PART 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 22 05 00 - Common Work Results for Plumbing.

.2 Section 23 05 00 - Common Work Results for HVAC.

.3 Section 26 05 00 - Common Work Results for Electrical.

1.2 DEFINITIONS

.1 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS Contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:

.1 Outage of main power supply in excess of back-up power sources, provided that:

.1 Automatic initiation of back-up was accomplished.

.2 Automatic shut-down and re-start of components was as specified.

.2 Failure of communications link, provided that:

.1 Controller automatically and correctly operated in stand-alone mode.

.2 Failure was not due to failure of any specified EMCS equipment.

.3 Functional failure resulting from individual sensor inputs or output devices, provided that:

.1 System recorded said fault.

.2 Equipment defaulted to fail-safe mode.

.3 AEL of total of all input sensors and output devices is at least 99% during test period.

1.3 DESIGN REQUIREMENTS

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

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Final Report: submit report to Departmental 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 Departmental 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 Departmental Representative.

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

1.5 COMMISSIONING

.1 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative.

.2 Correct deficiencies; re-test in presence of Departmental Representative until satisfactory performance is obtained.

.3 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.

.4 Load system with project software.

.5 Perform tests as required.

1.6 COMPLETION OF COMMISSIONING

.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Departmental Representative and PWGSC Commissioning Manager.

1.7 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

.1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

PART 2 PRODUCTS

2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system.

.2 Instrumentation accuracy tolerances to be 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 and readily accessible.

PART 3 EXECUTION

3.1 PROCEDURES

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

.2 Commission each system using procedures prescribed by the Departmental Representative.

.3 Commission integrated systems using procedures prescribed by the Departmental Representative.

.4 Debug system software.

.5 Optimize operation and performance of systems by fine-tuning PID.

.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.

3.2 FIELD QUALITY CONTROL

.1 Completion Testing.

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

.2 Include following activities:

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

.2 Test each DI to ensure proper settings and switching contacts.

.3 Test each DO to ensure proper operation and lag time.

.4 Test operating software.

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

.6 Verify each CDL including energy optimization programs.

.7 Debug software.

.8 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. This document will be used in final startup testing.

.3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and provide:

.1 2 technical personnel capable of re-calibrating field hardware and modifying software.

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

.3 Departmental Representative's acceptance signature to be on executive and applications programs.

.4 Commissioning to commence during final startup testing.

.5 O&M personnel to assist in commissioning procedures as part of training.

.6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.

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

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

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

.4 Perform Final Operational Testing to demonstrate that EMCS functions in accordance with contract requirements.

.1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.

.1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.

.2 Test to last at least 30 consecutive days.

.3 Tests to include:

.1 Demonstration of correct operation of monitored and controlled points.

.2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.

.4 System will be accepted when:

.1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.

.2 Requirements of Contract have been met.

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

.6 Correct defects when they occur and before resuming tests.

3.3 ADJUSTING

.1 Upon completion of commissioning as reviewed by Departmental Representative, set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

.1 Demonstrate to Departmental 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.

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 00 - Common Work Results for HVAC.

.2 Section 26 05 00 - Common Work Results for Electrical.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to 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.

.2 Submit reports within one week after completion of training program that training has been satisfactorily completed.

1.3 QUALITY ASSURANCE

.1 Provide bilingual, competent instructors thoroughly familiar with aspects of EMCS installed in facility.

.2 Departmental Representative reserves right to approve instructors.

1.4 INSTRUCTIONS

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

.2 Training to be project-specific.

1.5 TIME FOR INSTRUCTION

.1 Number of 8-hour days instruction to be as specified in this section.

1.6 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 (O&M).

1.7 TRAINING PROGRAM

.1 One day program to begin before 30 day test period at time mutually agreeable to Contractor and Departmental Representative and PWGSC Commissioning Manager.

.1 Train O&M personnel in functional operations and procedures to be employed for system operation.

.2 Supplement with on-the-job training during 30 day test period.

.3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.

