Part 1 General

1.1 SECTION INCLUDES

.1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:

.1 Start-up testing and verification of systems.

.2 Check out demonstration or proper operation of components.

.3 On-site operational tests.

1.2 RELATED SECTIONS

.1 Division 01 – General Requirements.

.2 Section 21 05 01 – Common Work Results for Mechanical.

.3 Section 25 05 01 - EMCS: General Requirements.

.4 Section 26 05 01 – Common Work Results for Electrical.

1.3 DEFINITIONS

.1 Design Criteria: All pertinent information for the design, including key assumptions and limitations including such as temperature, occupancy, codes, references and indoor air quality.

.2 Design Intent: a detailed explanation of the ideas, concepts and criteria that are defined by the Owner to be important.

.3 PID – Proportional, Integral and Derivative.

1.4 CONTROLS VERIFICATION

.1 EMCS contractor shall test each point system, and sequence, and submit verification reports to satisfaction of Owner's Representative.

.2 Reports required:

.1 Point Verification Report. – See Appendix II.

.2 Above noted report shall be submitted prior to interim inspection, or substantial performance.

1.5 DESIGN REQUIREMENTS

.1 Confirm with Owner's Representative that Design Criteria and Design Intents are still applicable.

.2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.6 SUBMITTALS

.1 Submittals in accordance with:

.1 Division 01 – General Requirements.

.2 Section 21 05 01 – Common Work Results for Mechanical, Part 1.5.

.2 Final Report: submit report to Owner's Representative:

.1 Include measurements, final settings and certified test results.

.2 Bear signature of commissioning technician and supervisor

.3 Report format to be approved by Owner's Representative before commissioning is started.

.4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Owner's Representative in accordance with Section 01 78 00 - Closeout Submittals.

.5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.7 CLOSEOUT SUBMITTALS

.1 Provide documentation, O&M Manuals, and training of O&M personnel for review by Owner's Representative before interim acceptance in accordance with Section 01 78 00 – Closeout Submittals.

1.8 CONTROL SYSTEM CHECKOUT AND TESTING

.1 Start-up Testing: All testing listed in this article shall be performed by the Contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner's Representative is notified of system demonstration and before the Commissioning Agent is to perform the functional performance testing.

.1 The Contractor shall furnish all labour and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.

.2 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

.3 Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers' recommendations.

.4 Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

.5 Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The Contractor shall check all control valves and automatic dampers to ensure proper action and closure. The Contractor shall make any necessary adjustments to valve stem and damper blade travel.

.6 Verify that the system operation adheres to the Sequences of Operation.

.7 Alarms and Interlocks:

.1 Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

.2 Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

.3 Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

.8 Mechanical deficiencies which may inhibit operation/control of the mechanical systems shall be brought to the attention of Owner's Representative.

1.9 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

.1 Demonstration:

.1 Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed its own tests.

.2 The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" in this specification. The Owner's Representative will be present to observe and review these tests. The Owner's Representative shall be notified at least 10 days in advance of the start of the testing procedures.

.3 The demonstration process shall follow that approved in "Submittals". The approved checklists and forms shall be completed for all systems throughout the demonstration.

.4 The contractor shall provide at least two persons equipped with two-way communication, and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes.

The purpose is to demonstrate the calibration, response, and action of every point/object and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.

.5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed. This will form part of the **"Point Verification Report" Appendix II**. Verification of all input/output points with regards to proper operation. Owner's Representative will inspect 100% of all points for physical installation, including conduit, wire, labels, connections, etc. Owner's Representative commissioning agent may choose to randomly inspect 50% of each point type for input/output response. Any failure will result in termination of inspection and future 100% inspections will be at the contractor's cost.

.2 Final Acceptance:

.1 This phase shall consist of verifying to Owner's Representative that the deficiencies as identified during "Demonstration" have been rectified. If deficiencies are still found, the Contractor will have one week to correct them and costs for additional inspection shall be billed to the contractor.

.2 Demonstrate compliance with "System Performance".

.3 Demonstrate and simulate compliance with Sequences of Operation through all modes of operation.

.4 Demonstrate complete operation of Operator Interface.

.5 Additionally, the following items shall be demonstrated:

.1 DDC Loop Response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in setpoint, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the setpoint, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the contractor.

.2 Optimum Start/Stop. The contractor shall supply a trend data output showing the capability of the algorithm. The hour-by-hour trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

.3 Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the Owner's Representative. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

.4 A power failure for the building will be simulated and proper system operation and recovery observed.

.3 Any tests that fail to demonstrate the proper operation of the system shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

.4 **Point Verification Reports Appendix II –** To be completed by the contractor and forwarded to the Owner's Representative prior to completing Demonstration. Owner's Representative will provide blank forms in Microsoft Excel format to the contractor as requested.

.5 The Owner's Representative will require testing, verification, of all commissioning for all points, and full simulation of all sequences. This contractor is to commit the necessary resources, manpower, and devices (example - radios) to allow Owner's Representative to complete commissioning.

.6 All software, database files, modem, phone number and instruction must be provided to Owner's Representative 10 days in advance of inspections.

.7 All repeat testing and commissioning due to noncompliance to specification will be at the contractor's expense.

.8 All tests described in this specification shall have been performed to the satisfaction of both the Owner's Representative prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the Owner's Representative. Such tests shall then be performed as part of the warranty.

.9 The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

1.10 CLEANING

.1 The contractor shall clean up all debris resulting from its activities daily. The contractor shall remove all cartons, containers, crates, etc., under its control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

.2 At the completion of work in any area, the contractor shall clean all of its work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

.3 At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

Part 2 Products

2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.

.2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.

.3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.

.4 Locations to be approved, readily accessible and readable.

.5 Application: to conform to ASHRAE Guideline 0-2013 – The Commissioning Process and Guideline 1.1 – 2007 – The HVAC Commissioning Process.

Part 3 Execution

3.1 PROCEDURES

.1 General: test installation of each system part after completion of mechanical and electrical hook-ups, to verify correct installation and function.

.1 Test each system independently and then in unison with other related systems.

.2 Commission each system using procedures prescribed by the Owner's Representative.

.3 Commission integrated systems using procedures prescribed by Owner's Representative.

.4 Debug Programming.

.5 Optimize operation and performance of systems by fine-tuning PID values and modifying programming as required.

.6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each analog to digital convertor.

.3 Test and calibrate each analog input using calibrated digital instruments.

.4 Test each binary input to ensure proper settings and switching contacts.

.5 Test each binary output to ensure proper operation and lag time.

.6 Test each analog output to ensure proper operation of controlled devices. Verify tight closure and signals.

.7 Test operating software.

.8 Test application software and provide samples of logs and commands.

.9 Debug software.

.10 Provide point verification list in table format including point identifier, point commissioning technician and Owner's Representative comments. This document will be used in final start-up testing.

.3 Demonstration: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Owner's Representative and provide:

.1 Two technical personnel capable of re-calibrating field hardware and modifying software.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 Owner's Representative Acceptance signature to be on executive and applications programs.

