

1 General

1.1 RELATED SECTIONS

- .1 Section 01 91 13 General Commissioning (Cx) Requirements.
- .2 Section 21 05 01 Mechanical General Requirements.

1.2 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 Submittal Procedures and 25 05 02 EMCS Submittals and Review Process.
- .2 Final Report: submit report to the Departmental Representative.
 - .1 Include measurements, final settings and certified test results.
 - .2 Bear signature of commissioning technician and supervisor
 - .3 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 Closeout Submittals.
 - .4 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.3 DESIGN REQUIREMENTS

- .1 Confirm with the Departmental 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.

1.4 COMMISSIONING

- .1 Do commissioning in accordance with Section 01 91 13 General Commissioning (Cx) Requirements.
- .2 Carry out commissioning under direction of the Departmental Representative. Provide the Departmental Representative advance notice of commissioning and the opportunity to witness it.
- .3 Correct deficiencies, re-test to requirements of the Departmental Representative.
- .4 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .5 Load system with project software.
- .6 The Departmental Representative reserves to right to test system to verify operation.

1.5 COMPLETION OF COMMISSIONING

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

1.6 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.

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 two (2) months prior to tests.

3 Execution

3.1 PROCEDURES

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system and integrated systems using procedures prescribed by the Departmental Representative.
- .3 Debug system software.
- .4 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .5 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 Pre-Installation Testing.
 - .1 General: consists of field tests of equipment just prior to installation.
 - .2 Testing to be on site unless prior permission received from the Departmental Representative.

- .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and two (2) sets of Building Controller's including MCU's, LCU's, and TCU's.
 - .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
 - .5 Additional instruments to include:
 - .1 Temperature sensor(s).
 - .6 In addition to test equipment, provide digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source and to BECC.
 - .7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.
 - .8 Transmitters above 0.5 % error will be rejected.
 - .9 DP switches to open and close within 2% of setpoint.
- .2 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 Verify each A-to-D convertor.
 - .3 Test and calibrate each AI using calibrated digital instruments.
 - .4 Test each DI to ensure proper settings and switching contacts.
 - .5 Test each DO to ensure proper operation and lag time.
 - .6 Test each AO 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 Verify each CDL including energy optimization programs.
 - .10 Debug software.
 - .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
 - .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units.
 - .3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system. Provide:
 - .1 Technical personnel capable of re-calibrating field hardware and modifying software.
 - .2 Commissioning to commence during final startup testing.
 - .3 O&M personnel may assist in commissioning procedures as part of training.
 - .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.

- .4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
 - .1 Prior to beginning of thirty (30) day test demonstrate that operating parameters (set-points, 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 thirty (30) consecutive twenty-four (24) hour 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.
- .5 The Departmental Representative reserves the right to verify reported results.

3.3 ADJUSTING

- .1 Final adjusting: upon completion of commissioning set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

- .1 Demonstrate to the 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 in accordance with Section 01 79 00 Demonstration and Training.

END OF SECTION

Part 1 - General

1.1 TRAINING PROPOSAL

- .1 Provide training proposal complete hour-by-hour schedule including brief overview of content of each segment to the Departmental Representative 30 days prior to anticipated date of commencement of training.
 - .1 List name of trainer, visual, and audio aids to be used.
 - .2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.

1.2 INSTRUCTORS

- .1 To be competent, thoroughly familiar with all aspects of EMCS installed in this facility.
- .2 The Departmental Representative reserves right to approve instructors, based on qualifications.

1.3 INSTRUCTION

- .1 Provide instruction to designated personnel in adjustment, operation, maintenance, pertinent safety requirements of EMCS installed.
- .2 Training to be project-specific.
- .3 The full extent of the training shall be video recorded and a copy provided to the Departmental Representative as part of the operation and maintenance manuals. The recording shall be provided by a third-party recording agency and shall include all aspects of training for future reference.

1.4 TIME FOR INSTRUCTION

- .1 A total of three person-days of instruction, or as otherwise deemed required by the Departmental Representative, to be as specified in this section (1 person-day = 8 h including two 15 min breaks and excluding lunch time).

1.5 TRAINING MATERIALS

- .1 Provide equipment, visual and audio aids, and materials for classroom training.
- .2 Provide manual for each trainee, describing in detail data included in each training program.

1.6 TRAINING PROGRAM

- .1 To be in 2 phases over 6 month period:
 - .1 Phase 1: before 30 day test period at time mutually agreeable to the Departmental Representative. Train O&M personnel in functional operations and procedures to be employed for system operation. Supplement with continuous on-the-job training during 30 day test period. To include overview of system architecture, communications, operation of

computer and peripherals, report generation; detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

- .2 Phase 2: 8 weeks after acceptance. For operators, equipment maintenance personnel and programmers. Use multiple instructors on pre-arranged schedule. Include at least following:
 - .1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
 - .2 Equipment maintenance training: provide personnel with maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.
 - .3 Programmers: provide personnel in following subjects in approximate percentages of total course shown:
 - Software 10%, architecture:
 - Applications 15%, program:
 - Controller 50%, programming:
 - Trouble shooting 15%, debugging:
 - Colour graphic 10%, generation:

Part 2 - General

2.1 NOT USED

- .1 Not Used.

Part 3 - General

3.1 NOT USED

- .1 Not Used.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 Mechanical General Requirements.
- .2 Section 23 05 53 Mechanical Identification.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
 - .1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
 - .1 ANSI/IEEE 260.1-1993, 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 135-2012, BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Consumer Electronics Association (CEA).
 - .1 CEA-709.1-B-2002, Control Network Protocol Specification.
- .5 Nova Scotia Department of Labour and Workforce Development.
 - .1 Electrical Bulletins.

1.3 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 Submittal Procedures and 25 05 02 EMCS: Shop Drawings, Product Data and Review Process.

