1 General

1.1 DEFINITIONS

.1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

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

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

- .1 Outage of main power supply in excess of back-up power sources, provided that:
  - .1 Automatic initiation of back-up was accomplished.
  - .2 Automatic shut-down and re-start of components was as specified.
- .2 Failure of communications link, provided that:
  - .1 Controller automatically and correctly operated in stand-alone mode.
  - .2 Failure was not due to failure of any specified EMCS equipment.
- .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
  - .1 System recorded said fault.
  - .2 Equipment defaulted to fail-safe mode.
  - .3 AEL of total of all input sensors and output devices is at least 99 % during test period.

1.2 DESIGN REQUIREMENTS

.1 Confirm with 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.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Final Report: submit report to Departmental Representative

- .1 Include measurements, final settings and certified test results.
- .2 Bear signature of commissioning technician and supervisor
- .3 Report format to be approved by Departmental Representative before commissioning is started.
- .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.

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

1.4 CLOSEOUT SUBMITTALS

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

1.5 COMMISSIONING

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

.2 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to commissioning or each test. Indicate:
- .1 Location and part of system to be tested or commissioned.
- .2 Testing/commissioning procedures, anticipated results.
- .3 Names of testing/commissioning personnel.

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

.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 Perform tests as required.

1.6 COMPLETION OF COMMISSIONING

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

1.7 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

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

2 Products

2.1 EQUIPMENT

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

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

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

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

.5 Application: to conform to normal industry standards.

3 Execution

3.1 PROCEDURES

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

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

.3 Commission integrated systems using procedures prescribed by Departmental Representative

.4 Debug system software.

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

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

3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.
- .1 General: consists of field tests of equipment just prior to installation.
- .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative
- .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 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).
- .6 In addition to test equipment, provide inclined manometer, 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 Departmental Representative to mark instruments tracking within 0.5 % in both directions as "approved for installation".
- .9 Transmitters above 0.5 % error will be rejected.
- .10 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 Blowout 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. Include space on commissioning technician and Departmental Representative. This document will be used in final startup testing.

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

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

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

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

.4 Commissioning to commence during final startup testing.

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

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

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

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

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

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

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

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

.2 Test to last at least 30 consecutive 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 Departmental Representative to verify reported results.

3.3 ADJUSTING

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

END OF SECTION

1 General

1.1 REFERENCES

.1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
- .1 ANSI/ISA 5.5, Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
- .1 ANSI/IEEE 260.1, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

.3 Canadian Standards Association (CSA International).
- .1 CAN/CSA-Z234.1, Canadian Metric Practice Guide.

.4 Consumer Electronics Association (CEA).
- .1 CEA-709.1-B, Control Network Protocol Specification.

.5 Electrical and Electronic Manufacturers Association (EEMAC).
- .1 EEMAC 2Y-1, Light Gray Colour for Indoor Switch Gear.

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

1.2 ACRONYMS AND ABBREVIATIONS

.1 Acronyms used in EMCS:
- .1 AEL - Average Effectiveness Level.
- .2 AI - Analog Input.
- .3 AIT - Agreement on International Trade.
- .4 AO - Analog Output.
- .5 BACnet - Building Automation and Control Network.
- .6 BC(s) - Building Controller(s).
- .7 BECC - Building Environmental Control Center.
- .8 CAD - Computer Aided Design.
- .9 CDL - Control Description Logic.
- .10 CDS - Control Design Schematic.
- .11 COSV - Change of State or Value.
- .12 CPU - Central Processing Unit.
- .13 DI - Digital Input.
- .14 DO - Digital Output.
- .15 DP - Differential Pressure.
- .16 ECU - Equipment Control Unit.
- .17 EMCS - Energy Monitoring and Control System.
- .18 HVAC - Heating, Ventilation, Air Conditioning.
- .19 IDE - Interface Device Equipment.
- .20 I/O - Input/Output.