.4 Demonstration testing is to be in accordance with the following conditions:

.1 Commissioning to commence during final start-up testing.

.2 O&M personnel may assist in commissioning procedures as part of training.

.3 Commissioning to be supervised by qualified supervisory personnel, Owner's Representative and Commissioning Agent.

.4 Commission systems considered as life safety systems before affected parts of the facility are occupied.

.5 Operate systems as long as necessary to commission entire project.

.6 Monitor progress and keep detailed records of activities and results.

3.2 ADJUSTING

.1 Final adjusting: upon completion of commissioning as reviewed by Owner's Representative, set and lock devices in final position and permanently mark settings.

3.3 DEMONSTRATION

.1 Demonstrate to Owner's Representative, operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.

1.2 RELATED SECTIONS

.1 Section 25 05 01 - EMCS: General Requirements.

1.3 SUBMITTALS

.1 Submittals in accordance with:

.1 Division 01 – General Requirements.

.2 Section 21 05 01 - Common Work Results – Mechanical.

.2 Submit training plan complete with hour-by-hour schedule including brief overview of content of each segment to Owner's Representative 30 days prior to the anticipated date of beginning of training:

.1 List name of trainer, and type of visual and audio aids to be used.

.2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.

.3 Submit training plan within one week following completion of controls testing and demonstration.

1.4 QUALITY ASSURANCE

.1 Provide competent trainers thoroughly familiar with aspects of EMCS installed in facility.

.2 Owner's Representative reserves the right to approve instructors.

1.5 INSTRUCTIONS

.1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.

.2 Training is to be project specific.

1.6 TRAINING

.1 Contractor shall instruct Owner's designated representatives on proper system use and maintenance, including set point changes, trending and simple program changes.

.2 Instructions shall be provided. One – 8 hour day total at Owner's request.

1.7 TRAINING MATERIALS

.1 Provide equipment, visual and audio aids, and materials for classroom training.

.2 Supply manual for each trainee, describing in detail data included in each training program.
.1 Review contents of manual in detail to explain aspects of operation and maintenance.

1.8 MONITORING OF TRAINING

.1 Owner's Representative to monitor training program and may modify schedule and content.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 TRAINING

.1 Provide a minimum of one onsite training class 8 hours in length during the construction period for personnel designated by the Owner's Representative.

.2 Train the designated staff of Owner's Representative and Owner to enable them to:
.1 Day-to-day Operators:
.1 Proficiently operate the system.
.2 Understand control system architecture and configuration.
.3 Understand DDC system components.
.4 Understand system operation including DDC system control and optimizing routines (algorithms).
.5 Operate the workstation and peripherals.
.6 Log on and off the system.
.7 Access graphics, point/object reports, and logs.
.8 Adjust and change system setpoints, time schedules, and holiday schedules.
.9 Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
.10 Understand system drawings included in the Operation and Maintenance Manual.
.11 Understand the job layout and location of control components.
.12 Access data from DDC controllers.
.13 Operate portable operator's terminals.
.2 Advance Operators:
.1 Make and change graphics on the workstation.
.2 Create, delete, and modify alarms, including annunciation and routing of these.
.3 Create, delete, and modify point/object trend logs, and graph or print these.

.4 Create, delete, and modify reports.

.5 Add, remove, and modify system's physical points/objects.

.6 Create, modify, and delete programming.

.7 Add panels when required.

.8 Add operator interface stations.

.9 Create, delete, and modify system displays – both graphical and otherwise.

.10 Perform DDC system field checkout procedures.

.11 Perform DDC controller unit operation and maintenance procedures.

.12 Perform workstation and peripheral operation and maintenance procedures.

.13 Perform DDC system diagnostic procedures.

.14 Configure hardware including PC boards, switches, communication, and I/O points/objects.

.15 Maintain, calibrate, troubleshoot, diagnose, and repair hardware.

.16 Adjust, calibrate, and replace system components.

.3 System Managers/Administrators:

.1 Maintain software and prepare backups.

.2 Interface with job-specific, third-party operator software.

.3 Add new users and understand password security procedures.

.4 Provide course outline and materials as per:

.1 Division 01 – General Requirements.

.2 Section 01 79 00 – Demonstration and Training.

.3 The trainer (s) shall provide one copy of training material per student.

.5 The trainer (s) shall be factory-trained instructors experienced in presenting this material.

.6 All Operation and Maintenance Manuals must be made available prior to training. Manuals will be a training tool, used during training sessions.

.7 List the name of the person conducting each session and the visual and audio aids employed.

.8 Owner's Representative may monitor the training program and reserves the right to modify the schedule, content, as well as replace instructors deemed unqualified.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and General Requirements Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

.1 Section 25 05 54 - EMCS: Identification.

1.3 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 DTI 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-Z234.1-00 (R2011), Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA):

.1 CEA-709.1-D-2014, Control Network Protocol Specification.

.6 Department of Justice Canada (Jus):

.1 Canadian Environmental Assessment Act (CEAA), 2012, C.19.

.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), 2011, C.232.

.10 Canadian Construction Documents Committee (CCDC):

.1 CCDC2-2008, Stipulated Price Contract.

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 residing and communicating on a **BACnet/IP Network.** The graphics shall be generated on the existing operator workstation. 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.

.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.

.5 Remove existing controls not re-used or not required. Place in approved storage for disposal as directed.

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 (CEC) 2018.

.2 National Building Code of Canada (NBC) 2015.

.3 ASHRAE 135-2010.

.4 FCC Regulation, Part 15- Governing Frequency Electromagnetic Interference.

.5 Underwriters Laboratories UL916 – Standard for Energy Management Equipment.

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	±0.5ºC
Ducted Air	±0.5ºC
Outside Air	±1.0ºC
Dewpoint	±1.5ºC
Water Temperature	±0.5ºC
Delta-T	±0.15ºC
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 *(See Note 3)*
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	±10% of full scale	
Temperature	±0.5ºC	
Humidity	±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:

.1 Division 01 – General Requirements.

.2 Section 21 05 01 – Common Work Results for Mechanical

.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 Submittals sections indicated herein. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by Owner's 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 Owner's 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 Owner's IT department on locations for UNC's, Ethernet communication cabling and TCP/IP addresses

1.9 OWNERSHIP OF PROPRIETARY MATERIAL

.1 The owner 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 owner 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 owner. 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 SCOPE OF WORK

.1 The words "controls", "BMS" and "EMCS" shall be considered interchangeable and all refer to the system of controls for HVAC systems. The work covered by this specification and related sections consists of providing shop drawings, equipment, labour, materials, engineering, technical supervision and transportation as required to furnish and install a fully operational Energy Management Control System (EMCS) to control the equipment as shown on plans and as required to provide the operation specified in strict accordance with these specifications and subject to the terms and conditions of the contract. The Work provided in this Section in general consists of, but is not limited to, the following:

.1 The preparation of submittals and provisions of all related services.

.2 Furnish and install programmable control units, sensors, control devices and wire in the facilities as required to provide the operation specified.