1.4 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 Management 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 NC - Normally Closed.
- .26 NO - Normally Open.
- .27 OS - Operating System.
- .28 O&M - Operation and Maintenance.
- .29 OWS - Operator Work Station.
- .30 PC - Personal Computer.
- .31 PCI - Peripheral Control Interface.
- .32 PCMCIA - Personal Computer Micro-Card Interface Adapter.
- .33 PID - Proportional, Integral and Derivative.
- .34 RAM - Random Access Memory.
- .35 SP - Static Pressure.
- .36 ROM - Read Only Memory.
- .37 TCU - Terminal Control Unit.
- .38 USB - Universal Serial Bus.
- .39 UPS - Uninterruptible Power Supply.
- .40 VAV - Variable Air Volume.

1.5 DEFINITIONS

- .1 AEL: ratio between total test period less any system downtime accumulated within that period and test period.
- .2 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.

- .3 Point: may be logical or physical.
 - .1 Logical points: values calculated by system such as set-points, 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.
- .4 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 short forms 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 short form 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.
- .5 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.
- .6 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
 - .1 Printouts: to ANSI/IEEE 260.1.

1.6 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.
- .8 Existing devices intended for re-use: submit test report.

1.7 SYSTEM DESCRIPTION

- .1 ***Refer to control schematics and for system architecture. There is an existing Delta enteliWEB system at the ELLIS building, providing full integration of the AHU's, hot water system, chilled water system, Glycol system, domestic hot water system, exhaust fans, etc. As part of the design and implementation of this project, only one Front End/OWS will be accepted. Multiple OWS systems from different manufactures will not be accepted. For example, one OWS for all central equipment and one OWS for all LAB controls will be unacceptable.***
- .2 Refer to control schematics and for system architecture.
- .3 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 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.
- .4 Design Requirements:
 - .1 Design and provide conduit and wiring linking elements of system.
 - .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed Departmental Representative prior to installation.
 - .3 Location of controllers as reviewed by Departmental Representative and Departmental Representative prior to installation.
 - .4 Provide utility power to EMCS and emergency power to EMCS as indicated.

- .5 Language Operating Requirements:
 - .1 Provide English operator selectable access codes.
 - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
 - .3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.
 - .4 System manager software: include in English 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:
 - .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-definitions).
 - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS and to be able to operate one terminal in English. Point name expansions in both languages.
 - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.8 QUALITY ASSURANCE

- .1 Have local office within 50 km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,
- .2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .3 Have access to local supplies of essential parts and provide 7-year guarantee of availability of spare parts after obsolescence.
- .4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

1.9 DELIVERY, STORAGE AND HANDLING

- .1 Provide Material Delivery Schedule to Departmental Representative within two (2) weeks after award of Contract.

1.10 EXISTING CONDITIONS - CONTROL COMPONENTS

- .1 Utilize existing control wiring and piping as indicated.

- .2 Re-use field control devices that are usable in their original configuration provided that they conform to applicable codes, standards specifications.
 - .1 Do not modify original design of existing devices without written permission from Departmental Representative.
 - .2 Provide for new, properly designed device where re-usability of components is uncertain.
- .3 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.
 - .1 Furnish test report within 40 days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair by Departmental Representative.
 - .2 Failure to produce test report will constitute acceptance of existing devices by contractor.
- .4 Non-functioning items:
 - .1 Provide with report specification sheets or written functional requirements to support findings.
 - .2 Departmental Representative will repair or replace existing items judged defective yet deemed necessary for EMCS.
- .5 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
- .6 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from the Departmental Representative.
 - .1 Be responsible for items repaired or replaced by the Departmental Representative.
 - .2 Be responsible for repair costs due to negligence or abuse of equipment.
 - .3 Responsibility for existing devices terminates upon final acceptance of EMCS as approved by the Departmental Representative.
- .7 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

2 Products

2.1 EQUIPMENT

- .1 Control Network Protocol and Data Communication Protocol: to ASHRAE Standard 135.
- .2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

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

3.2 PAINTING

- .1 Painting: Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
 - .1 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.
 - .2 Clean and prime exposed hangers, racks, fastenings, and other support components.
 - .3 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

END OF SECTION

1 General

1.1 REFERENCED SECTIONS

- .1 Section 21 05 01 Mechanical General Requirements.
- .2 Section 25 01 11 EMCS Start-up, Verification and Commissioning.
- .3 Section 25 05 01 EMCS General Requirements.

1.2 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 Submittal Procedures and this section.
- .2 Submit preliminary design document within five (5) working days after Tender closing and before contract award, for review by the Departmental Representative.
- .3 Shop Drawings to consist of one (1) hard copy and one (1) soft copy (.pdf format) of design documents, shop drawings, product data and software.
- .4 Hard copy to be completely indexed and coordinated to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.
- .5 Soft copy to be in AutoCAD - latest version and *.pdf format, structured using menu format for easy loading and retrieval on OWS.

1.3 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.
 - .13 Proof of demonstrated ability of system to communicate utilizing BACnet.

1.4 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, signal levels, pressures where new EMCS ties into existing control equipment.
- .3 Spare point capacity of each controller by number and type.
- .4 Controller locations.
- .5 Auxiliary control cabinet locations.
- .6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

1.5 DETAIL 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 Piping diagrams and hook-ups.
 - .4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
 - .5 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 Pneumatic schematics and schedules.
 - .5 Complete Point Name Lists.
 - .6 Set-points, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
 - .7 Software and programming details associated with each point.
 - .8 Manufacturer's recommended installation instructions and procedures.
 - .9 Input and output signal levels or pressures where new system ties into existing control equipment.
 - .6 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.
 - .7 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.
 - .8 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.
 - .9 Listing and example of specified reports.
 - .10 Listing of time of day schedules.
 - .11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.

- .12 Type and size of memory with statement of spare memory capacity.
- .13 Full description of software programs provided.
- .14 Sample of "Operating Instructions Manual" to be used for training purposes.
- .15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 EMCS Start-up, Verification and Commissioning.