.4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

1.8 ADDITIONAL TRAINING

.1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

PART 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 EXECUTION

3.1 NOT USED

.1 Not Used.

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 00 - Common Work Results for HVAC.

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

.3 Section 25 05 54 - EMCS: Identification.

.4 Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

.5 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 Institute of Electrical and Electronics Engineers (IEEE)
.1 IEEE 260.1-2004, IEEE Standard Letter Symbols for Units of Measurement (SI Customary Inch-Pound Units, and Certain Other Units).

.2 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
.1 ASHRAE 135-2012, BACnet - A Data Communication Protocol for Building Automation and Control Networks (ANSI Approved).

.3 Consumer Technology Association (Formerly CEA)
.1 CTA 709.1-D-2014, Control Network Protocol Specification (Formerly ANSI/CEA-709.1-D).

.4 Department of Justice Canada (Jus):
.1 Canadian Environmental Assessment Act (CEAA), 2012
.2 Canadian Environmental Protection Act (CEPA), 1999

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

.6 The International Society of Automation
.1 ISA 5.5-1985, Graphic Symbols for Process Displays.

.7 Transport Canada (TC):
.1 Transportation of Dangerous Goods Act (TDGA), 1992

1.3 ACRONYMS AND ABBREVIATIONS

.1 Acronyms used in EMCS:
.1 AEL – Average Effectiveness Level.
.2 AI – Analog Input.

.3 AIT – Agreement on International Trade.
.4 AO – Analog Output.
.5 BACnet – Building Automation and Control Network.
.6 BC(s) – Building Controller(s).
.7 BECC – Building Environmental Control Center.
.8 CAD – Computer Aided Design.
.9 CDL – Control Description Logic.
.10 CDS – Control Design Schematic.
.11 COSV – Change of State or Value.
.12 CPU – Central Processing Unit.
.13 DI – Digital Input.
.14 DO – Digital Output.
.15 DP – Differential Pressure.
.16 ECU – Equipment Control Unit.
.17 EMCS – Energy Monitoring and Control System.
.18 HVAC – Heating, Ventilation, Air Conditioning.
.19 IDE – Interface Device Equipment.
.20 I/O – Input/Output.
.21 ISA – Industry Standard Architecture.
.22 LAN – Local Area Network.
.23 LCU – Local Control Unit.
.24 MCU – Master Control Unit.
.25 NAFTA – North American Free Trade Agreement.
.26 NC – Normally Closed.
.27 NO – Normally Open.
.28 OS – Operating System.
.29 O&M – Operation and Maintenance.
.30 OWS – Operator Work Station.
.31 PC – Personal Computer.
.32 PCI – Peripheral Control Interface.
.33 PCMCIA – Personal Computer Micro-Card Interface Adapter.
.34 PID – Proportional, Integral and Derivative.
.35 RAM – Random Access Memory.
.36 SP – Static Pressure.
.37 ROM – Read Only Memory.
.38 TCU – Terminal Control Unit.
.39 USB – Universal Serial Bus.
.40 UPS – Uninterruptible Power Supply.
.41 VAV – Variable Air Volume.

1.4 DEFINITIONS

.1 Point: may be logical or physical.

.1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.

.2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.

.2 Point Name: composed of two parts, point identifier and point expansion.
.1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.
.1 Area descriptor: building or part of building where point is located.
.2 System descriptor: system that point is located on.
.3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25 character field for each point identifier.
.2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.
.3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
.1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.

.3 Point Object Type: points fall into following object types:
.1 AI (analog input).
.2 AO (analog output).
.3 DI (digital input).
.4 DO (digital output).
.5 Pulse inputs.

.4 Symbols and engineering unit abbreviations utilized in displays: to ISA 5.5.
.1 Printouts: to IEEE 260.1.
.2 Refer also to Section 25 05 54 - EMCS: Identification.

