends; reduced tube wall hairpin bends are not acceptable.
  - .2 Fins
    - .1 Die-formed 0.241 mm thick aluminum fins with full drawing fin collars to provide maximum tube contact. Maximum 120 fins per 254 mm.
  - .3 Headers
    - .1 Seamless copper with die-formed holes to provide a parallel surface to the coil tube for strong brazing joints. Header is supplied with 3.175 mm dia. brass female pipe thread (FPT) vents and drains. All circuiting is designed to gravity-drain.
  - .4 Casing
    - .1 Minimum 16-ga. G-90 galvanized steel (stainless steel for coils in cooling mode) with 38-mm die-formed flanges to permit easy stacking and mounting. Intermediate tube supports are supplied on coils over

1,118 mm fin length with additional supports every 1,067 mm multiple thereafter.

.5 Testing and Performance

.1 Each coil must undergo hydrostatic testing at 1,725 kPa (250 psig) and be able to withstand continuous pressure at 1,375 kPa (200 psig) and a service temperature of 220°F (105°C).

.2 The heating and/or cooling coils-must be certified under AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the coil selections are generated using the manufacturer's software; software must be AHRI certified.

**2.7 DRAIN PANS**

.1 Construction: 304 stainless steel.

.2 Drain connection: in bottom at low point.

.3 All drain pan corners shall be welded.

.4 Installation: slope at least 2% in two (2) directions to ensure no standing water.

.5 Dimensions: minimum 75 mm from upstream face of coil to 150 mm beyond downstream face of coil or eliminator and to include all return bends and headers.

.6 Comes with removable panel on the side of the air handling unit for coil removal. Side of the panel and removable coil to be determined by the subcontractor (see drawings).

**2.8 DIRECT DRIVE MULTIPLE FAN ARRAY**

.1 All fans within the fan matrix must have an AF wheel in compliance with the fan schedule.

.2 The fan diameters and the impeller surface areas shall have been determined and tested according to AMCA® standards.

.3 The fan construction shall be in accordance with the class required or specified in the project fan schedule. Fan shafts shall be sized so that the first critical rotational speed is at least 125% of the maximum operating rotational speed for classes I and II, and at least 142% of the maximum rotational speed for classes III and IV.

.4 The manufacturer shall certify the sound power level ratings in the eight octave bands. Sound power levels shall be in decibels referenced to 10-12 watts.

.5 All fans shall be certified to bear the AMCA® rating seal for air and sound, according to standards 211 and 311.



- .6 The fans shall have been statically and dynamically balanced by the fan manufacturer. An IRD or PMC analyzer shall have been used to measure velocity, the final balanced reading shall not exceed 0.1 inches/second.
- .7 Fan inlets shall be equipped with removable fan inlet grilles, designed according to OSHA standards.
- .8 Plenum fan shall have a protective and removable wheel enclosure designed according to OSHA standards.
- .9 The fans shall be manufactured by Twin City Fan, Greenheck Fans or an approved equivalent.

## **2.9 ELECTRICITY AND CONTROLS**

- .1 To avoid having to make holes in panels on site, the Manufacturer must make electrical connections for motors and flow sensors in factory. Wires from each motor and flow sensor will be via rigid galvanized steel conduits with EMT type ends up to the external panel where a terminal is anticipated for each motor. Anticipate sleeved openings for each of the control devices (sensors, actuators, etc.) to be connected to the units in coordination with Division 25; see AHU control documents for specific points.
- .2 All components and wiring shall be identified using printed self-adhesive labels, consistent with the numbering used in the wiring diagrams.
- .3 Light fixtures shall be “EMERGI-LITE” IPETM series IP65Surface mounting vapor-tight, 1.2 m (4’) long fixture with two 32 watt lamps (T8), rapid start high efficiency electronic ballasts, CSA certified. The body and lens shall be constructed of UV stabilized industrial grade vandal resistant polycarbonate. A durable formed gasket shall be provided between the enclosure and the lens and shall be designed specifically for hostile environments. The reflector shall be made of highly specular material and formed to maximize light output efficiency. All parts shall be corrosion resistant. A metal plate used to retain the ballast and reflector also serves to dissipate heat, therefore lengthening ballast life.
- .4 RC109W, CSA certified, 15 amps, 120 volt AC. Single pole Switch, illuminated pilot light, self grounding, side wire termination. Unless otherwise shown or specified, connect all air handling unit lighting fixtures to one switch. Junction box shall be “THOMAS & BETTS” universal FSU – 2 3/8” deep, cast aluminum and supplied with close-up plugs. Cover plate shall be made of stamped aluminum.
- .5 GF15WL, duplex, CSA certified, heavy duty, white, 15 Amps, 125 volt AC.
- .6 Variable frequency drive (VFD)
  - .1 Provide short circuit protection of motor circuits through means of using fuses with fuse blocks or circuit breakers.

