

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 For general commissioning requirements refer to sections 01 91 13, 01 91 31, 01 91 33, 01 91 41, 01 91 51.
- .2 Do commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements and Section 01 91 31 – Commissioning (Cx) Plan
- .3 Carry out commissioning in presence of Departmental Representative.
- .4 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.
- .5 Step 1 - Submit point by point commissioned checklist for each system described in Cx Plan, section 01 91 31. Complete verification with points of supervised systems as per drawing and technical specifications. Refer to Departmental Representative Guideline MD 250005 – 2009 for template of checklist.
- .6 Step 2 - Start verification of sequences of operation after point by point checklist was approved by Departmental Representative.
- .7 Step 3 – Start verification of integrated system after results of step 1 and step 2 are accepted by Departmental Representative. Verification protocols of integrated systems will be prepared by Departmental Representative and will be executed by EMCS commissioning technician. Provide a supplementary 5 days support during testing of integrated systems. Coordinate with Contractor Commissioning Agent to determine schedule for test of integrated systems.
- .8 Test of integrated systems will follow different status to verify systems' respond on multiple loops:
 - .1 Normal operation (occupied / unoccupied mode):
 - .1 Variation of set points on HVAC systems;
 - .2 Measurements of indoor ambient parameters (temperature, relative humidity, noise, vibration) and indoor air quality (CO₂);
 - .3 Measurements of pressure differential according to pressurisation drawings;
 - .4 Status for sprinkler system, fire pump and fire alarm system – diagram and graphics;
 - .5 Status for emergency power generator and components – diagram and graphics;
 - .6 Status for lighting – diagram and graphics;
 - .7 Status for access control and intrusion doors, diagram and graphics;
 - .8 Measured values, reports, graphics to be obtained from EMCS.
 - .2 Emergency status during fire alarm detection:
 - .1 Verification of HVAC systems to be off as per sequences of operation;

- .2 Verification of control access components interlocked with fire alarm system
- .3 Verification of alarms sent to EMCS and to security post. All emergency procedures to be prepared by others;
- .4 Verification of emergency lighting systems, measurements to respect minimum lighting level for security and corridor issues;
- .5 Verification of voice communication systems.
- .3 Electrical power failure mode:
 - .1 Verification of status for HVAC systems;
 - .2 Verification of status for boilers and components;
- .4 Alarm detection:
 - .1 Maintenance alarms - report from EMCS for all equipments base building and all laboratory equipments during commissioning process;
 - .2 Emergency alarms – alarms sent to security post and / or remote to central, phone, mobile.
- .9 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.
- .10 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .11 Load system with project software.
- .12 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. 30-day tests have to be submitted to Departmental Representative for review and approval on electronic format accompanied by three (3) hard copies. Graphic representation of 30-day tests has to be prepared and to include, for each system: variation curves, legend, proper scales in time and representative samples.
- .2 For weather sensitive systems, completion of commissioning will be completed during the appropriate season. Include cost for these differed tests.

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, and of approved 30-day tests.

2. PRODUCTS

2.1 Equipment

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

- .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. Submit copy of calibration certificate 14 days before starting commissioning 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 Commissioning Manager Departmental Representative.
- .3 Commission integrated systems using procedures prescribed by the Commissioning Manager Representative. These procedures of integrated systems (verification protocols) will be prepared based on detailed sequences of operation prepared by the EMCS contractor during construction phase.
- .4 Debug system software.
- .5 Optimize operation and performance of systems by fine-tuning PID values, modifying CDLs and modifying sequences of operation as required.
- .6 Test full scale emergency evacuation and life safety procedures 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).
 - .5 Additional instruments to include:
 - .1 DP transmitters.
 - .2 DP switches used for dirty filter indication and fan status.
 - .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.

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- .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 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. Include space on point verification list for commissioning technician and Departmental Representative signatures. This document will be used in final startup testing. Refer to PWGSC Guideline MD 250005-2009 for an example of verification point list.
 - .3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and provide:
 - .1 2 technical personnel capable of re-calibrating field hardware and modifying software.
 - .2 Detailed daily schedule showing items to be tested and personnel available.
 - .3 Departmental Representative's acceptance signature to be on executive and applications programs.
 - .4 Commissioning to commence during final startup testing.
 - .5 O&M personnel to assist in commissioning procedures as part of training.
 - .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
 - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
 - .8 Operate systems as long as necessary to commission entire project. Coordinate and check with sub-contractors that all conditions for continuous operation of the systems are met. Verify if any temperature, time schedule or other constraint could have an impact on continuous operation for system to be tested.
 - .9 Monitor progress and keep detailed records of activities and results.