1.5 SYSTEM DESCRIPTION

.1 Refer to control schematics and specifications for system architecture.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
.1 Building Controllers.
.2 Control devices as listed in I/O point summary tables.
.3 OWS(s).
.4 Data communications equipment necessary to effect EMCS data transmission system.
.5 Field control devices.
.6 Software/Hardware complete with full documentation.
.7 Complete operating and maintenance manuals.
.8 Training of personnel.

.9 Acceptance tests, technical support during commissioning, full documentation.
.10 Wiring interface co-ordination of equipment supplied by others.
.11 Miscellaneous work as specified in these sections and as indicated.

.3 Design Requirements:
.1 Design and provide conduit and wiring linking elements of system.
.2 Supply sufficient programmable controllers of types to meet project requirements.

.4 Language Operating Requirements:
.1 Provide English or French operator selectable access codes.
.2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English and French.
.3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English and or French.
.4 System manager software: include in English and or French system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
.5 Include, in English and French:
.1 Input and output commands and messages from operator-initiated functions and field related changes and alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).
.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in French and English at specified OWS and to be able to operate one terminal in English and second in French. Point name expansions in both languages.
.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Submittals and Review Process.

.2 Submit for review:
.1 Equipment list and systems manufacturers at time of tender within 48 h after award of contract.

.3 Quality Control:
.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Submittals and Review Process. Label or listing of specified organization is acceptable evidence.
.4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental 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 Departmental Representative.
.8 Existing devices intended for re-use: submit test report.

1.7 QUALITY ASSURANCE

.1 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

1.8 DESIGNATED CONTRACTOR

.1 Hire the services of Andover Continuum BAS by Schneider Electric or its authorized representative to complete the work of all EMCS sections.

PART 2 PRODUCTS

2.1 MATERIALS

.1 There is an existing Andover Continuum BAS by Schneider Electric system presently installed in the building. All materials must be selected to ensure compatibility with the existing Andover Continuum BAS system.

2.2 ADAPTORS

.1 Provide adaptors between metric and imperial components.

PART 3 EXECUTION

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 00 - Common Work Results for HVAC.

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

.3 Section 26 05 00 - Common Work Results for Electrical.

1.2 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following Contractor and systems information.
- .1 Location of local office.
- .2 Description and location of installing and servicing technical staff.
- .3 Location and qualifications of programming design and programming support staff.
- .4 List of spare parts.
- .5 Location of spare parts stock.
- .6 Names of sub-contractors and site-specific key personnel.
- .7 Sketch of site-specific system architecture.
- .8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
- .9 Descriptive brochures.
- .10 Sample CDL and graphics (systems schematics).
- .11 Response time for each type of command and report.
- .12 Item-by-item statement of compliance.

1.3 PRELIMINARY SHOP DRAWING REVIEW

.1 Submit preliminary shop drawings within 30 working days of award of contract and include following:
- .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
- .2 Detailed system architecture showing all points associated with each controller including signal levels and pressures where new EMCS ties into existing control equipment.
- .3 Controller locations.
- .4 Auxiliary control cabinet locations.
- .5 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

.6 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
.7 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.
.8 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.

1.4 DETAILED SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:
.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
.2 Wiring diagrams.
.3 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
.4 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
.1 Sensing element type and location.
.2 Transmitter type and range.
.3 Associated field wiring schematics, schedules and terminations.
.4 Complete Point Name Lists.
.5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
.6 Software and programming details associated with each point.
.7 Manufacturer's recommended installation instructions and procedures.
.8 Input and output signal levels or pressures where new system ties into existing control equipment.
.5 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
.6 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.
.7 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
.8 Listing and example of specified reports.
.9 Listing of time of day schedules.
.10 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.
.11 Type and size of memory with statement of spare memory capacity.
.12 Full description of software programs provided.
.13 Sample of "Operating Instructions Manual" to be used for training purposes.
.14 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

PART 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 EXECUTION

3.1 NOT USED

.1 Not Used.

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 00 - Common Work Results for HVAC.

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

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

.4 Section 26 05 00 - Common Work Results for Electrical.