1.6 QUALITY ASSURANCE

- .1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:
 - .1 Undertake functional review of preliminary design documents, resolve inconsistencies.
 - .2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
 - .3 Review interface requirements of materials supplied by others.
 - .4 Review "Sequence of Operations".
- .2 Contractor's programmer to attend meeting.
- .3 Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without additional costs.

2 Products

2.1 NOT USED

- .1 Not Used.

3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 Mechanical General Requirements.

1.2 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 Submittal Procedures and 25 05 02 EMCS Submittal and Review Process.
- .2 Record Documents to be in English.
- .3 Provide soft copies and hard copies in hard-back, 50 mm thick, 3 ring D-ring binders.
 - .1 Binders to be 2/3 maximum full.
 - .2 Provide index to full volume in each binder.
 - .3 Identify contents of each manual on cover and spine.
 - .4 Provide Table of Contents in each manual.
 - .5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.3 AS-BUILTS

- .1 Provide one (1) copy of detailed shop drawings generated and include:
 - .1 Changes to contract documents as well as addenda and contract extras.
 - .2 Changes to interface wiring.
 - .3 Routing of conduit, wiring and control air lines associated with EMCS installation.
 - .4 Locations of obscure devices to be indicated on drawings.
 - .5 Listing of alarm messages.
 - .6 Panel/circuit breaker number for sources of normal/emergency power.
 - .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
 - .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 EMCS Start-up, Verification and Commissioning.
 - .9 Basic system design and full documentation on system configuration.
- .2 Submit for final review by the Departmental Representative.
- .3 Provide before acceptance three (3) hard and one (1) electronic (*.pdf format) copies incorporating changes made during final review.

1.4 O&M MANUALS

- .1 Custom design O&M Manuals (both hard and electronic 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 three (3) hard copy and one (1) electronic 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 Specific functions of design philosophy and system.
 - .3 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.
 - .4 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
 - .5 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 Operation of computer peripherals, input and output formats.
 - .2 Emergency, alarm and failure recovery.
 - .3 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.
 - .4 General and specific instructions for the maintenance and operation of automatic and adjustable controls.
 - .5 Seasonal settings and changeovers.
 - .6 Document the limits of adjustment of manual controls.
- .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, and fully commented source listing of applicable driver/handler.
- .10 Preventative Maintenance (PM) Schedule.

2 Products

2.1 NOT USED

- .1 Not Used.

3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International):
 - .1 CSA C22.1, The Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

1.2 SUBMITTALS

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

1.3 EXISTING IDENTIFICATION

- .1 All new identification installed shall match the existing building identification methods as a minimum and shall meet the additional requirements as outlined below.

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 plastic tie.
- .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 Room sensors to have no manufacturers label on them.

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.
- .2 Install labels to manufacturer's instructions unless noted otherwise in this specification.
- .3 Lamicoïd identification to be mechanically fastened to equipment with screws or chains.
- .4 Identification to be in the English language.

3.2 EXISTING PANELS

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

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 Mechanical General Requirements.
- .2 Section 26 05 01 Electrical General Requirements.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI):
 - .1 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
 - .2 IEEE C2, National Electrical Safety Code.
- .2 Canadian Standards Association (CSA):
 - .1 CSA C22.1, Canadian Electrical Code, latest edition.

1.3 SYSTEM DESCRIPTION

- .1 Electrical:
 - .1 Controls Contractor shall provide power wiring as required to EMCS field panels and field installed controls components. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
 - .2 Controls Contractor shall provide hard wiring between field control devices and EMCS field panels.
 - .3 Provide communication wiring between EMCS field panels.
- .2 Pneumatic:
 - .1 Provide pneumatic tubing, valves and fittings for field control devices where applicable.
- .3 Mechanical:
 - .1 Pipe Taps Required for EMCS equipment will be supplied and installed by Division 23. Co-ordinate work. Costs to be carried by designated trade.
 - .2 Wells and control valves shall be supplied by EMCS Contractor and installed by Division 23. Costs to be carried by designated trade.
 - .3 Installation of dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs to be carried by designated trade.
- .4 Structural:
 - .1 Provide structural grade steelwork as required for installation of work.

1.4 PERSONNEL QUALIFICATIONS

- .1 Qualified supervisory personnel to:
 - .1 Continuously direct and monitor all work.
 - .2 Attend site meetings.

1.5 CUTTING, PATCHING AND FIRESTOPPING

- .1 Cutting, patching, and firestopping is the responsibility of this Contractor.

2 Products

2.1 SPECIAL SUPPORTS

- .1 Structural grade steel, primed and painted after construction and before installation.

2.2 PIPING FOR PNEUMATIC CONTROL SYSTEMS

- .1 Copper:
 - .1 Tubing: Type "K".
 - .2 Fittings: wrought copper solder type to ANSI/ASME B16.22, and 95.5 antimonial tin solder. At instruments use compression fittings.
 - .3 At panels and junction boxes where there is a transition from plastic to copper, use bulkhead fittings.
- .2 Plastic:
 - .1 Flame retardant, black PVC with minimum burst strength 200 psig at 75°F (installed in conduit).
 - .2 Fittings: compression or barbed type as required.

2.3 WIRING

- .1 As per requirements of Division 26.
- .2 For 70V and above: copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1. Run in EMT conduit.
- .3 For wiring under 70 volts: Use FT4 wiring run in conduit within all spaces. Run conduit for all exposed and U/G (i.e. buried) wiring including sensor wiring in ½" EMT conduit.
- .4 Sizes:
 - .1 120V Power supply: to match or exceed breaker, size #18 minimum.
 - .2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
 - .3 Field wiring to digital device: #20 stranded twisted pair.
 - .4 Analog inputs and outputs: #20 twisted pair, solid copper. Wiring must be continuous without joints.
 - .5 More than 4 conductors: #22 minimum solid copper.
 - .6 Communications wiring: #24 twisted shielded pair.
- .5 Terminations:

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

2.4 CONDUIT

- .1 As per requirements of Division 26 and the latest edition of the Canadian Electrical Code.
- .2 Electrical metallic tubing to CSA C22.2 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 56. Rigid steel threaded conduit to CSA C22.2 45.
- .3 Junction and pull boxes: welded steel.
 - .1 Surface mounting cast FS: screw-on flat covers.
 - .2 Flush mounting: covers with minimum extension all round.
- .4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.
- .5 Outlet boxes: 4" mm minimum, square.
- .6 Conduit boxes, fittings:
 - .1 Bushings and connectors: with nylon insulated throats.
 - .2 With push pennies to prevent entry of foreign materials.
- .7 Fittings for rigid conduit:
 - .1 Couplings and fittings: threaded type steel.
 - .2 Double locknuts and insulated bushings: use on sheet metal boxes.
 - .3 Use factory "ells" where 90 degree bends required for 1" and larger conduits.
- .8 Fittings for thin wall conduit:
 - .1 Connectors and couplings: steel, set screw type.