.3 Load all software and provide all "locks" or "keys" required to implement a complete and operational EMCS. EMCS shall be ready for use, including all operating parameters, set points and schedules.

.4 Provide system testing of every point, sequence verification and point's verifications prior to interim inspection. Submit point and sequence verifications prior to interim inspection.

.5 Scope of Work:

.1 Contractor shall be responsible for fully interfacing new control system to existing Alerton EMCS System (100% BACnet). Controls Contractor to integrate system graphics, trend logs, programming, etc. to existing system software.

.2 Graphics for new control system shall be designed to match existing AAFC EMCS Network infrastructure.

.3 Controls Contractor to provide trend logging to all new control points. All trend logs need to be trended for a minimum of 5 years.

.4 All points naming including trend logs shall match existing system (verify with user on naming convention).

.5 Division 26 to provide network drops for connection of new boiler control panels to AAFC EMCS network.

.6 All equipment shall have feedback (current sensors, actuator feedback, VFD speed and alarming points).

.7 All controllers shall communicate through a BACnet router to UDP/IP to the existing AAFC EMCS Network. The user shall provide an address and numbering scheme for the controllers.

.8 EMCS Contractor shall obtain all 120V power required for EMCS System operation, obtain from essential power circuits as indicated on plans.

.9 EMCS Contractor to provide control valves (where applicable).

.10 EMCS Contractor to provide damper actuators (where applicable).

2.2 APPROVED MANUFACTURERS

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

.1 Alerton – Manufacturer trained installer, Advanced Energy Management Ltd.

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 Remove existing devices where indicated. Turn over to Owner.

.2 Relocate existing devices where indicated or required for access.

.3 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, 2012, 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 Owner's 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 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.
- .10 All networking and control device wiring to be continuous wire runs only, no splicing is permitted.
- .11 All I/O wiring passing near or within the enclosure of a VFD will be shielded, with the shield terminated at the controller end.
- .12 All I/O wiring will be suitably identified using adhesive wire-marker or equivalent at the controller end.
- .13 All I/O wiring within controller enclosure shall be neat and tidy and suitably bundled and strapped or contained in wire duct or equivalent.
- .14 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.).
- .15 Low voltage I/O wiring may be mixed together within a conduit.

.16 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.

.17 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 Owner's 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 Owner's 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 Owner's 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 (2018).

.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 and requirements of Division 01 – General Requirements.

.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 EXISTING EQUIPMENT

.1 Wiring: The Contractor may reuse any abandoned wires. The integrity of the wire and its proper application to the installation is the responsibility of the Contractor. The wire shall be properly identified and tested as per this specification. Unused or redundant wiring must be properly identified as such.

.2 Local Control Panels: The Contractor may reuse any existing local control panel to locate new equipment. All redundant equipment within these panels must be removed. Panel face cover must be patched to fill all holes caused by removal of unused equipment, or replaced with new.

.3 Unless otherwise directed, the Contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the Contractor find existing equipment that requires maintenance, the Owner's Representative is to be notified immediately.

.4 Temperature Sensor Wells: The Contractor may reuse any existing wells in piping for temperature sensors. These wells shall be modified as required for proper fit of new sensors.

.5 Indicator Gauges: Where these devices remain and are not removed, they must be made operational and recalibrated to ensure reasonable accuracy. Maintain the operation of existing pneumatic transmitters and gauges.

.6 Room Thermostats: Shall be removed and turned over to the Owner, unless otherwise noted.

.7 Electronic Sensors and Transmitters: Unless specifically noted otherwise, remove and deliver to the Owner.

.8 Controllers and Auxiliary Electronic Devices: Deliver to the Owner upon removal.

.9 Pneumatic Controllers, Relays and Gauges: Deliver to Owner upon removal.

.10 Damper Actuators, Linkages and Appurtenances: Deliver to Owner upon removal.

.11 Control Valves: Salvage, recondition, and reuse.

.12 No modifications to the system shall cause the mechanical system to be shut down for more than 15 minutes or to fail to maintain space comfort condition during any such period. Perform cutover of controls that cannot meet these conditions outside of those hours.

.13 The scheduling of fans through existing or temporary time-clocks or control system shall be maintained throughout the DDC system installation.

.14 Install control panels where shown.

.15 Modify existing starter control circuits, if necessary, to provide Hand/Off/Auto control of each starter controlled.

.16 Patch holes and finish to match existing.

3.10 WIRING INSTALLATION

.1 All control and interlock wiring shall comply with national and local electrical codes.

.2 All CEC Class 1 (line voltage) wiring shall be UL listed in approved raceway per CEC.

.3 All low-voltage wiring shall meet CEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit).

.4 Where CEC 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

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).

.2 Related Sections:

.1 Section 25 05 01 - EMCS: General Requirements.

.2 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.2 SUBMITTALS

.1 Make submittals in accordance with:

.1 Division 01 – General Requirements.

.2 Section 21 05 01 – Common Work Results for Mechanical.

.3 Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and start-up instructions for each type of product indicated.

.4 Each control device labelled with setting or adjustable range of control.

.2 Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, and method of field assembly, components, and location and size of each field connection:

.1 Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.

.2 Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

.3 Details of control panel faces, including controls, instruments, and labeling.

.4 Written description of sequence of operation.

.5 Schedule of dampers including size, leakage, and flow characteristics.

.6 Schedule of valves including close-off and flow characteristics.

.7 Trunk cable schematic showing programmable control unit locations and trunk data conductors.

.8 Listing of connected data points, including connected control unit and input device.

.9 System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.

.10 System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

.3 Protocol Implementation Conformance/BACnet Interoperability Building Blocks Statements clarifying which BACnet objects and services are supported by each controller.

.4 ANSI / ASHRAE™ Standard 135-R2008, BACnet PIC/BIBB Statement: Proof of Compliance Level 3 or higher is required to protect building owner by reducing future maintenance and expansion costs.

.5 Samples: For each color required, of each type of thermostat cover.

.6 Software and Firmware Operational Documentation: Include the following:

.1 Engineering, Installation, Operation and Maintenance manuals.

.2 Program Software Backup: On a magnetic media or compact disc, complete with data files.

.3 Device address list.

.4 Printout of software application and graphic screens.

.5 Licenses, guarantee, and warranty documents for all equipment and systems.

.7 Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

.8 Schedules:

.1 Within two weeks of contract award, provide a schedule of the work indicating the following:

.1 Intended sequence of work items.

.2 Start dates of individual work items.

.3 Duration of individual work items.

.4 Planned delivery dates for major material and equipment, and expected lead times.

.5 Milestones indicating possible restraints on work by other trades or situations.

.2 Provide monthly written status reports indicating work completed, revisions to expected deliver dates, etc. an updated project schedule shall be included.

.9 Qualification Data: For firms and persons specified in “Quality Assurance” Article.

.10 Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.3 QUALITY ASSURANCE

.1 Bids by wholesalers, distributors, mechanical contractors and non-franchised contractors shall not be acceptable.

.2 The contractor shall have an established working relationship with the control system manufacturer, and be an authorized representative of the manufacturer at bid time.