- .2 The VFDs shall be designed for use with NEMA B squirrel cage induction motors, with a 1.15 service factor.
- .3 The drive as a whole, must be approved for a short-circuit current greater than the value shown at the connection point in the electrical plans. It must have a minimum short circuit current capacity of 20 000 A.
- .4 The motor manufacturer is responsible for selecting motors according to the speed range required for each application and shall ensure that the motors are compatible with the VFDs.
- .5 The installation and connection will be carried out by the electrical division 26.
- .6 Refer to electrical drawings for VFD quantities.
- .7 The variable frequency drive VFD shall be mounted in a dedicated enclosure for connection to single point power. Variable frequency drive enclosure shall be provided with a main disconnecting means. Provide appropriate cooling of enclosure. VFD s must meet the specifications of Section 25 30 02 including BACnet MSTP communication protocol.
- .8 Accepted Products
  - .1 The quality standards of the present section were defined according to technical information from the company ABB ACH550.
  - .2 Approved manufacturer: ABB, Schneider Electric, Cutler Hammer, Danfoss.
- .7 Motor circuit protectors (MCP) shall be used for each motor in the array.
- .8 Motor circuit protectors shall be housed and mounted in the VFD enclosure as required. Motor circuit protectors may be mounted in a remote enclosure that is separate from VFD enclosure if design requires. Variable frequency drive enclosure and remote motor circuit protector enclosure must be mounted at a minimal distance from fan array motors and each other.
- .9 At the inverter's outlet, each motor will be individually protected via its own thermal-magnetic circuit breaker (motor circuit protector) for automatic protection against overload, in addition to a manual switch, as needed.
- .10 Each thermal-magnetic circuit breaker (MCP) will have a green pilot light in proximity indicating the corresponding fan's operation.
- .11 Provide a green pilot light to indicate that inverter is in operation.
- .12 Provide a red pilot light to indicate an external fault forcing the inverter to stop.
- .13 Provide a red pilot light to indicate an inverter internal fault.
- .14 The cabinet will have a hinged access door with locking device on which the inverter touchpad and display will be installed. Buttons, switches and pilot lights will also be installed on this door.

- .15 As required by electrical design, when using variable frequency drives provide input line reactors with 3% impedance, mounted separately if not already integrated into the VFD. The EFV must meet the specifications of section 25 30 02 including BACnet MSTP communication protocol.
- .16 As required by electrical design, when using variable frequency drives provide output line reactors as required where filtering capacity or distance are problematic. Size the output filters accordingly to manufactures recommendations.
- .17 Filter Gauge – Each filter bank shall be furnished with: Magnehelic filter gauge with a 4<sup>3/4</sup>” OD white static pressure dial with black figures and zero pointer adjustment like Dwyer Series 2000 air filter gauge.

## **2.10 MULTI-BLADE DAMPERS**

- .1 Mixing boxes and economizers shall be equipped with parallel blade dampers. The damper blades shall be positioned to orient the air streams against each other to promote air mixing within the section.
- .2 The dampers’ maximum air leakage rate shall be certified by AMCA standard 511.
- .3 The damper frames shall consist of pre-fabricated aluminum extrusions.
- .4 The damper blades shall be airfoil type, double wall and be made of aluminum extrusions.
- .5 Air seal gaskets shall be made of synthetic rubber type TPE and EPDM.
- .6 All drive shafts shall be located out of the air stream and it shall be possible to install the actuators inside the cabinet without interference to the air flow.
- .7 Outside air, exhaust and isolation dampers shall be thermally insulated dampers manufactured by Tamco series (9000).
- .8 Recirculation and zone dampers shall be manufactured by Tamco series (1000).

## **2.11 FILTER BOX**

- .1 Material to match casing complete with flat V cartridge type filter arrangement as indicated. Provide access to filter through hinged door.
- .2 Filters: to Section 23 41 00 – HVAC Air Filtration.
- .3 Provide blank-off plates to ensure zero bypass around filters.