- .10 Inform Departmental Representative about progress, results and all modifications during the Commissioning process. Progress reports to be submitted on a bi-weekly basis.
- .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 and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
 - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
 - .2 Test to last at least 30 consecutive 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.
 - .3 30 day test trends to be supported with graphic reports sent every week to the Departmental Representative. Reports to demonstrate that the equipment responds adequately to the performance test. Alarm reports also to be sent with graphics report. Submit a template of report for approval before beginning the 30 day test. Report to include: variation curves of different parameters / points, set points, legend, frequency of sampling.
 - .4 Trends to be programmed for (if applicable):
 - .1 Temperature supply / exhaust for air / water system.
 - .2 Pressure in / out for air / water system.
 - .3 Room and open space temperature.
 - .4 Relative humidity in duct supply / return.
 - .5 Differential pressure for all laboratories or special room to be monitored and specify set point to maintain.
 - .6 Outdoor temperature.
 - .7 Static pressure supply / exhaust with set point to maintain.
 - .4 System will be accepted when:
 - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed 2 hours.
 - .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 Commissioning Manager 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.

3.4 Demonstration

- .1 Demonstrate to Commissioning Manager 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

1. GENERAL

1.1 Definitions

- .1 CDL - Control Description Logic.
- .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 33 00 - Submittal Procedures, supplemented and modified by requirements of this Section.
- .2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipated date of beginning of training.
 - .1 List name of trainer, and type of visual and audio aids to be used.
 - .2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.
- .3 Submit reports within one week after completion of training program that training has been satisfactorily completed.

1.3 Quality Assurance

- .1 Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2 Departmental Representative reserves right to approve instructors.

1.4 Instructions

- .1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
- .2 Training to be project-specific.

1.5 Time for Training

- .1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

1.6 Training Materials

- .1 Provide equipment, visual and audio aids, and materials for classroom training.
- .2 Supply manual for each trainee, describing in detail data included in each training program.
 - .1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

1.7 Training Program

- .1 Instruction for the Departmental Representative's personnel: the Specialized Contractor must make competent instructors available who will provide a complete training session to the designated personnel with regard to the location of system components, operating, programs and modifications to operating parameters.
 - .1 This instructional session will be given during the commissioning period.
 - .2 A total of eight (8) hours will be included in the contract for remote consultation that could be used during the warranty year.
 - .3 The operating personnel will receive necessary instruction to be able to operate the installed system and use system operating procedures. The training provided during this phase must include the following:
 - .1 Review of as-built control drawings and location of components.
 - .2 Operating sequences functioning (textually and in relation to controller programs).
 - .3 Command functions and interpretation of values and status for points from the operator work station and locally from the controllers.
 - .4 Modifications to operating parameters (schedules, set points, etc.).
 - .5 Alarm management (receiving, archiving, acknowledgement, etc.).
 - .6 Historical data, trends and summations.
 - .4 The Departmental Representative may record the training session for their own use.

1.8 Additional Training

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

1.9 Monitoring of Training

- .1 Departmental Representative to monitor training program and may modify schedule and content.

2. PRODUCTS

- .1 Not Used.

3. EXECUTION

- .1 Not Used.

End of Section

1. GENERAL

1.1 References

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
 - .1 ANSI/ISA 5.5-1985, 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-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA International).
 - .1 CAN/CSA-Z234.1-89(R1995), Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
 - .1 CEA-709.1-B-2002, Control Network Protocol Specification.
- .6 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .7 Electrical and Electronic Manufacturers Association (EEMAC).
 - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .9 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