.21 ISA - Industry Standard Architecture.
.22 LAN - Local Area Network.
.23 LCU - Local Control Unit.
.24 MCU - Master Control Unit.
.26 NC - Normally Closed.
.27 NO - Normally Open.
.28 OS - Operating System.
.29 O&M - Operation and Maintenance.
.30 PCI - Peripheral Control Interface.
.31 PCMCIA - Personal Computer Micro-Card Interface Adapter.
.32 PID - Proportional, Integral and Derivative.
.33 RAM - Random Access Memory.
.34 SP - Static Pressure.
.35 ROM - Read Only Memory.
.36 USB - Universal Serial Bus.
.37 UPS - Uninterruptible Power Supply.

1.3 DEFINITIONS

.1 Point: may be logical or physical.
- .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
- .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.

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

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

.4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
- .1 Printouts: to ANSI/IEEE 260.1.
- .2 Refer also to Section 25 05 54 - EMCS: Identification.

1.4 SYSTEM DESCRIPTION

.1 New control components to integrate completely with the existing facility EMCS system.
- .1 All EMCS input / output associated with this Coast Guard Project shall be mapped to the existing BIO operator workstation in the Van Steenburgh Building. All new operation sequences, BACnet points and objects associated with the this Coast Guard Project shall be created, viewed, modified, edited and deleted over the existing EMCS LAN using the existing operator work station graphics software. This Coast Guard Project EMCS related alarms shall be routed to the Commissionaires desk at the Holland Building. All EMCS input / output associated with this project shall be mapped to the existing BIO operator workstation in the Van Steenburgh Building. All new operation sequences, BACnet points and objects associated with the this project shall be created, viewed, modified, edited and deleted over the existing EMCS LAN using the existing Van Steenburgh Building operator work station graphics software.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
- .1 Control devices as listed in I/O point summary tables.
- .2 Data communications equipment necessary to effect EMCS data transmission system.
- .3 Field control devices.
- .4 Software/Hardware complete with full documentation.
- .5 Complete operating and maintenance manuals.
- .6 Training of personnel.
- .7 Acceptance tests, technical support during commissioning, full documentation.
- .8 Wiring interface co-ordination of equipment supplied by others.
- .9 Miscellaneous work as specified in these sections and as indicated.
- .10 Connecting to central EMCS system on site.

.3 Design Requirements:
- .1 Design and provide conduit and wiring linking elements of system.
- .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
- .3 Location of controllers as reviewed by Departmental Representative prior to installation.

.4 Provide utility power to EMCS as indicated.
.5 Metric references: in accordance with CAN/CSA Z234.1.

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

1.5 ACTION AND INFORMATIONAL 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.

.2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.

.3 Submit for review:
.1 Equipment list and systems manufacturers at time of bid tender within 48 h within 10 days after award of contract.
.2 List existing field control devices to be re-used included in bid tender, along with unit price.

.4 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: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 For materials whose compliance with organizational standards / codes / specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

.6 Permits and fees: in accordance with general conditions of contract.

.7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative

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

1.6 QUALITY ASSURANCE

.1 Have local office within 150 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 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

.4 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 Health and Safety Requirements.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with]manufacturer's name, address.

1.8 EXISTING-CONTROL COMPONENTS

.1 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.

2 Products

2.1 EQUIPMENT

.1 Complete list of equipment and materials to be used on project and forming part of bid tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

2.2 ADAPTORS

.1 Provide adaptors between metric and imperial components.

3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

END OF SECTION

1 General

1.1 DEFINITIONS

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

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.

.2 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.

.3 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

.4 Soft copy to be in AutoCAD - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

1.3 DETAILED SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:
- .1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
- .2 Wiring diagrams.
- .3 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
- .4 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
  - .1 Sensing element type and location.
  - .2 Transmitter type and range.
  - .3 Associated field wiring schematics, schedules and terminations.
  - .4 Complete Point Name Lists.
  - .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
  - .6 Software and programming details associated with each point.
  - .7 Manufacturer's recommended installation instructions and procedures.
  - .8 Input and output signal levels or pressures where new system ties into existing control equipment.
- .5 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
- .6 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.