## **2.12 VIBRATION ISOLATION**

- .1 Flexible connections to Section 23 33 00 – Air Duct Accessories.
- .2 Vibration isolators on each fan section to Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

**2.13 INSTRUMENT TEST PORTS**

- .1 16 gauge steel, zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28.56 mm minimum I.D. Length to suit insulation thickness.
- .4 Neoprene mounting gaskets.
- .5 Location: in each access door.
- .6 Standard of acceptance: Duro Dyne IP1 or IP2.

**2.14 ACCESS DOORS**

- .1 Access doors are constructed with a double wall construction and an extruded aluminum frame. The door frame features a built-in no-through-metal high density resin barrier and a perimeter gasket. Door frames with no thermal break are not acceptable. The door gasket is seamed together at each corner to prevent leakage through the door. Each door must be equipped with at least two stainless steel hinges and two handles (cane type), operable from both the outside and inside. Doors shall open against higher pressure side.
- .2 Inspection access panels and doors shall be sized and located to allow periodic maintenance and inspections. Provide access panels and doors in the following locations as shown on drawings.
- .3 Dual-paned tempered glass with vacuum seal windows with thermally broken frames shall be supplied as shown on unit drawings. Singled-paned windows with desiccant bag are not acceptable.

**2.15 ACOUSTICAL PERFORMANCE**

- .1 The acoustical performance of the cabinet panel system shall have been tested by a certified independent acoustical laboratory.
- .2 The acoustical procedural methods to establish the transmission loss of the panels shall comply with the standards ASTM, E90 and C413.
- .3 The acoustical procedural methods to establish the absorption coefficients of the panel systems with perforated liners shall comply with the standards ASTM, E795 and C423.
- .4 The independent laboratory test report shall be submitted to the consulting engineer upon request.

**Part 3 EXECUTION**

**3.1 INSTALLATION**

- .1 Provide appropriate protection apparatus.

- .2 Fabricate to provide smooth air flow through components.
  - .1 Limit air leakage to 1% of rated air flow at 2.5 kPa suction pressure.
- .3 Apply sealer into all seams prior to assembly.
  - .1 Secure toe angles on 300-mm centres for full length of casing continuous along entire length of assembly.
- .4 Provide, coordinate and install a concrete slab underneath each air handling unit.

### **3.2 FANS**

- .1 Suspension for hung units: install four-part hanger type, ceiling flange, top hanger, bottom hanger and vibration isolator with take-up for levelling.
- .2 Install flexible connections at fan inlets and outlets as required.
  - .1 Ensure metal bands of connectors are parallel and not touching.
  - .2 Ensure that each fan's outlet and connected duct are aligned when fan is running.

### **3.3 DRIP PANS**

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

## **Part 4 Testing**

### **4.1 GENERAL**

- .1 Complete assembled air handling units shall be factory tested by Manufacturer at factory and field tested by the Contractor and his Ventilation Subcontractor as an assembly to ensure compliance with these specifications.
- .2 The Manufacturer shall notify the NRC Representative one (1) week prior to scheduled factory tests. The NRC Representative will inform the Manufacturer if a representative is to witness the tests.

### **4.2 AIR LEAK TESTS**

- .1 The Ventilation Contractor shall hire a certified AABC test agency to test and verify tightness of each air handling unit manufactured and installed as per these specifications. The certified agency shall conduct all tests in accordance with the Associated Air Balance Council and the National Standards for Field Measurement and Instrumentation.
- .2 The allowable air leak of an air handling unit, measured in L/s, shall not exceed 1% of the highest designed L/s at the fan design internal static pressure and shall not be less than 1000 Pa w.g. (positive and negative).

- .3 With an appropriate test apparatus connected to the air handling unit, air leakage test apparatus shall hold negative and positive pressures for 15 minutes before reading any L/s leakage.
- .4 The NRC Representative shall be present at the pressure test.
- .5 Excessive leakage to be corrected in factory and air leakage tests repeated. All testing and corrections are to be performed in the presence of various representatives and witnesses to ensure acceptable test results before shipping and final start-up of units or modules.

