

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and General Requirements Specification Sections, apply to this Section.
- .2 Related Sections:
 - .1 Sequence of Operations - see drawings.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA):
 - .1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics DTIR Site Representatives (IEEE):
 - .1 ANSI/IEEE 260.1-2004, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - .1 ASHRAE STD 135-R2008, BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA International):
 - .1 CAN/CSA-Z234.1- (R2006), Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA):
 - .1 CEA-709.1-C-2010, Control Network Protocol Specification.
- .6 Department of Justice Canada (Jus):
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

- .7 Electrical and Electronic Manufacturers Association (EEMAC):
 - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .9 Transport Canada (TC):
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .10 Standard Construction Contract Documents - Version 2008.

1.3 ACRONYMS AND ABBREVIATIONS

- .1 Acronyms used in existing Delta DDC system on campus.

1.4 SUMMARY

- .1 This Section includes the EMCS (Energy Management Control System) equipment for HVAC systems and components, including open protocol control components for HVAC functions.
- .2 The control system shall be as shown and consist of a high-speed, peer-to-peer network of Direct Digital Control (DDC) controllers and an operator workstation residing and communicating on a BACnet/MSTP. The operator workstation shall be a personal computer (PC) with a colour monitor, mouse, keyboard and printer. The (PC) will allow a user to interface with the network via multi-tasking dynamic color graphics. Each mechanical system, building floor plan, and control device will be depicted by point-and-click graphics. Systems using gateways to route proprietary devices and objects to BACnet are not acceptable. Graphics shall match flow schematics outlined on drawings.
- .3 All further references within this section to the term "network", unless specifically excepted, refers to the BACnet network between the DDC panels referenced within these specifications.
- .4 Provide EMCS for all HVAC functions. Refer to schematics, floor plans, point list and sequence of operation.

1.5 CODES AND STANDARDS

- .1 All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids of the following codes:
 - .1 Canadian Electrical Code (2015).
 - .2 National Building Code (2015).
 - .3 ASHRAE 135-2001.
 - .4 FCC Regulation, Part 15- Governing Frequency Electromagnetic Interference.
 - .5 Underwriters Laboratories UL916.

1.6 SYSTEM PERFORMANCE

- .1 Performance Standards. The system shall conform to the following:
 - .1 Graphic Display: The system shall display a graphic with 20 dynamic points/objects with all current data within 10 seconds.
 - .2 Graphic Refresh: The system shall update a graphic with 20 dynamic points/objects with all current data within 10 seconds.
 - .3 Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.
 - .4 Object Scan: All changes of state and change of analog values will be transmitted over the high-speed Ethernet network such that any data used or displayed at a controller or workstation will have been current within the previous 2 seconds.
 - .5 Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.
 - .6 Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 1 second. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

- .7 Performance: Programmable controllers shall be able to execute DDC PID control loops at a frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
- .8 Multiple Alarm Annunciation: All workstations on the network must receive alarms within 5 seconds of each other.
- .9 Reporting Accuracy: The system shall report all values with an end-to-end accuracy equal to or better than those listed in Table 1.
- .10 Stability of Control: Control loops shall maintain measured variable at setpoint within the tolerances listed in Table 2.

.2 TABLE 1: Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C
Ducted Air	±0.5°C
Outside Air	±1.0°C
Dewpoint	±1.5°C
Water Temperature	±0.5°C
Delta-T	±0.15°C
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Air Pressure (ducts)	±25 Pa
Air Pressure (space)	±3 Pa
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power factor)	5% of reading
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm
Note 1: 10%-100% of scale	
Note 2: For both absolute and differential pressure	
Note 3: Not including utility-supplied meters	

.3 TABLE 2: Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	± 50 Pa ± 3 Pa	0-1.5 kPa -25 to 25 Pa
Airflow	$\pm 10\%$ of full scale	
Temperature	$\pm 0.5^{\circ}\text{C}$	
Humidity	$\pm 5\%$ RH	
Fluid Pressure	± 10 kPa	0-1 kPa
" " differential	± 250 Pa	0-12.5 kPa

1.7 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Submittals and Review Process.
- .2 Submit for review:
 - .1 Equipment list and systems manufacturers within 10 days after award of contract.
 - .2 List existing field control devices to be re-used included in tender, along with unit price.
- .3 Quality Control:
 - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
 - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
 - .3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Submittals and Review Process. Label or listing of specified organization is acceptable evidence.