1.2 O&M MANUALS

.1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.

.2 Provide 2 complete sets of hard and soft copies prior to system or equipment tests.

.3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.

.4 Functional description to include:

.1 Functional description of theory of operation.

.2 Design philosophy.

.3 Specific functions of design philosophy and system.

.4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.

.5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.

.6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.

.5 System operation to include:

.1 Complete step-by-step procedures for operation of system including required actions at each OWS.

.2 Operation of computer peripherals, input and output formats.

.3 Emergency, alarm and failure recovery.

.4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.6 Software to include:

.1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.

.2 Detailed descriptions of program requirements and capabilities.

.3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.

.4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device.

.5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.

.6 Software for each Controller and single section referencing Controller common parameters and functions.

.7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.

.8 System configuration document:

.1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.

.2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

.9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

PART 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 EXECUTION

3.1 NOT USED

.1 Not Used.

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 22 05 00 - Common Work Results for Plumbing.

.2 Section 23 05 00 - Common Work Results for HVAC.

.3 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.

PART 2 PRODUCTS

2.1 NAMEPLATES FOR PANELS

.1 Identify by Plastic laminate, 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by chain.

.2 Sizes: 50 x 100 mm minimum.

.3 Lettering: minimum 5 mm high produced from laser printer in black.

.4 Data to include: point name and point address.

.5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by stick-on labels using point identifier.

.2 Location: as directed by Departmental Representative.

.3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

.1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Departmental Representative's.

2.5 WIRING

.1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.

.2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 PNEUMATIC TUBING

.1 Numbered tape markings on tubing to provide uninterrupted tracing capability.

2.7 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

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.

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 00 - Common Work Results for HVAC.

.2 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-Z204-94 (R1999), Guideline for Managing Indoor Air Quality in Office Buildings.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit detailed preventative maintenance schedule for system components.

.3 Submit detailed inspection.

.4 Submit dated, maintenance task lists to include the following sensor and output point detail, as proof of system verification:

.1 Point name and location.
.2 Device type and range.
.3 Measured value.
.4 System displayed value.
.5 Calibration detail
.6 Indication if adjustment required,
.7 Other action taken or recommended.

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Maintain records and logs of each maintenance task on site.

.7 Organize cumulative records for each major component and for entire EMCS chronologically.

.8 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.

.9 Revise and submit to Departmental Representative "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Emergency Service Calls:
- .1 Initiate service calls when EMCS is not functioning correctly.
- .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
- .3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
- .4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.
- .5 Perform Work continuously until EMCS restored to reliable operating condition.

.2 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

.3 Work requests: record each service call request, when received separately on approved form and include:
- .1 Serial number identifying component involved.
- .2 Location, date and time call received.
- .3 Nature of trouble.
- .4 Names of personnel assigned.
- .5 Instructions of work to be done.
- .6 Amount and nature of materials used.
- .7 Time and date work started.
- .8 Time and date of completion.

.4 Provide system modifications in writing.
- .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

PART 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

.1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report Departmental Representative as described in Submittal article.

.2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:

.1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.

.2 Check and Calibrate each field input/output device in accordance with Canada Labour Code - Part I and CSA Z204.

.3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.

.4 Minor inspections to include, but not limited to:

.1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.

.2 Check equipment cooling fans as required.

.3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.

.4 Review system performance with Departmental Representative to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:

.1 Minor inspection.

.2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.

.3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.

.4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.

.5 Provide mechanical adjustments, and necessary maintenance on printers.

.6 Run system software diagnostics as required.

.7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.

.1 Perform network analysis and provide report as described in Submittal article.

.6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.7 Continue system debugging and optimization.

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 00 - Common Work Results for HVAC.

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

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

.4 Section 25 05 03 - EMCS: Project Record Documents.

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

.6 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

.7 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE):
.1 ASHRAE HVAC Applications Handbook, 2015.