#### **4.3 VIBRATION TESTS**

- .1 The unit fans shall be operated at the design rpm and a complete vibration spectrum shall be conducted. Such tests must be performed on all completely assembled units including all components. Unit manufacturer shall demonstrate compliance with all of the fan manufacturer's recommended vibration tolerances, but never less than requirements from ISO 2631 and 3945 standards.
- .2 Vibration signatures shall be taken for all fans and motor bearings.
- .3 For all systems, vibration signature of all fans and all fans' motor bearings are to be taken after the system has been installed and set to its normal operating conditions.
- .4 Maximum vibration acceptance criteria for displacement measurements on the fan in the vertical, axial and horizontal directions is the "Smooth line" on the fan manufacturer's Rathbone Balancing Chart (ref.: Peak-to-Peak vibration amplitude of 0.7 mils at 1,800 rpm). Perform all required balancing work required to respect acceptance criteria.
- .5 The results are to be submitted in a hard copy report.

#### **Part 5 Start-up**

- .1 Unit start-up and field performance testing shall be provided by the Subcontractor. The intent of this testing is to provide field verification of factory performance testing and to ensure that the air handling equipment and associated components are operating within the design parameters. The unit manufacturer shall be responsible for any corrective work necessary to meet the specified performance criteria.
- .2 Air handling unit shall be rigged and set in place on the job by the Contractor as detailed by the air handling unit manufacturer.
- .3 Air handling unit manufacturer shall provide field supervision by qualified factory personnel during start-up of the units.
- .4 After complete installation, the following verifications shall be done by the Contractor, supervised by the Manufacturer:
  - .1 Install all parts shipped loose.
  - .2 Check isolation inertia base and spring isolators.
  - .3 Check flexible connections at fan outlet.

- .4 Check and re-align all access doors and dampers to ensure smooth operation through the entire operating position range.
- .5 Upon start-up, each fan motor is to be checked for fan rotation and amp drawn for each phase. Amp readings are to be marked on the fan scroll.
- .6 All belt drives are to be re-adjusted for tension alignment and air flows.
- .7 Verify adjustable flow dampers for proper operation between maximum and minimum positions.
- .5 The following readings/tests shall be done by the Contractor:
  - .1 Functional testing of all unit components.
  - .2 Motor voltage and amperage.
  - .3 Vibration levels for motors/fans.
  - .4 Airborne noise level.
  - .5 Radiated noise level.
  - .6 Verification of design cfm.
  - .7 Unit static pressure profile at design cfm.
  - .8 The fans shall be statically and dynamically balanced after their field installation.

**END OF SECTION**

**Part 1          General**

**1.1            SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for steam injection mechanical, atomizing, plenum mounted drum, plenum or duct mounted pad, packaged electrode steam generating, packaged, gas fired, steam generator type humidifiers and accessories.
- .2 Related Sections:
  - .1 Section 00 10 00 – General Instructions.
  - .2 Section 00 15 45 – General Safety Section & Fire Instructions.
  - .3 Section 23 31 13.01 - Metal Ducts - Low Pressure to 500 Pa.

**1.2            REFERENCES**

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

**1.3            SUBMITTALS**

- .1 Submittals in accordance with Section 00 10 00 – General Instructions.
- .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 00 10 00 – General Instructions.



**1.4 HEALTH AND SAFETY**

- .1 Proceed with necessary measures in terms of health and safety in construction site as specified in section Section 00 15 45 – General Safety Section & Fire Instructions.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Waste Management and Disposal:
  - .1 Separate waste materials in accordance with Section 00 10 00 – General Instructions.

**1.6 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 00 10 00 – General Instructions.
  - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing, for inclusion into operating manual.
  - .3 Provide following: one complete set of renewable evaporator media.

**Part 2 Products**

**2.1 STEAM TO STEAM HUMIDIFIER**

- .1 CSA certified and ULC listed.
- .2 Steam to steam humidifier as described on mechanical drawings.
- .3 Complete unit with the following components:
  - .1 Stainless steel 304 evaporation chamber
  - .2 Copper steam heat exchanger
  - .3 Electronic water level control
  - .4 Steam electric modulating valve
  - .5 Access cover
  - .6 Control panel prewired in factory
  - .7 Support
  - .8 Cabinet thermal insulation
  - .9 Solid state panel.

- .10 Touch screen controller with intuitive color user interface.
  - .11 BMS communication protocols BACnet MSTP with Web and USb Interface.
  - .12 Modulating steam output of 20%-100%.
  - .13 Internal Drain Water tempering to 140°F (60°C) or less.
  - .14 Header SAM-e with insulation and Inlet kit.
  - .15 Solenoid valve on water and drain lines.
  - .16 Duct humidistat.
  - .17 Airflow proving switch.
  - .18 Adjustable flush cycle timer.
  - .19 Amp meter.
  - .20 Cylinder replacement indicator light.
- 
- .4 Components housed in factory fabricated cabinet with factory enameled finish and electrically interlocked door.
  - .5 Factory sealed disposable steam cylinder complete with factory installed electrodes to suit water condition.
  - .6 Duct distribution header complete with condensate drain and supply hose.
  - .7 Drane cooler.
  - .8 Capacity and characteristic on drawings.
  - .9 Product: Dristeem or approved equivalent.