2.5 WIRING DEVICES, COVERPLATES

- .1 Conform to CSA.
- .2 Receptacles:
 - .1 Duplex: CSA type 5-15R.
 - .2 Single: CSA type 5-15R.
 - .3 Coverplates and blank plates: finish to match other plates in area.
- .3 All wiring shall be installed within conduit.

2.6 STARTERS, CONTROL DEVICES

- .1 Electrical Starters: shall be provided by the Electrical Contractor. Where the starter is supplied with the mechanical equipment, the Electrical Contractor is responsible for wiring the power.

- .2 Auxiliary Control Devices:
 - .1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.
 - .2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.
 - .3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.
 - .4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.

2.7 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

- .1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.
 - .1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.
- .2 Exposed conduits or cables:
 - .1 2" diameter and smaller: one-hole steel straps.
 - .2 Larger than 2" diameter: two-hole steel straps.
- .3 Suspended support systems:
 - .1 Individual cable or conduit runs: support with 1/4" diameter threaded rods and support clips.
 - .2 Two or more suspended cables or conduits: support channels supported by 1/4" diameter threaded rod hangers.

3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

- .1 Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

3.2 INSTALLATION

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

3.3 MECHANICAL PIPING

- .1 Install piping straight, parallel and close to building structure with required grades for drainage and venting.
- .2 Ream ends of pipes before assembly.
- .3 Copper tubing not to come into contact with dissimilar metal.
- .4 Use non-corrosive lubricant or Teflon tape on male screwed threads.
- .5 Clean ends of pipes, tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.
- .6 Install di-electric couplings where dissimilar metals join.

- .7 Sleeves:
 - .1 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 1" above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint.
 - .2 Caulking:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere: provide firestopping to maintain fire rating integrity.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.
 - .3 Controls Contractor is responsible for caulking and firestopping work related to controls systems. Co-ordinate with Division 23 and other trades.
- .8 Pressure tests (co-ordinate with Division 23):
 - .1 Pressure test all piping systems modified under this contract to 1½ times maximum working pressure or 125 psig, whichever is greater, for 4 hours without loss of pressure.
 - .2 Isolate equipment, components, not designed to withstand test pressure.
 - .3 Introduce system pressure carefully into new piping.

3.4 SUPPORTS

- .1 Install special supports as required and as indicated.

3.5 PNEUMATIC CONTROL SYSTEMS

- .1 General:
 - .1 Install tubing in accessible concealed locations, straight, parallel and close to building structure with required grades for drainage and venting.
 - .2 Install drip legs and drains at low points.
 - .3 Tubing to be free from surface damage.
 - .4 Tubing NOT to pass through or touch unheated ducts or enclosures.
 - .5 Do not cover pneumatic tubing with insulation.
 - .6 Test tubing, check joints after connection to system.
- .2 Copper tubing:
 - .1 Not to come into contact with dissimilar metal. Use non-metallic stand-offs on air handling systems.
 - .2 Install dielectric couplings where dissimilar metals join.
- .3 Plastic tubing:
 - .1 Inaccessible locations: install plastic tubing in conduit.
 - .2 Inside panels: install in tube trays or racks, or clip individually to back of panel.
 - .3 Multiple tube bundles: install in tube trays, conduit or armoured flexible cable.

3.6 ELECTRICAL - GENERAL

- .1 Do complete installation in accordance with requirements of:
 - .1 Division 26, this specification.
 - .2 CSA 22.1 Canadian Electrical Code.
 - .3 IEEE C2.
- .2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage (above 70 V) contacts and mark to prevent accidental injury.
- .3 Do underground installation to CAN/CSA C22.3 No.7, except where otherwise specified.
- .4 Conform to manufacturer's recommendations for storage, handling and installation.
- .5 Check factory connections and joints. Tighten where necessary to ensure continuity.
- .6 Install electrical equipment between 40" and 80" above finished floor wherever possible and adjacent to related equipment.
- .7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
- .8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
- .9 Install conduits and sleeves prior to pouring of concrete.
- .10 Holes through exterior wall and roofs: flash and make weatherproof.
- .11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
- .12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.7 CONDUIT SYSTEM

- .1 Communication wiring shall be installed in EMT conduit. Provide complete conduit system to link Building Controllers. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.
- .2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.
- .3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Departmental Representative before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

- .4 Locate conduits at least 6" from parallel steam or hot water pipes and at least 2" at crossovers.
- .5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.
- .6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.
- .7 Limit conduit length between pull boxes to less than 100 ft..
- .8 Use conduit outlet boxes for conduit up to 1-1/4" diameter and pull boxes for larger sizes.
- .9 Fastenings and supports for conduits, cables, and equipment:
 - .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
 - .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
 - .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.
- .10 Install polypropylene fish cord in empty conduits for future use.
- .11 Where conduits become blocked, remove and replace blocked sections.
- .12 Pass conduits through structural members only after receipt of Departmental Representative's written approval.
- .13 Conduits may be run in flanged portion of structural steel.
- .14 Group conduits wherever possible on suspended or surface channels.
- .15 Pull boxes:
 - .1 Install in inconspicuous but accessible locations.
 - .2 Support boxes independently of connecting conduits.
 - .3 Fill boxes with paper or foam to prevent entry of construction material.
 - .4 Provide correct size of openings. Reducing washers not permitted.
 - .5 Mark location of pull boxes on record drawings.
 - .6 Identify AC power junction boxes, by panel and circuit breaker.
- .16 Install terminal blocks or strips indicated in cabinets to Division 26.
- .17 Install bonding conductor for 120 volt and above in conduit.
- .18 All control and electrical wiring shall be installed with a conduit system