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

1.3 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 shortforms or acronyms. Database must provide 25 character field for each point identifier.
- .2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.
- .3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
 - .1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.
- .3 Point Object Type: points fall into following object types:
 - .1 AI (analog input).
 - .2 AO (analog output).
 - .3 DI (digital input).
 - .4 DO (digital output).
 - .5 Pulse inputs.
- .4 Symbols and engineering unit abbreviations utilized in displays: to 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 Refer to control schematics for system architecture.
- .2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
 - .1 Building Controllers.
 - .2 Control devices as listed in I/O point summary tables.
 - .3 OWS(s).
 - .4 Data communications equipment necessary to effect EMCS data transmission system.
 - .5 Field control devices.
 - .6 Software/Hardware complete with full documentation.
 - .7 Complete operating and maintenance manuals.
 - .8 Training of personnel.
 - .9 Acceptance tests, technical support during commissioning, full documentation.
 - .10 Wiring interface co-ordination of equipment supplied by others.
 - .11 Miscellaneous work as specified in these sections and as indicated.
- .3 Design Requirements:
 - .1 Design and provide conduit and wiring linking elements of system.
 - .2 Supply sufficient programmable controllers of types to meet project requirements. 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 and emergency power to EMCS as indicated.
 - .5 Metric references: in accordance with CAN/CSA Z234.1.

- .4 Language Operating Requirements:
 - .1 Provide operator selectable access codes.
 - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. .
 - .3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation in English.
 - .4 System manager software: include 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 field related changes 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.
 - .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 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: Equipment list and list of systems, manufacturers at time of tender.
- .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.

1.6 Quality Assurance

- .1 Have an office staffed by trained personnel capable of remotely provide instruction, routine maintenance and emergency service on systems
- .2 Have the capacity to send experienced technicians on site within 48 hours to repair or debug a system or component that cannot be repaired or debugged remotely.
- .3 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .4 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.
- .5 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.
- .6 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .7 Sustainable Requirements:
 - .1 Construction requirements: in accordance with Section 01 47 15 - Sustainable Requirements: Construction.
 - .2 Verification: contractor's verification in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification.

1.7 Delivery, Storage and Handling

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 2weeks after award of Contract.

2. PRODUCTS**2.1 Equipment**

- .1 Control Network Protocol and Data Communication Protocol: to ASHRAE STD 135, to be BACNET/IP.
- .2 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.

3.2 **General Installation Requirements**

- .1 All controls and components shall be designed and installed for easy maintenance
- .2 Provide at least 1000 mm clearance in front of all equipment requiring calibration
- .3 All components shall be located to permit easy calibration and performance verification
- .4 Controls, relays and other components shall be installed in well-lighted easily accessible and maintainable control cabinets located well away from vibrating machinery.

End of Section

1. GENERAL

1.1 Summary

.1 Section Includes.

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

1.2 Definitions

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

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 Proprietary Communications Protocol BACnet Lontalk.

1.4 Action and Informational Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.
- .2 Submit preliminary design document within 5 working days after tender closing and before contract award, for review by Departmental Representative.
- .3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.
- .4 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. Documentation to be identified by system, according to section 01 91 31, Appendix A – Systems components list and additional specification during construction phase, if required.

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

1.5 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.
 - .7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
 - .8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.
 - .9 Sequences of operation including description of each system operation mode and status of each device.

1.6 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 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 Setpoints, 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 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 Detailed sequence of operation with developed narrative required to perform tests and verification.
- .16 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.7 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

- .1 Not Used.

3. EXECUTION

- .1 Not Used.

End of Section

1. GENERAL

1.1 Definitions

- .1 BECC - Building Environmental Control Centre.
- .2 OWS - Operator Work Station.
- .3 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 Submit Record Documents, as-built drawings, Operation and Maintenance Manual to Departmental Representative in English.
- .3 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. The test implementation shall be recorded with a description of the test exercise script of events and documented as 'Test procedures'. A provision for the measurement or observation of results forms the 'Test reports'.
 - .9 Basic system design and full documentation on system configuration.
- .2 Submit for final review by Departmental Representative.
- .3 Provide before acceptance 4 hard copies and 1 soft copy incorporating changes made during final review.

1.4 O&M Manuals

- .1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section. Only approved copies of shop drawings, technical specifications of equipments installed, control diagrams, sequences of operation, as-built documents, test and commissioning reports to be included in the O&M Manual.
- .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 c/w list of all alarms and text message associated with each alarm.
 - .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.
 - .5 Final updated sequences of operation for each system c/w values of set points in accordance to software as-built program.
- .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.

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- .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, and 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.
 - .3 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.
 - 2. PRODUCTS
 - .1 Not Used.
 - 3. EXECUTION
 - .1 Not Used.

End of Section

1. GENERAL

1.1 References

- .1 Canadian Standards Association (CSA International).
 - .1 CSA C22.1-02, The Canadian Electrical Code, Part I (19th Edition), 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.