**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 Humidifier and evaporator media to be new and clean when project is accepted.
- .3 Install humidistat as indicated in accessible location.

- .4 Water service overflow drain: to manufacturers' recommendation.
- .5 Install access doors or panels in adjacent ducting.
- .6 When installing in ducting, provide waterproof duct up and downstream in accordance with Section 23 31 13.01 - Metal Ducts - Low Pressure to 500 Pa.
- .7 Install capped drain connection at low point in duct.

### **3.3 FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
  - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its product[s] 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 Ministry Representative
- .2 Performance Verification (PV):
  - .1 General: in accordance with Section 00 10 00 – General Instructions.
  - .2 Timing:
    - .1 After TAB of ducted air systems.
    - .2 At same time as PV of related air handling units.
  - .3 PV procedures:
    - .1 Packaged Electrode Steam Generating type
- .3 Start-up:
  - .1 General: in accordance with Section 00 10 00 – General Instructions.

- .4 Commissioning Reports:
  - .1 General: in accordance with Section 00 10 00 – General Instructions. Include:
    - .1 PV results on approved PV Report Forms.
    - .2 Product Information Report Forms.

**3.4 DEMONSTRATION**

- .1 Training: in accordance with Section 00 10 00 – General Instructions.

**3.5 CLEANING**

- .1 Perform cleaning operations as specified in Section 00 10 00 – General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

<b>1.1</b>	<b>GENERAL</b> .....	<b>1</b>
<b>2.1</b>	<b>AIR HANDLING SYSTEMS AHU-04 – MAIN VENTILATION SYSTEM</b> .....	<b>2</b>
<b>2.2</b>	<b>ROOM CONTROL – SINGLE DUCT AND VARIABLE VOLUME UNITS, TERMINAL HEATING AND PERIMETER HEATING</b> .....	<b>4</b>
<b>2.3</b>	<b>STAIRWELL CABINET UNIT HEATERS</b> .....	<b>6</b>

**Part 1 GENERAL DESCRIPTIONS**

**1.1 GENERAL**

- .1 Coordination: EMCS contractor shall provide all control valves, temperature sensors, pressure sensors, control valve actuators, damper actuators, control wiring, emt conduit and all other accessories necessary to make the EMCS function as per the sequences below. Coordinate with mechanical contractor for location of all control devices. Mechanical contractor shall install all control valve and associated wells for controls sensors.
- .2 Consult Owner in order to obtain all schedules of events, schedules of various modes and to perform programming.
- .3 All operation parameters such as set points, data for adjusting tables, proportional, integral and derivative gains, etc., shall be programmed as variables in order to easily modify them without having to modify programming.
- .4 All proportional, integral and derivative gains shall be adjusted until each control loop is approved by NRC Representative.
- .5 Each motor must include a programmable parameter allowing sequential start-up of all motors following a power failure in order to avoid overloads. This parameter also applies to system re-start after a fire alarm. Contractor to demonstrate to NRC Representative that the parameter to be programmed complies with approved sequence upon power return. Furthermore, each motor's running time is to be calculated and displayed with runtime alarms upon operator request. A motor's running time can be reset to zero via operator command.
- .6 Supply, installation and connection of all electrical relays, interlocks, converters and other accessories required in order to meet operation sequences described in this section are the responsibility of present Contractor.
- .7 Any transition of set point or operation mode to another shall take place progressively in order to avoid abrupt operations. Transition time shall be adjustable according to application.
- .8 All alarms related to a system shall be deactivated when system is off. Moreover, an adjustable time period shall allow delay of activation of alarm function upon system start-up.
- .9 All flow values indicated on drawings and in this section shall not be considered as accurate. The Contractor shall obtain accurate values from ventilation, heating, cooling, and domestic hot water shop drawings; if in doubt, verify with NRC Representative.