- .4 In lieu of such evidence, submit certificate from testing organization, approved by Site Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
- .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
- .6 Permits and fees: in accordance with general conditions of contract.
- .7 Submit certificate of acceptance from authority having jurisdiction to Department Representative.
- .8 Existing devices intended for re-use: submit test report.

1.8 COORDINATION

- .1 Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- .2 Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panelboards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.
- .3 Coordinate supply of conditioned electrical circuits for control units and operator workstation.
- .4 Coordinate with the Department's IT department on locations for UNC's, Ethernet communication cabling and TCP/IP addresses

1.9 OWNERSHIP OF PROPRIETARY MATERIAL

- .1 The Department Representative shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Department Representative as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software. All project developed software and documentation shall become the property of the Department Representative.

These include, but are not limited to project graphic images, record drawings, project database, project specific application programming code, and all other associated documentation.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

- .1 Manufacturers Agent/Product: Subject to compliance with requirements, provide products by the following pre-qualified manufacturers:
 - .1 Delta.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Installation: to manufacturer's recommendations.
- .2 Installation by a manufacturers authorized product dealer and supplier.

3.2 MISCELLANEOUS REQUIREMENTS

- .1 Air Handler devices shall be accessible.

3.3 WIRING AND RACEWAYS

- .1 General: Provide copper wiring, plenum cable, and raceways as specified.
- .2 All insulated wire to be copper conductors. UL labelled for 90C minimum service.
- .3 Electrical work shall be in accordance with Canadian Electrical Code, latest edition, Electrical wiring, terminal blocks and other high voltage contacts shall be fully enclosed or properly guarded and marked to prevent accidental injury to personnel.
- .4 All wiring in mechanical rooms and ceiling spaces shall be in accordance with the latest edition electrical code. Conformance with this code will be the responsibility of the Contractor.

- .5 Low voltage wiring must be run in conduit unless Department Representative approves it to be run above suspended ceilings. All wiring under this section shall be by this contractor and shall include furnishing labour and miscellaneous material to make connections for all wiring related to the programmable controller.
 - .1 All wiring shall be concealed in cable tray or conduit from the stand-alone control panel to the ceiling space (as high as possible). Conduit is required in all areas.
 - .2 Low voltage wiring shall not be run in conduit containing high voltage wiring.
 - .3 Communication or shielded control wiring shall be installed away from high voltage wiring where possible.
 - .4 Provide all power wiring in EMT conduit.
 - .5 Identify each wire and cable in a permanent manner with wire numbers referenced to EMCS hardware address.
 - .6 Network (communication) wiring shall be run separately from other wiring.
 - .7 All control wiring to comply with manufacturers recommendations.
 - .8 Controls contractor to provide and install relays in motor starter's control circuit wiring as required to allow EMCS control.
 - .9 All control wiring to be yellow in color.
 - .10 120V receptacles to be placed within 10 feet of new control panels.**
 - .11 When the Subcontractor is interfacing into existing starters with hand-off-auto switches, it is the responsibility of the Subcontractor to ensure that the piece of equipment which they are controlling from the starter, the Department Representative can override the S.A.C.P. signal and operate the equipment in the hand position.
 - .12 Where there is a start/stop switch in place of a starter, the Contractor shall provide for manual override capability. S.A.C.P. (Stand Alone Control Panel) LED modules with HOA switch are acceptable providing the manual starter label reads "Manual Override within S.A.C.P. #". (Lamacoid Label Required).

- .13 All AHU heating coil valves shall be wired for fail safe operation. (i.e. heating controls to normally open position, cooling and outside air dampers fail to normally closed position).
- .14 Provide 120V, 15A power to each control panel from distribution panel and provide new locking circuit breakers. If emergency power exists, control panel shall be connected to the emergency power circuit.
- .15 All networking and control device wiring to be continuous wire runs only, no splicing is permitted.
- .16 All I/O wiring passing near or within the enclosure of a VFD will be shielded, with the shield terminated at the controller end.
- .17 All I/O wiring will be suitably identified using adhesive wire-marker or equivalent at the controller end.
- .18 All I/O wiring within controller enclosure shall be neat and tidy and suitably bundled and strapped or contained in wire duct or equivalent.
- .19 All I/O wiring that requires a transition to a different conductor to meet electrical code requirement shall be executed using a terminal strip. Marret connections are not acceptable for any connection other than to connect low-voltage pigtails at the device end (e.g. Thermistors, 24 VAC/VDC transducers, actuators, etc.).
- .20 Low voltage I/O wiring may be mixed together within a conduit.
- .21 Power Wiring:
 - .1 Provide power wiring and transformers and ground to each controller and transducer as per the manufacturer's specifications.
 - .2 Each Building Controller will have its own dedicated power supply. No other controller or I/O device will be powered from this supply.
 - .3 Custom Application Controllers may share a common power supply, but this supply will not be used for any other device (e.g. I/O devices).
 - .4 Power wiring shall not be mixed with I/O wiring in a conduit.
- .22 All control wiring to have a one (1) year warranty.