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, 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 or 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's.

2.5 Wiring

- .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
- .2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.
- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 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.

End of Section

1. GENERAL

1.1 References

- .1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
- .1 Canadian Standards Association (CSA International).
 - .1 CSA Z204-94(R1999), Guidelines for Managing Indoor Air Quality in Office Buildings.

1.2 Definitions

- .1 BC(s) - Building Controller(s).
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 Action and Informational Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.
- .3 Submit detailed inspection reports to Departmental Representative.
- .4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:
 - .1 Point name and location.
 - .2 Device type and range.
 - .3 Measured value.
 - .4 System displayed value.
 - .5 Calibration detail
 - .6 Indication if adjustment required,
 - .7 Other action taken or recommended.
- .5 Submit network analysis report showing results with detailed recommendations to correct problems found.
- .6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Maintain records and logs of each maintenance task on site.
 - .2 Organize cumulative records for each major component and for entire EMCS chronologically.
 - .3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.
- .7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.4 Maintenance Service During Warranty Period

- .1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
- .2 Emergency Service Calls:
 - .1 Initiate service calls when EMCS is not functioning correctly.
 - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
 - .3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
 - .4 Service personnel to be remotely available, ready to service EMCS within 2 hours after receiving request for service.
 - .5 If service cannot be restored remotely within 12 hours after receiving request for service, have an experienced technician available on site within 48 hours after request for service.
 - .6 Perform Work continuously until EMCS restored to reliable operating condition.
- .3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.
- .4 Work requests: record each service call request, when received separately on approved form and include:
 - .1 Serial number identifying component involved.
 - .2 Location, date and time call received.
 - .3 Nature of trouble.
 - .4 Names of personnel assigned.
 - .5 Instructions of work to be done.
 - .6 Amount and nature of materials used.
 - .7 Time and date work started.
 - .8 Time and date of completion.
- .5 Provide system modifications in writing.
 - .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

1.5 Service Contracts

- .1 Provide in-depth technical expertise and assistance to Departmental Representative and Commissioning Manager in preparation and implementation of service contracts and in-house preventive maintenance procedures.
- .2 Service Contracts to include:
 - .1 Annual verification of field points for operation and calibration.
 - .2 2 visits per year.
 - .3 Remote responses to emergency calls.
 - .4 Remote support

2. PRODUCTS

- .1 Not Used.

3. EXECUTION

3.1 Field Quality Control

- .1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative after each inspection within five (5) days.
- .2 Include one seasonal testing inspection visit and one testing inspection, one month before the end of the warranty period. During these visits, deferred testing will be performed in coordination with the Departmental Representative. Adjustment and optimization of systems will also be performed during these inspections.
- .3 Perform inspections during regular working hours, 08h00 to 16h30, Monday through Friday, excluding statutory holidays.
- .4 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
 - .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
 - .2 Calibrate each field input/output device in accordance with Canada Labour Code - Part I CSA Z204.
 - .3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.
- .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 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
 - .4 Review system performance with Operations Supervisor Departmental Representative to discuss suggested or required changes.
- .6 Major inspections to include, but not limited to:
 - .1 Minor inspection.
 - .2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.
 - .3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.
 - .4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
 - .5 Provide mechanical adjustments, and necessary maintenance on printers.
 - .6 Run system software diagnostics as required.

- .7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
 - .1 Perform network analysis and provide report as described in Submittal article.
- .7 Rectify deficiencies revealed by maintenance inspections and environmental checks.
- .8 Continue system debugging and optimization.
- .9 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
 - .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.
- .2 Submit detailed verification report after each test period of weather-sensitive systems.

End of Section

1. GENERAL

1.1 Summary

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

1.2 References

- .1 Canadian Standards Association (CSA International).
 - .1 CSA T529-95(R2000), Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
 - .2 CSA T530-99(R2004), Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).
- .2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.
 - .1 IEEE Std 802.3™-, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.
- .3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 TIA/EIA-568-March 2004, Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.
 - .2 TIA/EIA-569-A-December 2001, Commercial Building Standard for Telecommunications Pathways and Spaces.
- .4 Treasury Board Information Technology Standard (TBITS).
 - .1 TBITS 6.9-2000, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

1.3 Definitions

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

1.4 System Description

- .1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529 TIA/EIA-568 CSA T530 TIA/EIA-569-A TBITS 6.9.
 - .1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.
 - .2 Allow for future expansion of network, with selection of networking technology and communication protocols.
- .2 Data communication network to include, but not limited to:
 - .1 EMCS-LAN.
 - .2 Modems.