- .10 All readings from flow measuring devices (including coil differential pressure flow readings) are provided with adjustable dampening and mean average computation to achieve control loop stability.
- .11 When two or more components are to be used to perform the same task, an alternating sub-routine shall allow equal wear of both components. Moreover, operator shall be able to provide each component with desired operation priority.
- .12 Program all alarms related to the temperature and relative humidity of rooms and systems according to Owner's parameters list.
- .13 Program all alarms related to filter alarms for differential pressure sensors (on air and water systems).
- .14 Program high and low level alarms for all analog inputs. Status alarms will be programmed for digital points when control and status are available.
- .15 The Controls Contractor shall be responsible for verifying the operation of each instrument he controls, even if supplied by others.
- .16 All values will be programmed as a variable and can be changed easily on the screen of the EMCS computer.
- .17 Air flow indication must be zero if the fans are stopped.
- .18 All VAV boxes are to completely close their dampers when the flow set point is zero. The damper must not stop closing when the flow reading is zero; the actuator must close completely to 0% (closed) when the flow requirement is zero.

## **Part 2 Operating Sequences**

### **2.1 AIR HANDLING SYSTEMS AHU-04 – MAIN VENTILATION SYSTEM**

- .1 Required Sensors:
  - .1 AI - Supply air temperature sensor.
  - .2 AI - Return air temperature sensor.
  - .3 AI - Outdoor air temperature sensor.
  - .4 AI - Supply air humidity sensor.
  - .5 AI - Return air humidity sensor.
  - .6 AI - Outdoor air humidity sensor.
  - .7 AI - Freeze stat.
  - .8 AI - Pre-filter differential pressure sensor.
  - .9 AI - Final filter differential pressure sensor.
  - .10 AI - Supply ductwork pressure sensor.
  - .11 AI – Airflow measuring stations #1 (return)
  - .12 AI – Airflow measuring stations #2 (return)
  - .13 AI – Airflow measuring stations #3 (OA)

- 
- .2 Required control points:
- .1 AO - Cooling control valve.
  - .2 AO - Heating Control Valve.
  - .3 AO – Humidifier steam control valve.
  - .4 DO – Humidifier ON/OFF.
  - .5 Supply Fan VFD. Start, Stop, Status, Alarm, VFD speed.
  - .6 Return Fan VFD #1. Start, Stop, Status, Alarm, VFD speed.
  - .7 Return Fan VFD #2. Start, Stop, Status, Alarm, VFD speed.
  - .8 Heating pump. Start, Stop, Status.
  - .9 Outside air, return air and exhaust air dampers.
- .3 AHU-04 shall energize ON as per the owner occupancy schedule. Supply fan shall energize ON and shall ramp up over a period of 1 min seconds. After 30 seconds return fan shall energize on and shall ramp up over a period of 1 min.
- .4 Supply Fan VFD control: AHU supply fan shall VFD modulate to maintain ductwork static pressure of 175Pa. (adjustable). Location of static pressure sensor shall be approximately  $\frac{3}{4}$  distance away from AHU along longest ductwork run. Coordinate with air balancer to adjust duct static pressure appropriately to provide full airflow at maximum speed at furthest diffuser.
- .5 Return fan VFDs control: AHU return fan shall track supply fan to a maximum of 10% less than supply fan speed.
- .6 Supply Air: Supply air shall be 12.7°C (adjustable).
- .7 Enthalpy Control: EMCS shall modulate the outdoor air damper (OAD), exhaust air damper (EAD) and the mixing air damper (MAD) based on outdoor air enthalpy conditions to maximize the use of free cooling.
- .8 Control Valve: Modulate AHU associated chilled water and heating water control valves to maintain supply air temperature.
- .9 Provide sampling of all VAV boxes. If more than 50% of VAV boxes are at minimum position increase supply air temperature by 2°C for a period of 20 minutes. If boxes are still at minimum position continue to increase supply air temperature by 2°C every 20 minutes until boxes.
- .10 Freeze Protection: Provide freeze stat upstream of heating coil and downstream of heating coil before cooling coil. EMCS shall monitor temperature downstream of heating coil. If air temperature falls below 4 deg C for a period of more than 1 min close OAD and provide alarm at EMCS. If temperature does not rise above freezing temperatures after 1 min AHU shall shut down and provide alarm at EMCS. Alarm should use manual reset. Freeze protection should be wired directly to the fan's VFD.
- .11 Humidification Control: EMCS shall provide humidity control sensor in return air ductwork. EMCS shall energize humidifier HUM-01 on during winter months November – April. Modulate new humidifier to maintain a maximum return air humidity of 50% relative humidity (adjustable).