.23 Wiring in plenum spaces to be FT6 or in conduit.

3.4 EXAMINATION

- .1 The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Department Representative for resolution before rough-in work is started.
- .2 The Contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Department Representative for resolution before rough-in work is started.
- .3 The Contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the Contractor's work, and the plans and the work of others - the Contractor shall report these discrepancies to the Department Representative and shall obtain written instructions for any changes necessary to accommodate the Contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the Contractor to report such discrepancies shall be made by and at the expense of this Contractor.

3.5 PROTECTION

- .1 The Contractor shall protect all work and material from damage by its work or employees, and shall be liable for all damage thus caused.
- .2 The Contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted. The Contractor shall protect any material that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.6 COORDINATION

- .1 Site:
 - .1 Where the mechanical work will be installed in close proximity to, or will interfere with work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. If the Contractor installs its work before coordinating with other trades, so as to cause any interference with work of other trades, the Contractor shall make the necessary changes in its work to correct the condition without extra charge.
 - .2 Coordinate and schedule work with all other work in the same area, or with work which is dependent upon other work, to facilitate mutual progress.
- .2 The Contractor shall furnish all tools necessary to interface to the control system for test and balance purposes.
- .3 Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the Contractor as follows:
 - .1 Each supplier of controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
 - .2 This Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other sections or divisions.

3.7 GENERAL WORKMANSHIP

- .1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- .2 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- .3 Install all equipment in readily accessible locations as defined by Canadian Electrical Code (latest version).

- .4 All wiring shall be verified for its integrity to ensure continuity and freedom from shorts and grounds.
- .5 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.8 FIELD QUALITY CONTROL

- .1 All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.
- .2 Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- .3 Contractor shall have work inspected by local and provincial authorities having jurisdiction over the work.

3.9 WIRING INSTALLATION

- .1 All control and interlock wiring shall comply with national and local electrical codes.
- .2 All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway per NEC.
- .3 All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit).
- .4 Where NEC Class 2 (current-limited) wires are in concealed and accessible locations including ceiling return air plenum, approved cables not in raceway may be used, provided that cables are UL listed for the intended application. For example, cables used in ceiling plenum shall be UL listed specifically for that purpose.
- .5 All wiring in mechanical, electrical, or service rooms or where subject to mechanical damage shall be installed in raceway at levels below 3m.

- .6 Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- .7 Do not install wiring in raceway containing tubing.
- .8 Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it, and neatly tied at 2m intervals.
- .9 Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- .10 All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- .11 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- .12 Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Contractor shall provide step-down transformers.
- .13 All wiring shall be installed as continuous lengths, with no splices permitted between termination points/objects.
- .14 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- .15 Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendation and Canadian Electrical Code requirements, except as noted elsewhere.
- .16 Include one pull string in each raceway 2.5 cm or larger.
- .17 Use coded conductors throughout with different coloured conductors.

- .18 Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- .19 Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm from high-temperature equipment (e.g., steam pipes or flues).
- .20 Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- .21 Adhere to Electrical Code requirements where raceway crosses building expansion joints.
- .22 Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
- .23 The Contractor shall terminate all control and/or interlock wiring, and shall maintain updated (as-built) wiring diagrams with termination identified at the job site.
- .24 Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 1 m in length and shall be supported at each end. Flexible metal raceway less than ½" electrical trade size shall not be used. In areas exposed to moisture including chiller and boiler rooms liquid-tight, flexible metal raceways shall be used.
- .25 Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (per code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.
- .26 FT6 wiring must be used where wires are run through a space used as a plenum. Controls wiring to meet manufacturers recommend installation guidelines.

END OF SECTION