.2 Canadian Standards Association (CSA International):
.1 C22.2 No. 205-12, Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE)
.1 IEEE C37.90.1-2002, IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

.4 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services:
.1 MD 250005-2009, Energy Monitoring and Control Systems (EMCS) Design Guidelines.

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTION

.1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.

.1 Provide sufficient controllers to meet intents and requirements of this section.

.2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.

.2 Controllers: stand-alone intelligent Control Units.

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

.3 Capable of interfacing with operator interface device.

.4 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 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 AI and DI 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 for MCUs and LCUs: at least 25% of each point type distributed throughout the MCUs and LCUs.

.3 Field Termination and Interface Devices:

.1 To: CSA C22.2 No.205.

.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 AI, AO, DI, DO functions as specified.

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

.4 AI 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 AO 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 V DC.

.3 Meet IEEE C37.90.1 surge withstand capability.

.6 DI 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 DO 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 24 V AC.

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

.4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees 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 Departmental Representative 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 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 - EMCS: Submittals and Review Process.
.1 Submit product data sheets for each product item proposed for this project.

1.7 MAINTENANCE PROCEDURES

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

PART 2 PRODUCTS

2.1 MASTER CONTROL UNIT (MCU)

.1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.

.2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.
.1 MCU must support Proprietary Protocol.

.3 MCU local I/O capacity as follows:
.1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.
.2 LCUs may be added to support system functions.

.4 Central Processing Unit (CPU):
.1 Processor to consist of minimum 16 bit microprocessor capable of supporting software to meet specified requirements.
.2 CPU idle time to be more than 30% when system configured to maximum input and output with worst case program use.
.3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
.1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
.2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.
.4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.

.5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise specified in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

.1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Departmental Representative.

.2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.

.3 Display simultaneously minimum of 16 point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English and French.

.4 Functions to include, but not be limited to, following:

.1 Start and stop points.

.2 Modify setpoints.

.3 Modify PID loop parameters.

.4 Override PID control.

.5 Change time/date.

.6 Add/modify/start/stop weekly scheduling.

.7 Add/modify setpoint weekly scheduling.

.8 Enter temporary override schedules.

.9 Define holiday schedules.

.10 View analog limits.

.11 Enter/modify analog warning limits.

.12 Enter/modify analog alarm limits.

.13 Enter/modify analog differentials.

.5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.

.6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.

.7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.

.8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.2 LOCAL CONTROL UNIT (LCU)

.1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.

.2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.

.3 Points integral to one Building System to be resident on only one controller.

.4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:

.1 Include minimum 2 interface ports for connection of local computer terminal.

.2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.
.3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
.4 Include power supplies for operation of LCU and associated field equipment.
.5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
.6 Provide conveniently located screw type or spade lug terminals for field wiring.

2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

.1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
.1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.

.2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.

.3 VAV Terminal Controller.
.1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook.
.2 Controller to support point definition; in accordance with Section 25 05 01 - EMCS: General Requirements.
.3 Controller to operate independent of network in case of communication failure.
.4 Controller to include damper actuator and terminations for input and output sensors and devices.

2.4 SOFTWARE

.1 General.
.1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation – CDL's.
.2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
.3 Include initial programming of Controllers, for entire system.

.2 Program and data storage.
.1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.

.2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

.3 Programming languages.

.1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.

.2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.

.4 Operator Terminal interface.

.1 Operating and control functions include:

.1 Multi-level password access protection to allow user/manager to limit workstation control.

.2 Alarm management: processing and messages.

.3 Operator commands.

.4 Reports.

.5 Displays.

.6 Point identification.

.5 Pseudo or calculated points.

.1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.

.2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).

.6 Control Description Logic (CDL):

.1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Departmental Representative must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.

.2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.

.3 Perform changes to CDL on-line.

.4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.

.5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.

.6 MCU to be able to perform following pre-tested control algorithms:

.1 Two position control.

.2 Proportional Integral and Derivative (PID) control.

.3 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.

.4 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.5 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

.7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

.8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.