.7 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
.8 Listing and example of specified reports.
.9 Listing of time of day schedules.
.10 Type and size of memory with statement of spare memory capacity.
.11 Full description of software programs provided.
.12 Sample of "Operating Instructions Manual" to be used for training purposes.
.13 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.4 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 cost to Departmental Representative

2 Products N/A

3 Execution N/A

END OF SECTION

1 General

1.1 DEFINITIONS

.1 BECC - Building Environmental Control Centre.

.2 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.

.2 Provide soft copies and hard copies in hard-back, 50 mm 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 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process 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 Departmental Representative

.3 Provide before acceptance 4 Hard and 1 soft copy incorporating changes made during final review.

1.4 OPERATION AND MAINTNEANCE MANUALS

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

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

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

.4 Functional description to include:
- .1 Functional description of theory of operation.
- .2 Design philosophy.
- .3 Specific functions of design philosophy and system.
- .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
- .5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
- .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.

.5 System operation to include:
- .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
- .2 Operation of computer peripherals, input and output formats.
- .3 Emergency, alarm and failure recovery.
- .4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.6 Software to include:
- .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
- .2 Detailed descriptions of program requirements and capabilities.
- .3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.
- .4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device
- .5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.

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

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

.8 System configuration document:

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

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

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

2 Products N/A

3 Execution N/A

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 DEFINITIONS

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

1.3 SYSTEM DESCRIPTION

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

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.

.2 Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

2 Products

2.1 NAMEPLATES FOR PANELS

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

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by chain 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 Identify by stick-on labels using point identifier.

.2 Location: as directed by Departmental Representative.

.3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

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

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

2.5 WIRING

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

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

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

2.6 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: use fluorescent orange paint and confirm colour with Departmental Representative during "Preliminary Design Review".

3 Execution

3.1 NAMEPLATES AND LABELS

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

3.2 EXISTING PANELS

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

END OF SECTION

1 General

1.1 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.

.3 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.
- .1 MD1380, Energy Management and Control Systems (EMCS) Design Manual. English: ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf

1.2 DEFINITIONS

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

1.3 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 Field Termination and Interface Devices:
- .1 To: CSA C22.2 No.205.
- .2 Electronically interface sensors and control devices to processor unit.
- .3 Include, but not be limited to, following:
  - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
  - .2 Power supplies for operation of logics devices and associated field equipment.
  - .3 Lockable wall cabinet.
  - .4 Required communications equipment and wiring (if remote units).
  - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
  - .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
  - .7 Wiring terminations: use conveniently located screw type or spade lug terminals.

.4 AI interface equipment to:
- .1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.
- .2 Provide for following input signal types and ranges:
  - .1 4 - 20 mA;
  - .2 0 - 10 V DC;
  - .3 100/1000 ohm RTD input;
- .3 Meet IEEE C37.90.1 surge withstand capability.
- .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
- .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 AO interface equipment:
- .1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.
- .2 Provide for following output signal types and ranges:
  - .1 4 - 20 mA.
  - .2 0 - 10 V DC.
- .3 Meet IEEE C37.90.1 surge withstand capability.

.6 BI 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 BO interface equipment:
- .1 Respond to controller processor output, switch respective outputs. Each BO hardware to be capable of switching up to 0.5 amps at 24 V AC.
- .2 Switch up to 5 amps at 220 V AC using optional interface relay.

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

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

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

1.5 MAINTENANCE

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 EMCS Project As-Built Drawings.

2 Products

2.1 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 New TCU/ECU shall operate on the same baud rate as the existing.

.4 Quantity of TCU/ECU on existing MSTP shall not exceed Manufacturer's recommendation.

2.2 SOFTWARE

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

.2 Program and data storage.
- .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
- .2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

.3 Programming languages.
- .1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.
- .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.

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

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

.5 Control Description Logic (CDL):

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

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

.3 Perform changes to CDL on-line.