- .3 Network interface cards.
- .4 Network management hardware and software.
- .5 Network components necessary for complete network.

1.5 Design Requirements

- .1 EMCS Local Area Network (EMCS-LAN).
 - .1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.
 - .2 EMCS-LAN to: BACnet, Proprietary Protocol.
 - .3 Each EMCS-LAN to be capable of supporting at least 50 devices.
 - .4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
 - .5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.
 - .6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
 - .7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.
- .2 Dynamic Data Access.
 - .1 LAN to provide capabilities for OWSs, either network resident or connected remotely, 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 of building equipment.
- .3 Network Medium.
 - .1 Network medium: twisted cable, shielded twisted cable, fibre optic cable compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

2. PRODUCTS

- .1 Not Used.

3. EXECUTION

- .1 Not Used.

End of Section

1. GENERAL

1.1 Summary

.1 Section Includes:

- .1 Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS)..

1.2 Definitions

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

1.3 OWS System Description

- .1 Consists of commercially available personal computer in current production, with sufficient memory and processor capacity to perform functions specified.
- .2 The workstation must be an “all in one” computer mounted inside a touch screen panel.

1.4 Action and Informational Submittals

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

1.5 Environmental Conditions

- .1 OWS to operate in conditions of 10°C to 32°C and 20 % to 90 % non-condensing RH.

1.6 Maintenance

- .1 Provide maintenance in accordance with Section 25 05 03 - EMCS: Project Record Documents.

2. PRODUCTS

2.1 OWS PC Components

- .1 The computer will have the following features, at the very least:
 - .1 “All in one” computer mounted inside a touch screen panel.
 - .2 Intel Core i3 (1.8 GHz).
 - .3 Operating system: Windows 10, 64-bit.
 - .4 Memory: 4 Gb.
 - .5 Hard drive: 500 Gb.
 - .6 Touch screen, resistive or capacitive technology, 15 in.
 - .7 Ethernet connection, 10/100/1000.
 - .8 Wireless network: 802.11 a/b/g/n
 - .9 4 USB ports
 - .10 1 VGA port
 - .11 Integrated speakers

- .12 Suggested product:
 - .1 The specs are based on Reliable Controls TSP-15-i3.
 - .2 Any “all in one” touch-screen computer solution compatible with the EMCS system can be proposed as long as it’s running a complete version of Windows 10 and meets or exceeds the listed specifications.
- .13 The touch screen computer will be installed in the mechanical room on the ground floor.
- .14 The computer will be installed inside a wall mounted metal enclosure. The enclosure must be key lockable and must provide a cut-out to access the touch screen.
- .15 The computer will operate independently and at the same time as the other computers without causing interference and will be protected by a password for each user.
- .16 No specific software is necessary. All selections necessary for the complete interface, as described in the present document, will be via a standard Internet Explorer/Edge navigator.

2.2 OWS Control Software

- .1 OWS is not to form part of real-time control functions either directly or indirectly or as part of communication link. Real-time control functions to reside in MCUs, LCUs, and TCUs with peer to peer communication occurring at MCU to MCU device level.
- .2 Time Synchronization Module.
 - .1 System to provide Time Synchronization of real-time clocks in controllers.
 - .2 System to perform this feature on regular scheduled basis and on operator request.
- .3 User Display Interface Module.
 - .1 OWS software to support "Point Names" as defined in Section 25 05 01 - EMCS: General Requirements.
 - .2 Upon operator's request in either text, graphic or table mode, system to present condition of single point, system, area, or connected points on system to OWS. Display analog values digitally to 1 place of decimal with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. For systems supporting COSV, refresh rate of screen data not to exceed 5 seconds from time of field change and system is to execute supervisory background scan every 20 seconds to verify point data value. For other systems refresh rate not to exceed 5 seconds for points displayed. Initial display of new system graphic display (with up to 30 active points), including presentation of associated dynamic data not to exceed 8 seconds.
- .4 General Event Log Module: to record system activities occurring at OWS or elsewhere in system including:
 - .1 Operator Log-in from user interface device.
 - .2 Communication messages: errors, failures and recovery.
 - .3 Event notifications and alarms by category.
 - .4 Record of operator initiated commands.