.1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:

.1 Time of day scheduling.
.2 Calendar based scheduling.
.3 Holiday scheduling.
.4 Temporary schedule overrides.
.5 Optimal start stop.
.6 Night setback control.
.7 Enthalpy (economizer) switchover.
.8 Peak demand limiting.
.9 Temperature compensated load rolling.
.10 Fan speed/flow rate control.
.11 Cold deck reset.
.12 Hot deck reset.
.13 Hot water reset.
.14 Chilled water reset.
.15 Condenser water reset.
.16 Chiller sequencing.
.17 Night purge.

.2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.

.9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.

.1 MCUs to accumulate and store automatically run-time for binary input and output points.

.2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.

.3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.

.4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWH, litres, tonnes, etc.).

.6 Store event totalization records with minimum of 9,999,999 events before reset.

.7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.5 LEVELS OF ADDRESS

.1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.

.1 Display analog values digitally to 1 place of decimals with negative sign as required.

.2 Update displayed analog values and status when new values received.

.3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.

.4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.6 POINT NAME SUPPORT

.1 Controllers (MCU, LCU) to support PWGSC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

PART 3 EXECUTION

3.1 LOCATION

.1 Location of Controllers to be approved by Departmental Representative.

3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures as indicated or as directed by Departmental Representative.

.2 Provide necessary power from local 120 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.

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 07 84 00 - Firestopping.

.2 Section 23 05 00 - Common Work Results for HVAC.

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

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

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

.6 Section 25 05 54 - EMCS: Identification.

.7 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

.8 Section 26 05 00 - Common Work Results for Electrical.

.9 Section 26 27 26 - Wiring Devices.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)
.1 ANSI C12.7-2014, Requirement for Watthour Meter Sockets.

.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 ANSI/AMCA 500-D-12, Laboratory Methods for Testing Dampers for Rating.

.5 Canadian Standards Association (CSA International)
.1 CSA C22.1-15, Canadian Electrical Code, Part 1 (3rd Edition), Safety Standard for Electrical Installations.

.6 Institute of Electrical and Electronics Engineers
.1 IEEE C57.13-2016, IEEE Approved Draft Standard Requirements for Instrument Transformers.

1.3 DEFINITIONS

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

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Pre-Installation Tests.
.1 Submit samples at random from equipment shipped, as requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.

.3 Manufacturer's Instructions:
.1 Submit manufacturer's installation instructions for specified equipment and devices.

1.5 EXISTING CONDITIONS

.1 Repair surfaces damaged during execution of Work.

.2 Turn over to Departmental 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 degrees 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.

.9 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

2.2 TEMPERATURE SENSORS

.1 General: except for room sensors to be resistance or thermocouple type to following requirements:

.1 Thermocouples: limit to temperature range of 200 degrees C and over.

.2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.

.3 Sensing element: hermetically sealed.

.4 Stem and tip construction: copper or type 304 stainless steel.

.5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.

.6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm as indicated.

.2 Room temperature sensors and display wall modules.

.1 Room temperature sensors.

.1 Wall mounting, in slotted type covers having brushed aluminum finish, with guard as indicated.

.2 Element 10-50 mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.

.3 Outdoor air temperature sensors:

.1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

2.3 ELECTROMECHANICAL RELAYS

.1 Requirements:

.1 Double voltage, DPDT, plug-in type with termination base.

.2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.

.3 Contacts: rated at 5 amps at 120 V AC.

.4 Relay to have visual status indication.

2.4 SOLID STATE RELAYS

.1 General:
- .1 Relays to be socket or rail mounted.
- .2 Relays to have LED Indicator
- .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
- .4 Operating temperature range to be -20 degrees C to 70 degrees C.
- .5 Relays to be CSA Certified.
- .6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.
- .7 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.