3.8 WIRING

- .1 Install multiple wiring in ducts simultaneously.
- .2 Do not pull spliced wiring inside conduits or ducts.
- .3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.
- .4 Tests: use only qualified personnel. Demonstrate that:
 - .1 Circuits are continuous, free from shorts, unspecified grounds.
 - .2 Resistance to ground of all circuits is greater than 50 Megohms.
- .5 Provide Engineer with test results showing locations, circuits, results of tests.
- .6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.
- .7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.
- .8 Do not allow wiring to come into direct physical contact with compression screw.
- .9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.
- .10 All wiring shall be installed within conduit.

3.9 WIRING DEVICES, COVERPLATES

- .1 Receptacles:
 - .1 Install vertically in gang type outlet box when more than one receptacle is required in one location.
- .2 Coverplates:
 - .1 Install suitable common cover plate where wiring devices are grouped.
 - .2 Use flush type cover plates only on flush type outlet boxes.

3.10 CONTROL DEVICES

- .1 Install and make power and control connections as indicated.
- .2 Install correct over-current devices.
- .3 Identify each wire, terminal for external connections with permanent number marking identical to diagram.
- .4 Performance Verification:
 - .1 Operate switches and controls to verify functioning.
 - .2 Perform start and stop sequences of contactors and relays.
 - .3 Check that interlock sequences, with other separate related starters,

equipment and auxiliary control devices, operate as specified.

3.11 GROUNDING

- .1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.
- .2 Install separate grounding conductors in conduit within building.
- .3 Install ground wire in all PVC ducts and in tunnel conduit systems.
- .4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.12 TESTS

- .1 General:
 - .1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Commissioning.
 - .2 Give fourteen (14) days written notice of intention to test.
 - .3 Conduct in presence of Departmental Representative and authority having jurisdiction.
 - .4 Conceal work only after tests satisfactorily completed.
 - .5 Report results of tests to Departmental Representative in writing.
 - .6 Preliminary tests:
 - .1 Conduct as directed to verify compliance with specified requirements.
 - .2 Make needed changes, adjustments, replacements.
 - .3 Insulation resistance tests:
 - .1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.
 - .2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Departmental Representative and authority having jurisdiction.

3.13 IDENTIFICATION

- .1 Refer to Section 25 05 54 EMCS Identification.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 70 00 Contract Closeout.
- .2 Section 25 05 01 EMCS General Requirements.

1.2 SYSTEM DESCRIPTION

- .1 Purpose: To ensure that facility is fully commissioned by Commissioning process includes assurance that systems meet design criteria, design intents and requirements of specifications.

1.3 DESIGN REQUIREMENTS

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

1.4 CO-ORDINATION

- .1 Co-ordinate commissioning procedures with other Divisions.

1.5 TIMING

- .1 Commissioning to commence only after satisfactory completion of start-up, verification of performance and 30-day test period as specified above.
- .2 Commissioning of occupancy-, weather-, and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied, except as follows:
 - .1 Commission systems considered as life safety systems before affected parts of facility are occupied.

1.6 INSTRUMENTATION

- .1 Provide sufficient permanent and temporary instrumentation. Verify locations, access, illumination for readings.
- .2 Instrumentation accuracy tolerances: higher order of magnitude than equipment, or system, being tested.
- .3 Locations to be approved, readily accessible and readable.
- .4 Application: to conform to normal industry standards.

1.7 OPERATION OF SYSTEMS

- .1 Operate systems as long as necessary to commission entire project.

1.8 SUPERVISION AND MONITORING

- .1 Commissioning to be supervised by qualified supervisory personnel.
- .2 Monitor progress. Keep detailed records of activities, results.

1.9 DOCUMENTATION

- .1 Documentation, O&M Manuals, training of O&M personnel to be complete to satisfaction of the Departmental Representative before starting commissioning. Refer to Section 01 70 00 Contract Closeout.

1.10 USE OF O&M PERSONNEL

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

1.11 PROCEDURES

- .1 Test each system independently and then in unison with other related systems.
- .2 Test weather-sensitive systems twice - once at near winter design conditions and again under near summer design conditions.
- .3 Debug system software.
- .4 Optimize operation, performance of systems by fine-tuning PID values and modifying CDL's as required.
- .5 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.

1.12 DEMONSTRATIONS

- .1 Demonstrate to User/Occupant operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down, interlocks, lock-outs.

1.13 FINAL SETTINGS

- .1 Upon completion of commissioning to satisfaction of the Departmental Representative, set and lock devices in final position, permanently mark settings.

1.14 FINAL REPORT

- .1 Submit report to the Departmental Representative. Report to:
 - .1 Include measurements, final settings, certified test results.
 - .2 Bear signature of commissioning technician and supervisor.

- .3 Be subject to verification by the Departmental Representative.
- .2 Report format to be approved by the Departmental Representative before commissioning started.

1.15 COMMISSIONING ACTIVITIES DURING WARRANTY PERIOD

- .1 Continue system debugging and optimization.
 - .1 Perform two (2) checks of environmental conditions. Submit written report to the Departmental Representative.
- .2 Revise "As-built" documentation, commissioning reports to reflect changes, adjustments, modifications to EMCS as set during commissioning.
- .3 Recommend additional changes, modifications deemed advisable in order to improve performance, environmental conditions, energy consumption.