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- .5 General Event Log:
 - .1 Hold minimum of 4months information and be readily accessible to operator.
 - .2 Able to be archived as necessary to prevent loss of information.

 - .6 Operator Control Software Module: to support entry of information into system from keyboard and mouse, disk, or from another network device. Display of information to user; dynamic displays, textual displays, and graphic displays to display logging and trending of system information and following tasks:
 - .1 Automatic logging of digital alarms and change of status messages.
 - .2 Automatic logging of analog alarms.
 - .3 System changes: alarm limits, set-points, alarm lockouts.
 - .4 Display specific point values, states as selected.
 - .5 Provide reports as requested and on scheduled basis when required.
 - .6 Display graphics as requested, and on alarm receptions (user's option).
 - .7 Display list of points within system.
 - .8 Display list of systems within building.
 - .9 Direct output of information to selected peripheral device.
 - .10 On-line changes:
 - .1 Alarm limits.
 - .2 Setpoints.
 - .3 Deadbands.
 - .4 Control and change of state changes.
 - .5 Time, day, month, year.
 - .6 Control loop configuration changes for controller-based CDLs.
 - .7 Control loop tuning changes.
 - .8 Schedule changes.
 - .9 Changes, additions, or deletions, of points, graphics, for installed and future systems.
 - .11 According to assigned user privileges (password definition) following functions are to be supported:
 - .1 Permit operator to terminate automatic (logic based) control and set value of field point to operator selected value. These values or settings to remain in effect until returned to automatic (logic based) control by operator.
 - .2 Requests for status, analog values, graphic displays, logs and controls to be through user interface screens.
 - .12 Software and tools utilized to generate, modify and configure building controllers to be installed and operational on the OWS.

 - .7 Dial-up host Module for off site OWSs.
 - .1 Operators at dial-up OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.
 - .2 Operator to be able to access remote buildings by selection of facility by its logical name. Dial-up module to maintain user-definable cross-reference of buildings and associated telephone numbers without manual dialing.

- .3 Local OWS may serve as dial-up host for remotely connecting OWSs, remote controllers or networks. Alarms and data file transfers handled via dial-up transactions must not interfere with local LAN activity. LAN activity not to prevent work-station from handling incoming calls.
- .8 Message Handling Module - and Error Messages: to provide message handling for following conditions:
 - .1 Message and alarm buffering to prevent loss of information.
 - .2 Error detection correction and retransmission to guarantee data integrity.
 - .3 Informative messages to operator for data error occurrences, errors in keyboard entry, failure of equipment to respond to requests or commands and failure of communications between EMCS devices.
 - .4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event of faulty designated OWS.
- .9 Access ControlModule.
 - .1 Minimum 5 levels of password access protection to limit control, display, or data base manipulation capabilities. Following is preferred format of progression of password levels:
 - .1 Guest: no password data access and display only.
 - .2 Operator Level: full operational commands including automatic override.
 - .3 Technician: data base modifications.
 - .4 Programmer: data base generation.
 - .5 Highest Level : system administration - password assignment addition, modification.
 - .2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = 3 minutes.
- .10 Trend Data Module: includes historical data collection utility, trend data utility, control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate.
 - .1 Historical data collection utility: collect concurrently operator selected real or calculated point values at operator selectable rate 30-480 minutes. Samples to include for each time interval (time-stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point. Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator. Temporary storage to have at least 6 month capacity.
 - .2 Trend data utility: continuously collect point object data variables for variables from building controllers as selected by operator, including at minimum; present value of following point object types - DI, DO, AI, AO set points value, calculated values. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of 05seconds to 3600 seconds, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on minimum 96 h basis in temporary storage until removed from trend data list by operator. Option to archive data before overwriting to be available.
 - .3 Control loop plot utility: for AO Points provide for concurrent plotting of Measured value input - present value, present value of output, and AO setpoint. Operator selectable sampling interval to be selectable between 1 second to 20 seconds. Plotting utility to scroll to left as plot reaches right side of display window. Systems not supporting control loop plot as separate function must provide predefined groups of values. Each group to include values for one control loop display.