2.5 CURRENT TRANSDUCERS

.1 Requirements:
- .1 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:
  - .1 4-20 mA DC.
  - .2 0-1 volt DC.
  - .3 0-10 volts DC.
  - .4 0-20 volts DC.
- .2 Frequency insensitive from 10 - 80 hz.
- .3 Accuracy to 0.5% full scale.
- .4 Zero and span adjustments. Field adjustable range to suit motor applications.
- .5 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.6 CURRENT SENSING RELAYS

.1 Requirements:
- .1 Suitable to detect belt loss or motor failure.
- .2 Trip point adjustment, output status LED.
- .3 Split core for easy mounting.
- .4 Induced sensor power.
- .5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.
- .6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
- .7 Adjustable latch level.

2.7 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements:
- .1 Construction: steel, cast iron, aluminum.
- .2 Control signal: 0-10V DC or 4-20 mA DC.
- .3 Positioning time: to suit application. 90 sec maximum.
- .4 Fail to normal position as indicated.
- .5 Scale or dial indication of actual control valve position.
- .6 Size actuator to meet requirements and performance of control valve specifications.
- .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.
- .8 Minimum shut-off pressure: use shut-off pressure rating of pumps.

2.8 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 Departmental Representative without adding additional cabinets.

.3 Panels to be lockable with same key.

2.9 WIRING

.1 In accordance with Section 26 27 26 - Wiring Devices.

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

.3 Wiring must be continuous without joints.

.4 Sizes:
- .1 Field wiring to digital device: #18AWG.
- .2 Analog input and output: shielded #18 minimum solid copper.

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 in accordance with Section 07 84 00 - Firestopping. Maintain fire rating integrity.

.6 Electrical:

.1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.3 Refer to electrical control schematics included as part of control design schematics in Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Departmental Representative before beginning Work.

.4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

.5 Install communication wiring in conduit.

.1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).

.2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

.3 Maximum conduit fill not to exceed 40%.

.4 Design drawings do not show conduit layout.

.6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

.7 VAV Terminal Units: supply, install and adjust as required.

.1 Air probe, actuator and associated vav controls.

.2 Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators.

.3 Co-ordinate air flow adjustments with balancing trade.

3.2 TEMPERATURE AND HUMIDITY SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.

.3 Outdoor installation:

.1 Protect from solar radiation and wind effects by non-corroding shields.

.2 Install in NEMA 4 enclosures.

.4 Duct installations:
.1 Do not mount in dead air space.
.2 Locate within sensor vibration and velocity limits.
.3 Securely mount extended surface sensor used to sense average temperature.
.4 Thermally isolate elements from brackets and supports to respond to air temperature only.
.5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors.
.1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
.2 Wire multiple sensors in series for low temperature protection applications.
.3 Wire multiple sensors separately for temperature measurement.
.4 Use software averaging algorithm to derive overall average for control purposes.

.6 Thermowells: install for piping installations.
.1 Locate well in elbow where pipe diameter is less than well insertion length.
.2 Thermowell to restrict flow by less than 30%.
.3 Use thermal conducting paste inside wells.

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 AIR FLOW MEASURING STATIONS

.1 Protect air flow measuring assembly until cleaning of ducts is completed.

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.

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 00 - Common Work Results for HVAC.

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

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

.4 Section 25 05 54 - EMCS: Identification.

.5 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.

.6 Section 26 05 00 - Common Work Results for Electrical.

.7 Section 26 27 26 - Wiring Devices.

1.2 SEQUENCE OF OPERATION

.1 VAV System

.1 Heating:

.1 Air from the air handling units will be supplied at temperatures to provide some heating.

.2 Comfort level heating will be provided through the control of the supplemental fin-tube radiant heaters at the sub-zone level.

.2 Cooling:

.1 Cooling will be provided through the air handling units and controlled based on space sensors and requirements.

.2 Zone VAV terminals will adjust air flows to satisfy cooling requirements.

.2 Transfer/Exhaust Fans

.1 New transfer and exhaust fans to operate based on occupancy schedule. Fans to be on during occupied periods and are to be off during unoccupied periods.

.2 Fan on/off status are to be monitored through EMCS system.

PART 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 EXECUTION

3.1 NOT USED

.1 Not Used.