1.16 MAINTENANCE ACTIVITIES DURING WARRANTY PERIOD

- .1 The Controls Contractor shall be responsible for operation and maintenance of the existing control systems throughout the construction phases of the Project consistent with the existing Maintenance Agreement in place between the Departmental Representative and the Controls Contractor. Following the completion of the construction phases of the Project, the existing Maintenance Agreement will be amended as required in recognition of the new controls systems and mechanical equipment installed within during the construction phases of the Project.
- .2 Provide services, materials, equipment and maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components.
- .3 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to the Departmental Representative.
- .4 Major inspections to include, but not limited to:
 - .1 Minor inspections.
 - .2 Clean 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 Provide mechanical adjustments, new ribbons or cartridges, and necessary maintenance on printers.
 - .5 Run system software diagnostics as required.
 - .6 The following inspections will be considered minimum requirements, and shall not be interpreted to mean satisfactory performance. Calibrations will be performed using test equipment having traceable, certifiable accuracy at minimum 50% greater than the accuracy of system displaying or logging the value. Check and/or calibrate each field input/output device. Provide dated, maintenance task lists to the Departmental Representative as proof of execution of complete system verification. Maintenance task lists to

- include the following sensor and output point detail; point name, location, device type and range, measured value, system displayed value, calibration detail, indication if adjustment required, and any other action taken or recommended.
- .7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability. Perform network analysis and provide report of results with detailed recommendations to correct any problems found.
 - .5 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 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding legal holidays.
 - .4 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
 - .5 Review system performance with Operations Supervisor and/or the Director and discuss suggested or required changes.
 - .6 Emergency Service Calls:
 - .1 Service calls will be initiated when there is indication that EMCS is not functioning correctly. Have qualified control personnel available during contract period to provide service to "CRITICAL" components whenever required at no extra cost. Furnish the Departmental Representative with telephone number where service personnel may be reached at any time. Service personnel to be on site ready to service EMCS within 2 h after receiving request for service. Perform work continuously until EMCS restored to reliable operating condition.
 - .7 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and to be as recommended by manufacturer.
 - .8 Records and logs: maintain records and logs of each maintenance task. Organize cumulative records for each major component and for entire EMCS chronologically. Complete forms and submit after inspection indicating that planned and systematic maintenance has been accomplished.
 - .9 Work requests: record each service call request, when received separately on approved form. Form to include serial number identifying component involved, its location, date and time call received, nature of trouble, names of personnel assigned, instructions of work to be done, amount and nature of materials used, time and date work started, time and date of completion.
 - .10 System modifications: provide in writing. No system modification, including operating parameters and control settings, to be made without prior written approval of the Departmental Representative.
 - .11 Rectify deficiencies revealed by maintenance inspections and environmental checks.

1.17 COMPLETION OF COMMISSIONING

- .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved to full satisfaction of the Departmental Representative.

1.18 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

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

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 Mechanical General Requirements.
- .2 Section 25 05 01 EMCS General Requirements.

1.2 ACRONYMS

- .1 Acronyms used in this section include see Section 25 05 01 EMCS General Requirements.

1.3 SYSTEM DESCRIPTION

- .1 LAN to network Master Control Units as indicated. To be able to expand or modify network either via LAN.
- .2 The LAN System shall meet the requirements of the Electrical Design Specification Section 27 10 05 Structured Cabling for Communication Systems and shall be compatible with the current Topology of the current Building Automation System installed within the Building.

1.4 MCU PANEL SUPPORT

- .1 The Master Control Unit to reside directly on LAN so that communications may be executed directly between work-stations and controllers on peer-to-peer basis.

1.5 DYNAMIC DATA ACCESS

- .1 LAN to provide capabilities for Operator Work Station devices to be able to access point status and application report data or execute control functions for other devices via LAN.
- .2 Access to data to be based upon logical identification or building equipment.

2 General

2.1 NOT USED

- .1 Not Used.

3 General

3.1 NOT USED

- .1 Not Used.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 Mechanical General Requirements.
- .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.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 C22.2 No.205, Signal Equipment.
- .2 Institute of Electrical and Electronics Engineers (IEEE).
 - .1 IEEE C37.90.1, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

1.3 SUBMITTALS

- .1 Submit one (1) electronic copy of shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 EMCS Submittals and Review Process.
- .2 Include:
 - .1 Information as specified for each device.
 - .2 Manufacturer's detailed installation instructions.
- .3 Pre-Installation Tests:
 - .1 Submit samples at random from equipment shipped, if requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.
- .4 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions for specified equipment and devices.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit operating and maintenance data for inclusion in operation and maintenance manual in accordance with Section 25 05 03 EMCS Project Record Documents and Section 01 33 00 Submittals.

1.5 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 reviewed by Departmental Representative at time of preliminary design review.
- .2 Controllers: standalone 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 another 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).
- .3 A USB connection compatible with laptops or tablet personal computers is not required, however, the Controls Contractor shall ensure they are able to connect to each specific piece of equipment for verification and maintenance purposes. The Controls Contractor may use their discretion for the type of connection required.

1.6 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.
 - .1 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 14 degrees Fahrenheit to 110 degrees Fahrenheit and 20 % to 90 % non-condensing relative humidity.
- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed alike lockable 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 Provide surge and low voltage protection for interconnecting wiring connections.

2 Products

2.1 MASTER CONTROL UNIT (MCU)

- .1 All software and hardware provided by the Controls Contractor shall communicate directly with all field / supervisor controllers and the heating plant monitoring system.

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 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 All software and hardware provided by the Controls Contractor shall communicate directly with all field / supervisor controllers and the heating plant monitoring system.

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 decimal place 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 point naming convention as defined in Section 25 05 01 EMCS General Requirements.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 The Controls Contractor is responsible for all 120/1/60 wiring required for the controls components and panels.

3.3 SYSTEM STARTUP

- .1 System startup shall be provided by factory certified and trained employees of the laboratory and animal ventilation control system manufacturer. Start-up shall include the following:
 - .1 Determine when the HVAC equipment and physical space is ready for operational testing.
 - .2 All steps of system startup shall be formally recorded when performed and provided to the Departmental Representative as part of the as built documentation.