.3 The contractor shall have successfully completed control system manufacturers classes on the control system. Departmental Representative reserves the right to request proof of training.

.4 The system manufacturer shall, as a minimum, manufacture and supply the Variable Air Volume Direct Digital Controller, Unitary Equipment Controller, Advanced Application Controller and Graphical User Interface.

.5 All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this.

.6 The EMCS contractor shall have a full service facility within 200 km of the project that is staffed with engineers trained in Integrating Interoperable Systems and technicians fully capable of providing routine emergency maintenance service on all system components.

.7 Mechanical equipment manufacturers that are listed as approved to provide DDC type controls may submit a bid with factory mounted controls, and shall also provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the EMCS contractor.

.8 Electrical Components, Devices, and Accessories: Listed and labelled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

.9 Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

.10 Comply with Canadian Electric Code, UL-916 Energy Management Systems, ULC, FCC Part 15, subpart J, Class B Computing Devices.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

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

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

.4 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan.

.5 Place materials defined as hazardous or toxic in designated containers.

.6 Handle and dispose of hazardous materials in accordance with Regional and Municipal, regulations.

.7 Label location of salvaged material's storage areas and provide barriers and security devices.

.8 Ensure emptied containers are sealed and stored safely.

.9 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Site Representative.

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for building Energy Monitoring and Control System (EMCS) Work.

1.2 RELATED SECTIONS

.1 Section 25 05 01 - EMCS: General Requirements.

.2 Section 25 05 02 - EMCS: Submittals and Review Process.

.3 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.3 PROJECT RECORD DOCUMENT

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals and 21 05 01 – Common Work Results.

.2 Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and shall include:

.1 Project Record Drawings. These shall be as-built versions of the submittal shop drawings. One set of electronic files including DXF drawing files also shall be provided. Provide on a DVD, USB or SD Media Card.

.2 Testing and Commissioning Reports and Checklists. Completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Section 25 01 11 Part 1.8 - Control System Demonstration and Acceptance.

.3 Operation and Maintenance (O & M) Manual. This shall include as-built versions of the submittal product data. In addition to the information required for submittals, the Operations and Maintenance Manual shall include:

.1 Contractor to provide names, addresses and 24-hour telephone numbers of all installation contractors, equipment suppliers and service representatives.

.2 Operators Manual with procedures for operating the control systems, including logging on/off , alarm handling, producing point/object reports, trending data, overriding computer control, and changing setpoints and other variables.

.3 **One set** of Programming Manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point/object database creation and modification, program creation and modification, and use of the editor.

.4 Engineering, Installation, and Maintenance Manual (s) that explain how to design and install new points/objects, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.

.5 A listing and documentation of all custom software created using the programming language, including the setpoints, tuning parameters, and object database. One set of magnetic/optical media containing files of the software and database also shall be provided.

.6 One set of files containing all colour graphic screens created for the project.

.7 A list of recommended spare parts with part numbers and suppliers.

.8 Complete original issue documentation, installation, and maintenance information for all third-party hardware provided, including computer equipment and sensors.

.9 Complete original media source for all software provided, including operating systems, programming language, operator workstation software, and graphics software.

.10 Licenses, guarantee, and warranty documents for all equipment and systems.

.11 Recommended preventive maintenance procedures for all system components, including a schedule of tasks inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.

.12 System Drawings: **Include all system as-built line drawings showing interconnections of EMCS system hardware components and system layouts. Layouts to show sensor locations, valves, dampers, fans and heating/cooling control valves as per point list. Manuals are to include floor plan layouts for each building.**

Floor plans are to indicate location of all components (i.e. DDC Panels, Hydronic heater valves, duct dampers (outside mech. Room) sensors, exhaust fans, contactors, transducers, timers, etc. in addition to all built-up systems, indicated in block form (i.e. HRV, AHU, A/C unit, boilers, etc.) under EMCS control. Include routing of all network control wiring and major control wiring runs. Floor plan layouts are to be in AutoCAD format. Submit on 11 x 17" size for including in manual. All items on floor plans are to be labelled and all rooms to be numbered as per EMCS tender document sketches. Manuals shall include EMCS as-built control wiring schematics.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Requirements and procedures for identification of Building Energy Monitoring and Control System (EMCS) devices such as: sensors; wiring; tubing; conduit; and equipment. This section covers requirements for nameplate materials, colours and lettering sizes.

1.2 RELATED SECTIONS

.1 Division 01 – General Requirements.

.2 Section 25 05 01 - EMCS: General Requirements.

.3 Section 23 05 53 01 – Mechanical Identification.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International):

.1 CSA C22.1 - The Canadian Electrical Code, 2012, Safety Standard for Electrical Installations.

1.4 SYSTEM DESCRIPTION

.1 Language Operating Requirements: provide identification for control items in English.

1.5 SUBMITTALS

.1 Submittals in accordance with:

.1 Division 01 – General Requirements.

.2 Section 21 05 01 – Common Work Results for Mechanical.

.2 Submit samples to Owner's Representative for pre-approval. Include samples of nameplates, identification tags and list of proposed wording.

Part 2 Products

2.1 WARNING LABELS

.1 Permanent warning labels shall be affixed to all equipment which can be automatically started by the EMCS system.

.1 Labels shall use white lettering (12-point type or larger) on a red background.

.2 Warning labels shall read as follows:

C A U T I O N

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

.2 Permanent warning labels shall be affixed to all motor starters and all control panels which are connected to multiple power sources utilizing separate disconnects.

.1 Labels shall use white lettering (12-point type or larger) on a red background.

.2 Warning labels shall read as follows:

C A U T I O N

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

2.2 IDENTIFICATION OF HARDWARE AND WIRING

.1 All wiring and cabling, including that within factory-fabricated panels, shall be labelled at each end within 5 cm of termination with the information provided as sample. See Appendix I – Object Tagging.

Field Equipment Identification: To be as per laminated sample.

.1 To include the following:

.1 Scale/set-up range.

.2 Panel (controller) address.

.3 Point address.

.4 Device Part #/Manufacturer.

.5 To be orange background.

.2 All pneumatic tubing shall be labelled at each end within 5 cm of termination with a descriptive identifier.

.3 Permanently label or code each point/object of field terminal strips to show the instrument or item served.

.4 Identify control panels with minimum 1 cm letters on laminated plastic nameplates.

.5 Identify all other control components with permanent labels. All plug-in components shall be labelled such that removal of the component does not remove the label.

.6 Identify room sensors relating to terminal box or valves with nameplates.

.7 Identifiers shall match record documents.

.8 Conduit:

.1 Colour code EMCS conduit. Confirm colour coding with Owner's Representative during project start-up meeting.

.2 Pre-paint box covers and conduit fittings as per Owner's Standards.

Part 3 Execution

3.1 NAMEPLATES AND LABELS

.1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

3.2 EXISTING PANELS

.1 Correct existing nameplates and legends to reflect changes made during Work.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Requirements and procedures for warranty and activities during warranty period for building Energy Monitoring and Control System (EMCS).