- .12 Outside air dampers should be equipped with double contact limit switch actuators.
- .13 Filter Monitoring: Provide filter differential pressure sensor around both pre-filter section and final filter section. Provide dirty filter alarm at EMCS.
- .14 Alarms: Provide the following alarms:
  - .1 Freeze Alarm.
  - .2 Dirty filter alarm.
  - .3 Supply fan VFD general alarm
  - .4 Return fan VFD #1 general alarm.
  - .5 Return fan VFD #2 general alarm.
  - .6 Humidifier general alarm.
  - .7 Supply air temperature alarm.
  - .8 Return air humidity alarm.
  - .9 Heating pump.

## **2.2 ROOM CONTROL – SINGLE DUCT AND VARIABLE VOLUME UNITS, TERMINAL HEATING AND PERIMETER HEATING**

- .1 Required Sensors:
  - .1 AI – Space temperature sensor.
- .2 Required control points:
  - .1 AO – VAV heating coil control valve.
  - .2 AO – Perimeter heating control valve.
  - .3 AO – VAV Controller. Position, airflow, Alarm.
- .3 This sequence applies to single duct VAV boxes.
- .4 General description:
  - .1 Each room is supplied by a variable air volume box.
  - .2 The air flow set points are adjusted based on occupied mode.
  - .3 Each room thermostat displays actual temperature, set point, override button and network connection.
- .5 Occupied-Unoccupied mode:
  - .1 Occupied mode:
    - .1 Occupied mode shall be as per owner occupancy schedule. Occupied mode can also be activated by a thermostat override button by the user and will be maintained for a programmable length of time.



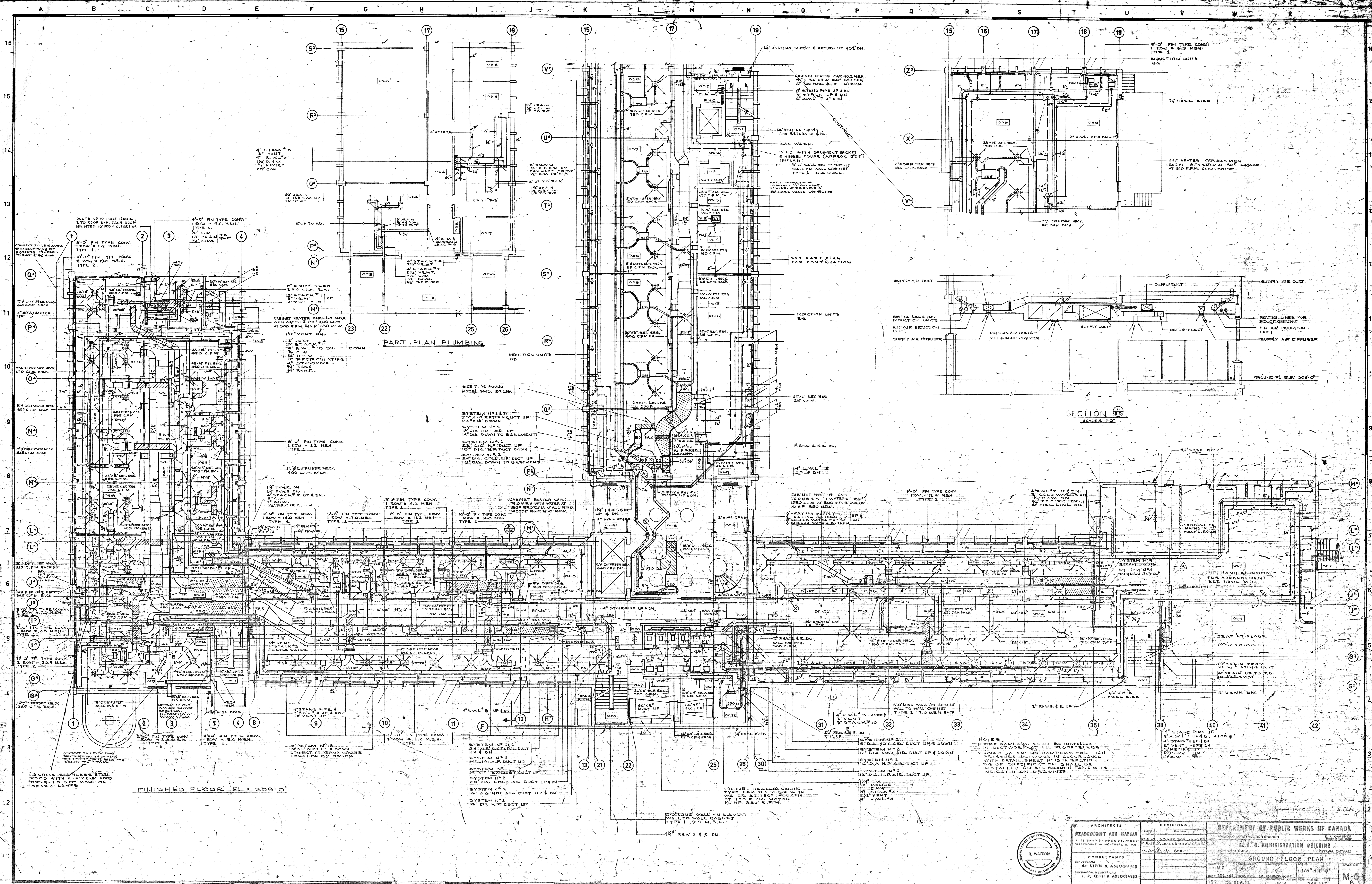
- 
- .2 The box's supply air volume is variable flow (see schedules on drawings)
  - .3 The temperature set point is equivalent to the temperature set point in occupied mode:
    - .1 The set point is determined at the thermostat by the user with possible adjustment of +/-1°C from the programmed set point.
    - .2 Cooling set point = 24°C (adjustable)
    - .3 Heating set point = 22°C (adjustable)
  - .2 Unoccupied mode:
    - .1 The box's minimum supply air flow set point is reduced (see schedule on drawings taking into consideration values to be programmed, see section 2.8.2.2).
    - .2 The temperature set point is equivalent to the temperature set point in unoccupied mode:
      - .1 Cooling set point in unoccupied mode = 25°C (adjustable)
      - .2 Heating set point in unoccupied mode = 18°C (adjustable)
  - .6 Heating & Cooling Control
    - .1 Spaces are equipped with perimeter heating. Perimeter heating is controlled via 2way valves.
    - .2 Perimeter VAV's are equipped with heating coils. Reheat coils are controlled via 2 way valves.
    - .3 VAV controller shall determine if space requires heating or cooling based on space temperature sensor.
    - .4 VAV controller shall energize heating control valves at perimeter heating and VAV heating coil to maintain space temperature.
  - .7 Cooling Set point readjustment signal:
    - .1 The VAV network will forward information between the boxes and their associated AHU in a bidirectional manner to optimize system conditions in order to maintain satisfactory control.
    - .2 Valve opening and flow for each VAV boxes are displayed and recorded.
    - .3 This information will reset supply temperature and static pressure set points when the systems approach their system limits.
    - .4 For greater detail, refer to VAV boxes reset signal operating sequences.