3.4 TRAINING

- .1 The contractor shall provide competent instructors to give complete and specific on-site instruction to Departmental Representative designated personnel in the adjustment, operation and maintenance of the installed system, in lieu of a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter and the installed system. All training shall be held on weekdays during the normal work hours of 8:00 a.m. to 4:30 p.m.
- .2 Training shall be as specified in 25 01 12 for Departmental Representative designated operating personnel. Training shall include:
 - .1 Explanation of as built drawings, overall system operation and user required maintenance.
 - .2 A thorough walk-through of the job to locate control components.
 - .3 Explanation of adjustment, calibration and replacement procedures.
- .3 Since the Departmental Representative may desire that specific personnel have more comprehensive understanding of the system and its components; additional training shall be available from the Contractor at a future agreeable date.

3.5 LOCATION

- .1 Location of Controllers to be shown on shop drawings submitted for review by Departmental Representative.

3.6 INSTALLATION

- .1 Install Controllers in lockable enclosures.
- .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 where shown.

3.7 IDENTIFICATION

- .1 Identify field devices properly.

- .2 Refer to Section 25 05 54 EMCS Identification.

3.8 TESTING

- .1 Calibrate and test field devices for accuracy and performance. Submit report detailing tests performed, results obtained to Departmental Representative for approval. Departmental Representative will verify results at random. Provide testing equipment and manpower necessary for this verification.

3.9 COMMISSIONING

- .1 Refer to Section 25 08 20 EMCS Commissioning.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 01 Mechanical general requirements.
- .2 Section 25 05 01 EMCS General Requirements.
- .3 Section 25 05 02 EMCS Submittals and Review Process.
- .4 Section 25 05 54 EMCS Identification.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI).
 - .1 ANSI C12.7, Requirements for Watt-hour Meter Sockets.
 - .2 ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM B148, Standard Specification for Aluminum-Bronze Sand Castings.
- .3 National Electrical Manufacturer's Association (NEMA).
 - .1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 Air Movement and Control Association, Inc. (AMCA).
 - .1 AMCA Standard 500-D, Laboratory Method of Testing Dampers for Rating.
- .5 Canadian Standards Association (CSA International).
 - .1 CSA-C22.1-2012, Canadian Electrical Code, Safety Standard for Electrical Installations.

1.3 SUBMITTALS

- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 01 33 00 Submittal Procedures, Section 21 05 01 Mechanical General Requirements, and Section 25 05 02 EMCS Submittals and Review Process.

2 Products

2.1 GENERAL

- .1 Control devices of each category to be of same type and manufacturer.
- .2 Operating conditions: -10 – 44 degrees C with 10 - 90 % RH (non-condensing) unless otherwise specified.
- .3 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .4 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.

- .5 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .6 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.
- .7 Cutting and Patching: Restore work areas and existing works outside areas of demolition to match condition of adjacent, undisturbed areas.
- .8 Use the existing "global" outside air temperature (OAT) sensor for pump control. Refer to the new in-line duplex pump sequence of operation on the Drawings.

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°C and over.
 - .2 RTD's: 100 or 1000 ohm at 0°C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored lead wires. Coefficient of resistivity: 0.00385 ohms/ohm °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°C.
 - .6 Room temperature sensors not to display name of manufacturer or control company without prior permission
- .2 Room temperature sensors and display wall modules.
 - .1 Temperature sensing and display wall module.
 - .1 LCD display to show space temperature and temperature setpoint.
 - .2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
 - .3 Jack connection for plugging in laptop personal computer for access to zone bus.
 - .4 Integral thermistor sensing element 10,000 ohm at 24°C.
 - .5 Accuracy 0.2°C over range of 0 to 70 °C.
 - .6 Stability 0.02°C drift per year.
 - .7 Separate mounting base for ease of installation.
 - .2 Room temperature sensors.
 - .1 Wall mounting, in slotted type covers having brushed aluminum / brushed stainless steel 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°C.
 - .3 Where sensors are mounted on surface mounted boxes use cover with rounded corners and edges that do not project beyond the box.

2.3 TEMPERATURE TRANSMITTERS

- .1 Requirements:

- .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0°C, platinum resistance detector type sensors.
- .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01°C per volt change.
- .3 Output signal: 4 - 20 mA into 500-ohm maximum load.
- .4 Input and output short circuit and open circuit protection.
- .5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.
- .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.
- .7 Maximum current to 100 or 1000-ohm RTD sensor: not to exceed 25 mA.
- .8 Integral zero and span adjustments.
- .9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50°C.
- .10 Long term output drift: not to exceed 0.25 % of full scale/ 6 months.
- .11 Transmitter ranges: select narrowest range to suit application from following:
 - .12 Minus 50°C to plus 50°C, plus or minus 0. °C.
 - .13 0 to 100°C, plus or minus 0.5°C.
 - .14 0 to 50°C, plus or minus 0.25°C.
 - .15 0 to 25°C, plus or minus 0.1°C.
 - .16 10 to 35°C, plus or minus 0.25°C.

2.4 HUMIDITY SENSORS

- .1 Room and Duct Requirements:
 - .1 Range: 5 - 90 % RH minimum.
 - .2 Operating temperature range: 0 - 60°C.
 - .3 Absolute accuracy:
 - .1 Duct sensors: plus, or minus 3 %.
 - .2 Room sensors: plus, or minus 2 %.
 - .4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.
 - .5 Maximum sensor non-linearity: plus, or minus 2% RH with defined curves.
 - .6 Room sensors: locate in air stream near RA grille wall mounted as indicated.
 - .7 Duct mounted sensors: locate so that sensing element is in air flow in duct.

2.5 HUMIDITY TRANSMITTERS

- .1 Requirements:
 - .1 Input signal: from RH sensor.
 - .2 Output signal: 4 -20 mA onto 500-ohm maximum load.
 - .3 Input and output short circuit and open circuit protection.
 - .4 Output variations: not to exceed 0.2 % of full scale output for supply voltage variations of plus or minus 10 %.
 - .5 Output linearity error: plus, or minus 1.0% maximum of full scale output.
 - .6 Integral zero and span adjustment.
 - .7 Temperature effect: plus, or minus 1.0% full scale/ 6 months.
 - .8 Long term output drift: not to exceed 0.25% of full scale output/ 6 months.