1.2 RELATED SECTIONS

.1 Division 01 – General Requirements.

.2 Section 25 05 01 - EMCS: General Requirements.

1.3 WARRANTY

.1 Provide standard warranty twelve (12) months from approval date of substantial completion.

.2 EMCS Contractor shall perform all maintenance on installed equipment and software during the warranty period. Provide all personnel, vehicles, materials, and labour necessary.

.3 Warrant all work as follows:

.1 Labour and materials for the control system specified shall be warranted free from defects for a period of 12 months after the substantial completion date is accepted. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. The contractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours.

.2 All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period. In this case, each building will have separate warranty dates.

.3 At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Owner's Representative, the Owner's Representative shall sign certificates certifying that the control system operation has been tested and accepted in accordance with the terms of this specification. The date of substantial completion shall be the start of warranty.

.4 Operator workstation software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the contractor shall be provided at no charge during the warranty period.

All firmware updates or functional enhancements associated with the above mentioned items must be provided during the warranty period. Written authorization by the Owner must, however, be granted prior to the installation of any of the above mentioned items.

.5 Exception: The contractor shall be required to warrant reused devices. Contractor to bear necessary cost. The contractor shall warrant all installation labour and materials.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 System requirements for Local Area Network (LAN)-for Building Energy Monitoring and Control System (EMCS).

1.2 RELATED SECTIONS

.1 Section 25 05 01 – EMCS: General Requirements.

1.3 SYSTEM DESCRIPTION

.1 Data communication network to link Operator Workstations and EMCS Control Panels:

- .1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.
- .2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to include, but not limited to:

- .1 EMCS-LAN.
- .2 Modems.
- .3 Network interface cards.
- .4 Network management hardware and software.
- .5 Network components necessary for complete network.

1.4 DESIGN REQUIREMENTS

.1 All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and Operator Workstations) shall conform to ANSI/ASHRAE Standard 135-2012, BACnet.

.2 Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device class.

.3 The Contractor shall provide all communication media, connectors, repeaters, bridges, hubs, switches, and routers necessary for the internetwork.

.4 All controllers shall have a communication port for connections with the Operator Workstations using the BACnet Data Link/ Physical layer protocol.

.5 A device on the internetwork shall be provided with a 56k-baud modem that will allow for remote Operator Workstation using the BACnet PTP Data Link/ Physical layer protocol. Remote Operator Workstation via this modem shall allow for communication with any and all controllers on this network as described in this section.

.6 Connection of an Operator Workstation device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.

.7 All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.

.8 The time clocks in all controllers shall be automatically synchronized daily. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the network.

.9 Network Medium: CAT6 minimum, #22-24 shielded twisted cable, or fibre optic cable compatible with network protocol to be used within buildings.

.10 Provide minimum FTV rated cable where run in conduit; use FT6 rated cable otherwise.

Part 2 Products

2.1 ETHERNET SWITCHES

.1 Refer to Section 25 30 02 – EMCS: Field Control Devices.

.2 Contractor to connect to existing owner supplied LAN switch. Supply and install communication wiring from Boiler Room panels to LAN switch location. Coordinate set-up and termination with Departmental Representative.

Part 3 Execution

3.1 COMMUNICATION WIRING

.1 The Contractor shall adhere to the items listed in the “Wiring Installation” Article in the specification.

.2 All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer’s installation recommendations for all communication cabling.

.3 Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

.4 Maximum pulling tension and bend radius for cable installation as specified by the cable manufacturer shall not be exceeded during installation.

.5 Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

.6 When a cable enters or exists a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer’s instructions.

.7 All runs of communication wiring shall be un-spliced length when that length is commercially available.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 All DDC building controllers.

1.2 RELATED SECTIONS

.1 Section 25 05 01 - EMCS: General Requirements.

.2 Section 25 30 02 - EMCS: Field Control Devices.

1.3 REFERENCES

.1 **http://www.bacnetinternational.net/btl/**

1.4 SYSTEM DESCRIPTION

.1 General. Provide an adequate number of Building Controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these panels shall meet the following requirements.

.1 The Energy Management and Control System shall be comprised of one or more independent, standalone, microprocessor-based Building Controllers to manage the global strategies described in the System Software section.

.2 The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.

.3 Data shall be shared between networked Building Controllers.

.4 The operating system of the Building Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.

.5 Controllers that perform scheduling shall have a real-time clock.

.6 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

1.5 DESIGN REQUIREMENTS

.1 To include:

.1 Scanning of Analog Input and Binary Output connected inputs for detection of change of value and processing detection of alarm conditions.

.2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.

.3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.

.4 Control of systems as described in sequence of operations.

.5 Execution of optimization routines as listed in this section.

.2 Total spare capacity: at least 25 % of each point type distributed throughout the controllers.

.3 Field Termination and Interface Devices:

.1 To: CSA C22.2 No.205-12 – Signal Equipment.

.2 Electronically interface sensors and control devices to processor unit.

.3 Include, but not be limited to, following:

.1 Programmed firmware or logic circuits to meet functional and technical requirements.

.2 Power supplies for operation of logics devices and associated field equipment.

.3 Lockable wall cabinet.

.4 Required communications equipment and wiring (if remote units).

.5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

.6 Input Output interface to accept as minimum Analog Input, Analog Output, Digital Input, Digital Output functions as specified.

.7 Wiring terminations: use conveniently located screw type or spade lug terminals.

.4 Analog Input interface equipment to:

.1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.

.2 Provide for following input signal types and ranges:

.1 4 - 20 mA;

.2 0 – 10 V DC;

.3 100/1000 ohm RTD input;

.3 Meet IEEE C37.90.1 surge withstand capability.

.4 Have common mode signal rejection greater than 60 dB to 60 Hz.

.5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 Analog Outputs interface equipment:

.1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 - 20 mA.

.2 0 – 10 VDC.

.3 Meet IEEE C37.90.1 surge withstand capability.

.6 Binary Input interface equipment:

.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

.2 Meet IEEE C37.90.1 surge withstand capability.

.3 Accept pulsed inputs up to 2 kHz.

.7 Binary Output interface equipment:

.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24V AC.

.2 Switch up to 5 amps at 220V AC using optional interface relay.

.4 Controllers and associated hardware and software: operate in conditions of 0°C to 44 °C and 20 % to 90 % non-condensing RH.

.5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.

.1 Provide for conduit entrance from top, bottom or sides of panel.

.2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.

.3 Mounting details as approved by Engineer for ceiling mounting.

.6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.7 Provide surge and low voltage protection for interconnecting wiring connections.

1.6 SUBMITTALS

.1 Make submittals in accordance with:

.1 Division 01 – General Requirements.

.2 Section 21 05 01 – Common Work Results for Mechanical.

1.7 MAINTENANCE PROCEDURES

.1 Provide manufacturers recommended maintenance procedures in Operations and Maintenance Manual.

Part 2 Products

2.1 BUILDING CONTROLLER

.1 General Requirements:

.1 BACnet Conformance:

.1 Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.