- .8 Heating Set Point readjustment signal:
  - .1 VAV's are equipped with reheat coil. VAV controller shall determine if space requires heating or cooling.
- .9 System on:
  - .1 The VAV box's controller shall modulate the volume of cool air supplied to the space to maintain the ambient temperature at its set point.
  - .2 The flow is maintained by independent pressure control.
- .10 Emergency or maintenance mode:
  - .1 Upon activation of emergency electrical power (generator started), the VAV box remains activated.
  - .2 When supply unit AHU-04 stops, the VAV box remains activated.
- .11 Protection:
  - .1 None.
- .12 Alarms:
  - .1 High and low temperature alarms and flow reading alarms. Temperature alarms to be floating based on their respective set points. Flow alarms are activated after a programmable time delay only when the box is in occupied mode.

### **2.3 CABINET UNIT HEATERS**

- .1 EMCS shall energize cabinet unit heater supply fan ON and OFF to maintain space temperature of 20°C (adjustable). Provide Alarm at EMCS if associated space temperature ever falls below 10°C.

**END OF SECTION**



**PART PLAN PLUMBING**

**SECTION 10**  
SCALE 1/4" = 1'-0"

FINISHED FLOOR EL. 309'-0"

NOTES:  
 1. PIPES DAMPERS SHALL BE INSTALLED IN ALL DUCTWORK AT ALL FLOOR CLASSES.  
 2. ROUND BALANCING DAMPERS FOR HIGH PRESSURE DUCTWORK IN ACCORDANCE WITH DETAIL SHEET H-15 IN SECTION 36 OF SPECIFICATION SHALL BE INSTALLED ON ALL BRANCH TAKE OFFS INDICATED ON DRAWINGS.

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CONSULTANTS		APPROVED BY		GROUND FLOOR PLAN	
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