2.6 COMBINATION RELATIVE HUMIDITY / TEMPERATURE SENSOR

- .1 Where there is a requirement for the monitoring of both relative humidity and temperature at the same location, the BMS Contractor has the option to provide a combination relative humidity sensor and temperature sensor. The individual sensors must each meet the specification details above.

2.7 ELECTRIC / PNEUMATIC (E/P) TRANSDUCERS

- .1 Requirements:
 - .1 Input range: 4 to 20 mA.
 - .2 Output range: proportional 20-104 kPa or 20-186 kPa as applicable.
 - .3 Housing: dustproof or panel mounted.
 - .4 Internal materials: suitable for continuous contact with industrial standard instrument air.
 - .5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2 % of full scale over entire range.
 - .6 Integral zero and span adjustment.
 - .7 Temperature effect: plus, or minus 2.0 % of full scale/ 50°C or less.
 - .8 Regulated supply pressure: 206 kPa maximum.
 - .9 Air consumption: 16.5 ml/s maximum.
 - .10 Integral gauge manifold c/w gauge (0-206 kPa).

2.8 PANELS

- .1 Wall or bracket mounted enameled 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.
- .3 Panels to be lockable with same key.

2.9 WIRING

- .1 In accordance with requirements included within Division specification sections, CSA-C22.1 Canadian Electrical Code, Safety Standard for Electrical Installation, current edition and Nova Scotia Department of Labor and Workforce Development Bulletin 2012-02.
- .2 Wiring must be continuous without joints.
- .3 All controls wiring shall be run in 13 mm diam. galvanized steel EMT conduit.
- .4 Sizes:
 - .1 Field wiring to digital device: #18 AWG copper, 105°C, 300V.
 - .2 Analog input and output: shielded #18 minimum copper, 105°C, 300V.

2.10 CONTROL TRANSFORMERS

- .1 Indoor type MC enclosed style, single phase 50 VA - 5000 VA.

- .2 Features:
 - .1 Rugged split side covers provide easy access to wiring compartments and allow installation with either solid or flexible conduit.
 - .2 Attractive aluminum side supports enhance heat dissipation capability.
 - .3 Many multi-voltage primary and secondary models increase range of applications per unit.
 - .4 Solidly fixed terminals with standard combination screw connections facilitate wiring.
 - .5 All terminals clearly identified with additive polarity markings.
 - .6 Every coil bobbin wound for greater efficiency and superior heat evacuation capability.
 - .7 All models built with heat-proof insulation for compact size and long life.
 - .8 Standard electrical knockouts and double "D" fuse knockouts are provided on all units.
 - .9 All units can be mounted either vertically or horizontally.
 - .10 All units CSA certified.

- .2 Engineering Specifications:
 - .1 Input voltages: 600, 480, 416, 380, 347, 277, 240, 208, 120.
 - .2 Output voltages: 240, 120, 32, 24, 16, 12.
 - .3 Output VA range: 50-5000.
 - .4 Operating frequency: 57-63 Hz.
 - .5 Insulation systems: 130°C (50-1000VA), 155°C (1500-5000VA).
 - .6 Sound level: Less than 35 db.
 - .7 Polarity: Additive.

2.11 PRESSURE / CURRENT TRANSMITTERS

- .1 Requirements:
 - .1 Range: to suit application. Operating point ideally at mid span of range.
 - .1 Pressure sensing elements: bourdon tube, bellows or diaphragm type.
 - .2 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
 - .2 Output signal: 4 - 20 mA into 500-ohm maximum load.
 - .3 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.
 - .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5% of full scale output over entire range.
 - .5 Integral zero and span adjustment.
 - .6 Temperature effects: not to exceed plus or minus 1.5% full scale/ 50°C.
 - .7 Over-pressure input protection to at least twice rated input pressure.
 - .8 Output short circuit and open circuit protection.
 - .9 Accuracy: plus or minus 1% of Full Scale.

2.12 CURRENT/PNEUMATIC (I/P) TRANSDUCERS

- .1 Requirements:
 - .1 Input range: 4 to 20 mA.
 - .2 Output range: proportional 2 - 15 psig or 2 - 30 psig as applicable.

- .3 Housing: dustproof or panel mounted.
- .4 Internal materials: suitable for continuous contact with industrial standard instrument air.
- .5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2% of full scale over entire range.
- .6 Integral zero and span adjustment.
- .7 Temperature effect: plus, or minus 2.0% full scale/ 50°C or less.
- .8 Regulated supply pressure: 30 psig maximum.
- .9 Air consumption: 0.035 cfm maximum.
- .10 Integral gauge manifold c/w gauge (0 - 30 psig).

2.13 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.

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 Controllers, valves, and 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 where required. Maintain fire-rating integrity of structure.

- .6 Electrical:
 - .1 CSA-C22.1-2012, Canadian Electrical Code, Safety Standard for Electrical Installations.
 - .2 Refer to control schematics included as part of control design on drawings. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by the Departmental Representative before beginning Work.
 - .3 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
 - .4 Install all wiring in EMT conduit: Make final connection to field devices using flexible metal conduit. Install conduit in accordance with CEC 12-1999 through 12-1014 and 12-1400 through 12-1410.
 - .1 Provide complete conduit system to link any new Building Controllers, field panels, etc. to the existing Controls infrastructure.
 - .2 Maximum conduit fill not to exceed 40%.
 - .3 Design drawings do not show conduit layout.
 - .5 Communications wiring to be in separate EMT.
 - .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.
- .7 Repair surfaces damaged during execution of Work.
- .8 Turn over to the Departmental Representative existing materials removed from Work not identified for re-use.

3.2 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.

3.3 IDENTIFICATION

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

3.4 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