.2 Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

.2 Communication:

.1 Each Building Controller shall support direct Ethernet or a communications card. The Building Controller shall be connected to the BACnet network using the ISO 8802-3 (Ethernet) Data Link/ Physical layer protocol.

.2 Each Building Controller with a communications card shall perform BACnet routing if connected to a network of Custom Application and Application Specific Controllers.

.3 The controller shall provide a service communication port using BACnet Data Link/ Physical layer protocol P-T-P for connection to a hand-held workstation/ and/or modem.

.4 The Building Controller secondary communication network shall support BACnet MS/TP.

.3 Environment: Controller hardware shall be suitable for the anticipated ambient conditions.

.1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 32°F to 100°F and 10 to 90% RH.

.2 Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 32°F to 120°F.

.4 Building Controllers shall be fully peer to peer.

.5 Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field- removable, modular terminal strips — or to a termination card connected by a ribbon cable.

.6 Memory: The Building Controller shall have as a minimum standard SRAM of 256 KB, standard DRAM of 1MB and standard non-volatile 1 MB of flash memory in lieu of EPROM. Memory shall be user extendible through RAM chip sockets and SIMMs for future memory expansion.

.7 Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. The Building Controller shall maintain all database information including BIOS and programming information in the event of a power loss for at least 72 hours. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m.

.8 Inputs/Outputs:

.1 Inputs: Controller input/output board shall support dry contact, 0-5 VDC and 0-10 VDC- voltage, 4-20 mA- current and thermistor-resistive signal types on an individual basis for connecting any status or sensing device. Analog resolution shall be 10-bit A to D.

.2 Outputs: Controller input/output board shall support plug-and-play I/O modules or built in HOA modules configured with manual-auto-off override switch, potentiometer and input channel for feedback status or and unrelated analog or digital input. Output supported shall be 0-10 VDC. All HOA's shall be supervised.

.3 Diagnostics: Controller input/output board shall have red LEDs providing input status indication.

.4 External Power: Controller input/output board shall have one on-board 24 VDC terminal for directly connected active transducers.

2.2 ADVANCED APPLICATION CONTROLLERS

.1 General: Provide an adequate number of Advanced Application Controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these panels shall meet the following requirements.

.1 The Advanced Application Controller shall have sufficient memory to support its operating system, database, and programming requirements.

.2 Advanced Application Controllers shall be fully peer to peer.

.3 The operating system of the Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.

.4 All equipment that requires scheduling shall be scheduled in that equipment's controller.

.5 Both firmware and controller database shall be loadable over the network.

.2 Communication:

.1 Each Advanced Application Controller shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol.

.2 The controller shall provide a service communication port using BACnet Data Link/ Physical layer protocol for connection to portable operator's workstation and allow access to the entire network.

.3 Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

.1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 0°C to 40°C.

.2 Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 0°C to 50°C.

.4 Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips — or to a termination card connected by a ribbon cable.

.5 Memory: The Advanced Application Controller shall be non-volatile FLASH memory.

.6 Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to120 Hz and from keyed radios up to 5 W at 1 m.

2.3 APPLICATION SPECIFIC CONTROLLERS

.1 General: Provide an adequate number of Advanced Application Controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these panels shall meet the following requirements.

.1 The Application Specific Controller shall have sufficient memory to support its operating system, database, and programming requirements.

.2 Application Specific Controllers shall be fully peer to peer.

.3 The operating system of the Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.

.4 Both firmware and controller database shall be loadable over the network.

.5 Advanced Application Controllers shall be BTL listed as a B-ASC device.

.2 Communication:

.1 Each Application Specific Controller shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol.

.2 The controller shall provide a service communication port using BACnet Data Link/ Physical layer protocol for connection to portable operator's workstation and allow access to the entire network.

.3 Environment: Controller hardware shall be suitable for the anticipated ambient conditions.

.1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 0°C to 40°C.

.2 Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 0°C to 50°C.

.4 Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips — or to a termination card connected by a ribbon cable.

.5 Memory: The Application Specific Controller shall be non-volatile FLASH memory.

.6 Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to120 Hz and from keyed radios up to 5 W at 1 m.

2.4 INPUT/OUTPUT INTERFERENCE

.1 Hardwired inputs and output points/objects may be wired into the system through building, Custom Application.

.2 All input and output points shall be protected such that shorting of the point to itself, to another point, or to ground, will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 volts of any duration, such that contact with this voltage will cause no damage to the controller.

.3 Digital inputs shall allow the monitoring of ON/OFF signals from remote devices. The digital inputs shall provide a current of at least 12 mA to be compatible with commonly available control devices, and shall be protected against the effects of contact bounce and noise. Digital inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.

.4 Analog inputs shall allow the monitoring of 0-5 VDC, 0-10 VDC-voltage, 4-20 mA-current, or thermistors. Analog inputs shall be compatible, and be field configurable to commonly available sensing devices.

.5 Digital outputs shall provide for ON/OFF operation. Digital outputs on Building and Advanced Application Controllers shall have three-position override switches, Hand-Off-Auto with status lights. Outputs shall be selectable for either normally open or normally closed operation.

.6 Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide a 0 to 10 VDC signal as required to provide proper control of the output device. Analog outputs on Building or Advanced Application Controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.

.7 Tri-State Outputs: Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct mounted heating coils, zone dampers, radiation, etc.).

.8 Input/Output points/objects shall be universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point/object with appropriate properties. Application Specific Controllers are exempted from this requirement.

.9 System Object Capacity: The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The Operator Workstations installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.5 CONTROL PANELS

.1 Local Control Panels: Unitized NEMA 1 cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.

.1 Fabricate panels of 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.

.2 Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

.3 Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.

.4 Provide ON/OFF power switch with over-current protection for control power sources to each local panel.

.5 When a control panel is located in a mechanical room with a HTHW heat exchanger, the panel shall be located in a NEMA 4x cabinet. If there is any question or an acceptable type panel, clarify with Owner's Representative.

.6 Provide engraved plastic nameplates indicating panel identification and all instruments and controls inside the cabinet and on the cabinet face.

2.6 TREND LOGS

.1 The operator shall be able to define a custom trend log for any data object in the system. This definition shall include change-of-value digital, change-of-value analog, time interval, start time, and stop time. Trend data shall be sampled and stored on the Building Controller panel, and be archiveable on the hard disk and be retrievable for use in spreadsheets and standard database programs. Contractor to set up all trend logging requested by Owner's Representative.

As a minimum, Contractor to set up trend logging as outlined below:

Data logging to be set up by Contractor, format to be pre-approved by the Owner's Representative. The following points must be logged hourly for typical systems. Logs must be continuously updated.

.1 D/N Points:

- D/N point switch over
- Space setpoint used as a D/N reference point
- Space actual temperature used as a D/N reference point
- Building override status, if used

If there are multiple zones, with separate D/N control, provide a trend log for each, containing the above information.