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

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

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

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

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

2.3 LEVELS OF ADDRESS

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

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

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

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

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

3 Execution

3.1 LOCATION

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

3.2 INSTALLATION

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

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

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

.4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

END OF SECTION

1 General

1.1 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 B 148, 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, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

1.2 DEFINITIONS

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

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

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

2 Products

2.1 GENERAL

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

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

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

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

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

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

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

2.2 TEMPERATURE SENSORS

.1 General: except for room sensors to be resistance or thermocouple type to following requirements:
- .1 Thermocouples: limit to temperature range of 200degrees C and over.
- .2 RTD's: 100 or 1000 ohm at 0degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
- .3 Sensing element: hermetically sealed.
- .4 Stem and tip construction: copper or type 304 stainless steel.
- .5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.
- .6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm.

.2 Room temperature sensors and display wall modules.
- .1 Temperature sensing and display wall module.
  - .1 LCD display to show space temperature ed and temperature setpoint.
  - .2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
  - .3 Jack connection for plugging in laptop personal computer contractor supplied zone terminal unit contractor supplied palm compatible handheld device for access to zone bus.
  - .4 Integral thermistor sensing element 10,000 ohm at 24 degrees.
  - .5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
  - .6 Stability 0.02 degrees 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 10-50mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:
- .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.
- .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees 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 + or - 1.0 % of full scale/ 50 degrees 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:
  - .1 Minus 50 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.
  - .2 0 to 100 degrees C, plus or minus 0.5 degrees C.
  - .3 0 to 50 degrees C, plus or minus 0.25 degrees C.
  - .4 0 to 25 degrees C, plus or minus 0.1 degrees C.
  - .5 10 to 35 degrees C, plus or minus 0.25 degrees C.

2.4 CONTROL VALVES

.1 Body: ball.
- .1 Flow characteristic as indicated on control valve schedule: equal percentage.
- .2 Normally open as indicated.
- .3 Two Ports.
- .4 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
- .5 Packing easily replaceable.
- .5 Ball &Stem, stainless steel.
- .7 NPS 2 and under:
  - .1 Screwed National Pipe Thread (NPT) tapered female connections.
  - .2 Valves to ANSI Class 250, valves to bear ANSI mark.
  - .3 Rangeability 50:1 minimum.

2.5 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements:
- .1 Construction: steel, cast iron, aluminum.
- .2 Control signal: 0-10V DC or 4-20 mA DC.
- .3 Positioning time: to suit application. 90 sec maximum.
- .4 Fail to normal position as indicated.
- .5 Scale or dial indication of actual control valve position.
- .6 Size actuator to meet requirements and performance of control valve specifications.

.7 For interior and perimeter terminal heating applications floating control actuators are acceptable.

2.6 WIRING

.1 In accordance with the following sections from Division 26, Electrical
- .1 Section 26 05 20 Wire and Box Connectors 0-1000 V
- .2 Section 26 05 21 Wires and Cables (0-1000 V)
- .3 Section 26 05 29 Hangers and Supports for Electrical Systems
- .4 Section 26 05 31 Splitters, Junction, Pull Boxes and Cabinets
- .5 Section 26 05 32 Outlet Boxes, Conduit Boxes and Fittings
- .6 Section 26 05 34 Conduits, Conduit Fastenings and Conduit Fittings

.2 All EMCS Control wiring shall be in EMT conduit

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

.4 Wiring must be continuous without joints.

.5 Sizes:
- .1 Field wiring to digital device: #18AWG 20AWG stranded twisted pair.
- .2 Analog input and output: shielded #18 minimum solid copper #20 minimum stranded twisted pair.

3 Execution

3.1 INSTALLATION

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

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

.3 Temperature transmitters, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

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

.5 Electrical:
- .1 Complete installation in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
- .3 Install communication wiring in conduit.
  - .1 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

.2 Maximum conduit fill not to exceed 40%.
.3 Design drawings do not show conduit layout.

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

.6 VAV Terminal Units: supply, install and adjust as required.
.1 Air probe, actuator and associated VAV controls.
.2 Tubing from air probe to DP sensor as well as installation and adjustment of air flow sensors and actuators.
.3 Co-ordinate air flow adjustments with balancing trade.

3.2 TEMPERATURE SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

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

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

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

3.3 PANELS

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

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

.3 Identify wiring and conduit clearly.

3.4 IDENTIFICATION

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

3.5 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