.2 Scheduled Water:

- OAT temperature
- Scheduled water actual temperature
- Valve position (EMCS output signal) or boiler control input from EMCS
- Schedules water setpoint
- Scheduled water actual temperature

.3 Pump Control:

- OAT temperature
- Lowest space value
- Pump control output value from EMCS (pump status value preferred if available)
- Pump status value if available

2.7 POWER SUPPLIES AND LINE FILTERING

.1 Control transformers shall be UL listed. Furnish Class 2 current-limiting type, or furnish over-current protection in both primary and secondary circuits for Class 2 service per NEC requirements. Limit connected loads to 80% of rated capacity.

.1 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.

.1 Unit shall operate between 0°C and 50°C. EM/RF shall meet FCC Class B and VDE 0871 for Class B, and MIL-STD 810C for shock and vibration.

.2 Line voltage units shall be UL recognized and CSA approved.

.2 Power line filtering:

.1 Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:

.1 Dielectric strength of 1,000 volts minimum.

.2 Response time of 10 nanoseconds or less.

.3 Transverse mode noise attenuation of 65 dB or greater.

.4 Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

.3 Each panel shall have its own power supply/transformer.

Part 3 Execution

3.1 LOCATION

.1 Location of Controllers to be approved by Owner's Representative.

3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures. Provide 120 V duplex receptacles on outside of each main control cabinet.

.2 Provide necessary power from local 120 E.P.S. V branch circuit panel for equipment.

.3 Install tamper locks on breakers of circuit breaker panel.

.4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode. The UPS shall be rated for 850 VA/450W minimum and provide 90 minutes of backup power at 40W.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Control devices integral to the Building Energy Monitoring and Control System (EMCS): transmitters, sensors, controls, switches, transducers, dampers, damper operators, valves, valve actuators, low voltage current transformers, variable frequency drives.

1.2 RELATED SECTIONS

.1 Division 01 – General Requirements.

.2 Section 25 05 01 - EMCS: General Requirements.

1.3 REFERENCES

.1 American National Standards Institute (ANSI):

.1 ANSI C12.7-2014 (R1999), Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13-2008, Standard Requirements for Instrument Transformers.

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

.1 ASTM B148-14, Standard Specification for Aluminum-Bronze Sand Castings.

.3 National Electrical Manufacturer's Association (NEMA):

.1 NEMA 250-2014, Enclosures for Electrical Equipment (1000 Volts Maximum).

.4 Air Movement and Control Association, Inc. (AMCA):

.1 AMCA Standard 500-D-12, Laboratory Method of Testing Dampers for Rating.

.5 Canadian Standards Association (CSA):

.1 CSA-C22.1-15, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

1.4 DEFINITIONS

.1 Acronyms and Definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.5 SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with:

.1 Division 01 – General Requirements.

.2 Section 21 05 01 – Common Work Results for Mechanical.

.2 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions for specified equipment and devices.

1.6 EXISTING CONDITIONS

.1 Cutting and Patching: in accordance with Division 01 – General Requirements supplemented as specified herein.

.2 Repair surfaces damaged during execution of Work.

.3 Turn over to Owner's Representative existing materials removed from Work not identified for re-use.

Part 2 Products

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant, assembly.

.3 Operating conditions: 0 – 32°C with 10 - 90% RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.

.8 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

2.2 TEMPERATURE SENSORS

.1 General: to be resistance or thermocouple type to following requirements:

The following sensors shall apply to thermistor and resistance temperature sensors as applicable:

.1 Sensing element to be hermetically sealed.

.2 Stem and tip construction to be copper.

.3 Sensors to have a time constant response of less than 3 seconds to a temperature chance of 10ºC.

.4 Sensors shall operate over the following ranges with the accuracies over the noted range of the sensor.

-50ºC to +50ºC, plus or minus 0.5ºC.

0ºC to +50ºC, plus or minus 0.25ºC.

0ºC to 25ºC, plus or minus 0.1ºC.

0ºC to 100ºC, plus or minus 1ºC.

.5 Immersion wells shall be of (stainless steel) materials. Heat transfer compound to be compatible with sensor. Unless noted otherwise, where an existing sensor or well is not available, a strap-on sensor will be acceptable.

.6 Immersion sensors shall be provided with a separable brass well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.

.7 Provide matched temperature sensors for differential temperature measurement.

.2 Temperature sensors shall be of the following types:

.1 General Purpose Duct Type: Suitable for insertion into air ducts at any angle, insertion length of 457 mm and 760 mm as noted on schedule or drawings.

.2 Spring-Loaded Thermowell Type: Spring-loaded construction with compression fitting for 20 mm NPT well-mounting. Lengths of 100 mm or 150 mm as noted.

.3 Space Temperature Sensors:

(Type 1) – Surface Space Temperature Sensor: to be acceptable product – Greystone TSRC, Delta, or approved equal.

(Type 2) – Surface-Mounted Space Temperature Sensor complete with setpoint adjustment: Acceptable Products – Greystone, TSRC-S, Delta, or approved equal.

(Type 3) – Network Type Surface Space Temperature Sensor adjustment and programmable pushbutton, Pushbutton, Temperature Display, Setpoint adjust, built-in occupancy sensor: Acceptable Products – Delta, Greystone or approved equivalent. To be c/w protective open wire guard where indicated.

.4 Outdoor Air Type: Complete with non-corroding shield designed to minimize solar and wind effects, threaded fittings for mating to 13 mm conduit, probe length of 100-150 mm

2.3 PRESSURE TRANSDUCERS

.1 Requirements:

.1 Transducer shall have linear output signal. Zero and span shall be field-adjustable.

.2 Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.

.3 Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi. minimum. Transducer shall be complete with 1 – 5 vdc or 4 to 20 mA output, required mounting brackets and block and bleed valves.

.4 Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 1 – 5 VDC or 4 to 20 mA output, required mounting brackets, and five-valve manifold.

Acceptable Products: Greystone, ACI, BAPI.

2.4 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Requirements:

.1 Air System Differential Pressure Transducer:

.1 Provide proportional electrical output for unidirectional pressure range.

.2 Pressure Media: Typically air or similar non-conducting gases.

.3 Maximum Line Pressure: 62 Pa H_20 Gage.

.4 Accuracy: < ± 1.0% full scale.

Resolution: Infinite.

Repeatability: < 0.3% F.S.

.5 Environmental & Mechanical Data:

.1 Temperature: 0 to 175ºF.

.2 Case: Fire-retardant glass filled polyester.

.3 Pressure Connections: 4.76 mm barbed brass pressure fitting for 6.35 mm push-on tubing.

.6 Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application, or as shown.

Acceptable Products – Greystone, ACI, BAPI.

2.5 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements:

.1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.

.2 Adjustable setpoint and differential.

.3 Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application, or as shown.

.4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.

.5 Accuracy: within 1% repetitive switching.

.6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.

.7 Switches on steam and high temperature hot water service: provide pigtail syphon.

Acceptable Products – Greystone, ACI, BAPI.

2.6 ELECTROMECHANICAL RELAYS

.1 Requirements: Double pole double throw (DPDT) relays control and status indication of alarms and/or electrical starters and equipment where shown on point schedule.

.1 Relay coils shall be rated for 120V or 24V. Where other voltages occur, provide transformer.

.2 Contacts rated at 5 amps at 130V AC.

.3 Relays to be plug-in type with termination base.

.4 Relay to have visual status indication.

2.7 SOLID STATE RELAYS

.1 General:

.1 Input and output Barrier Strips to accept 14 to 28 AWG wire.

.2 Operating temperature range to be -20°C to 70°C.

.3 Relays to be CSA Certified.

.4 Input/output Isolation Voltage to be 4000 VAC at 25°C for 1 second maximum duration.

.5 Operational frequency range, 45 to 65 HZ.

.2 Input:

.1 Control voltage, 3 to 32 VDC.

.2 Drop out voltage, 1.2 VDC.

.3 Maximum input current to match AO (Analog Output) board.

.3 Output.

.1 AC or DC Output Model to suit application.

2.8 CURRENT TRANSDUCERS

.1 Requirements: Supply and install where status points on equipment are required, unless otherwise noted.

.1 AC current transducers will be self-powered combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 0-5vdc two-wire output. Unit ranges shall be 10A, 20A, 50A, 100A, 150A, and 200A full scale, internal zero and span adjustment, and ± 1% full scale accuracy at 500 ohm maximum burden.

.2 Transducer shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.

.3 Unit shall be split-core type for clamp-on installation.

2.9 ELECTRONIC CONTROL DAMPER ACTUATORS

.1 Requirements:

.1 Electronic direct-coupled actuation shall be provided.

.2 For damper actuators, the actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a “V” bolt design with associated “V” shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage.

All actuators to be spring-return.

Spring return actuators shall have a “V” clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 27 mm when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable.

.3 The actuator shall have electronic overhead or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to de-activate the actuator at the end of rotation are not acceptable.

.4 For power failure/safety applications, an internal mechanical spring-return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.

.5 All spring-return actuators shall be capable of both clockwise and counter-clockwise spring-return operation by simply changing the mounting orientation.

.6 Proportional actuators shall accept a 0 – 10 VDC or 0 to 20 mA control input and provide a 2 to 10 VDC or 4 to 20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper or valve is acceptable. All actuators shall provide a 2 to 10 VDC position feedback signal.

.7 All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall now require more than 11 VA.

.8 All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.

.9 Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

.10 Actuators shall be Underwriters Laboratories Standard UL60 7030-1 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standard.

.11 All damper actuators shall provide no less than 12.2 $N.M/M^2$.

.12 All valve actuators shall be shipped already mounted to their respective valves.

.13 Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rate torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.

.14 Actuators shall provide direct positional feedback to the control system.

.15 Acceptable Products: Belimo, Neptronic and Siemens.

.16 This Contractor is responsible to provide necessary quality of actuators and linkages to properly operate all damper sections.

2.10 PANELS

.1 Wall mounted enamelled steel cabinets with hinged and key-locked front door.

.2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as required by Owner's Representative without adding additional cabinets.

.3 Panels to be lockable with same key.

2.11 WIRING

.1 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.

.2 Wiring must be continuous without joints.

.3 Sizes:

.1 Field wiring to digital device: #18AWG stranded twisted pair.

.2 Analog input and output: #18 minimum stranded twisted pair.

2.12 ETHERNET SWITCHES

.1 16-Ports.

.2 Managed.

.3 Rack Mountable.

.4 Approved Product: HP V1910-16G switch, manufacturing part: JE005A #ABA.

2.13 CONTROL VALVES

.1 General: Contractor shall select valves according to manufacturer's instructions, submit schedule indicating CV and pressure drop. Maximum PD 138 kPa (20 psi).

.2 Pressure Independent Characterized Control Valve (PICCV):

.1 13 mm to 50 mm size (1/2" to 2") 2-way.

.2 Body: Brass, Nickel plated.

.3 Ball: Stainless Steel ball and stem c/w brass characterizing disc.

.4 Seats: Teflon PTFE.

.5 Seat O-rings: Viton.

.6 Stem O-ring: EPDM (lubricated).

.7 Temp Rating: -18°C to 100°C (0°F to 212°F).

.8 Press Rating:

.1 ½", ¾", 1" valves: 4137 kPa (600 psi).

.2 1-1/4", 1-1/2", 2": 2758 kPa (400 psi).

.9 Close-off pressure: 1380 kPa (200 psi).

.10 Differential Pressure: 34.5 to 345 kPa (5 to 50 psi).

.11 Actuator: Normally open, fail open, control inputs: Multi-Function Technology (2-10Vdc) modulating, spring return and feedback signal.

.12 Refer to schedule on drawings for size/capacity and additional information.

.13 2-Way Butterfly Valve:

.1 Body: ductile iron ASTM A536 with epoxy powder coat finish.

.2 End fitting: for ASME/ANSI class 125/150 flange.

.3 Disc: 304 Stainless Steel.

.4 Shaft: 416 Stainless Steel.

.5 Seat: EPDM.

.6 Stem packing: EPDM (lubricated).

.7 Bushing: RPTFE.

.8 Trim: HD.

.9 Temp Rating: -30°C to 120°C (-22°F to 250°F).

.10 Pressure Rating: consistent with ASME/ANSI class 125.

.11 Close-off pressure:

.1 1379 kPa (200 psi) (2" – 12").

.12 Actuator: Normally open, fail open, control inputs: Multi-Function Technology (2-10Vdc) modulating, electronic fail safe and feedback signal.

.13 Refer to schedule on drawings for size/capacity and additional information.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

.2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.

.3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

.4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.

.5 Fire stopping: provide space for fire stopping. Maintain fire rating integrity.

3.2 INSTALLATION OF SENSORS

.1 Install all sensors in accordance with the manufacturer's recommendations.

.2 Mount sensors rigidly and adequately for the environment within which the sensor operates.

.3 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

.4 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

.5 Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across duct. Each bend shall be supported with a capillary clip.

.6 Low limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m^2 of coil area.

.7 All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

.8 Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

.9 Strap-on sensor installation shall be as follows:

.1 Scrape and sand the top portion of the bare pipe, where the sensor is installed.

.2 Install heat conductive compound.

.3 Submerse sensor in compound.

.4 Completely cover the top of the sensor with additional compound.

.5 Cover compound with a reflective heat shield. Install tightly over complete installation.

.6 Install pipe bracket. (Gear clamp).

.7 Install insulation over complete installation.

.10 Stainless steel plate sensors to utilize a foam gasket to isolate sensor perimeter from direct contact with wall surface. Foam fill cavity directly behind space sensor then installation is recessed into wall.

3.3 PANELS

.1 Arrange for conduit and tubing entry from top, bottom or either side.

.2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

.3 Identify wiring and conduit clearly.

3.4 IDENTIFICATION

.1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

3.5 ACTUATORS

.1 Mount and link control damper actuators per manufacturer's instructions.

.1 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5°C open position, manually close the damper, and then tighten the linkage.

.2 Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

.3 Provide all mounting hardware and linkages for actuator installation.

.2 Electric/Electronic:

.1 Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.

.2 Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.6 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

END OF SECTION