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- .4 Trend data Module to include display of historical or trend data to OWS screen in X Y plot presentation. Plot utility to display minimum of 6 historical points or 6 trend points concurrently or 1 Control Loop Plot. For display output of real time trend data, display to automatically index to left when window becomes full. Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.
 - .5 Provide separate reports for each trend utility. Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials. Implement reports using report module. Ensure trend data is exportable to third party spreadsheet or database applications for PCs.
 - .11 Report Module: reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level. Refer also to Section 25 30 01 - EMCS: Building Controllers.
 - .1 Reports to include time, day, month, year, report title, operator's initials.
 - .2 Software to provide capability to:
 - .1 Generate and format reports for graphical and numerical display from real time and stored data.
 - .2 Print and store reports as selected by operator.
 - .3 Select and assign points used in such reports.
 - .4 Sort output by area, system, as minimum.
 - .3 Periodic/automatic report:
 - .1 Generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device. Software to permit modifying periodic/automatic reporting profile at any time.
 - .2 Reports to include:
 - .1 Power demand and duty cycle summary: see application program for same.
 - .2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.
 - .3 Run time summary: summary of accumulated running time of selected equipment. Include point name, run time to date, alarm limit setting. Run time to accumulate until reset individually by operator.
 - .4 Summary of run time alarms: include point name, run time to date, alarm limit.
 - .5 Summary of start/stop schedules: include start/stop times and days, point name.
 - .6 Motor status summary.
 - .4 Report types:
 - .1 Dynamic reports: system to printout or display of point object data value requested by operator. System to indicate status at time of request, when displayed, updated at operator selected time interval. Provide option for operator selection of report type, by point name, and/or output device. Ensure reports are available for following point value combinations:
 - .2 Points in accessible from this OWS (total connected for this location), multiple "areas".
 - .3 Area (points and systems in Area).
 - .4 Area, system (points in system).
 - .5 System (points by system type).

- .6 System point (points by system and point object type).
 - .7 Area point (points by system and point object type).
 - .8 Point (points by point object type).
 - .5 Summary report: printout or display of point object data value selected by operator. Report header to indicate status at time of request. Ensure reports are available on same basis as dynamic reports. Provide option as to report type, point name, output device.
 - .6 Include preformatted reports as listed in Event/Alarm Module.
- .12 Graphics Display Module: graphics software utility to permit user to create, modify, delete, file, and recall graphics required by Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.
 - .1 Provide capacity for 100% expansion of system graphics. Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlaid with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.
 - .2 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). Include capability to call up and cancel display of graphic picture.
 - .3 Library of pre-engineered screens and symbols depicting standard air handling components (fans, coils, filters, dampers, VAV), complete mechanical system components (chillers, boilers, pumps), electrical symbols.
 - .4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:
 - .1 Modify portion of graphic picture/schematic background.
 - .2 Delete graphic picture.
 - .3 Call up and cancel display of graphic picture.
 - .4 Define symbols.
 - .5 Position and size symbols.
 - .6 Define background screens.
 - .7 Define connecting lines, curves.
 - .8 Locate, orient, size descriptive text.
 - .9 Define, display colours of elements.
 - .10 Establish co-relation between symbols or text and associated system points or other graphic displays.
 - .5 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.
 - .6 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.
 - .7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress. If interface is unable to display several different types of display at same time, provide at minimum 2 OWS's.

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- .8 Utilize graphics package to generate system schematic diagrams as required in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation, and as directed by Departmental Representative. In addition provide graphics for schematic depicted on mechanical plan flow diagrams, point lists and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location. For floor graphic include secondary diagram to show TCU-VAV box actuator and flow sensor. Diagram to be single line schematic of ductwork as well as associated heating coil or radiation valve. Departmental Representative to provide CAD floor layouts. Provide display of TCU -VAV's in table form, include following values as minimum; space temp, setpoint, mode, actual flow, min flow setpoint, max flow setpoint, cooling signal value, and heating signal value. Organize table by rooms and floor groupings.
 - .9 Provide complete directory of system graphics, including other pertinent system information. Utilize mouse or pointing device to "point and click" to activate selected graphic.
 - .10 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS. Provide access to sequence of operation graphic by link button on each system graphic. Provide translation of sequence of operation, a concise explanation of systems operation, from control descriptive logic into plain English and/or French language.
 - .13 Event/Alarm Module : displays in window alarms as received and stored in General Event Log.
 - .1 Classify alarms as "critical", "cautionary", "maintenance". Alarms and alarm classifications to be designated by personnel requiring password level.
 - .2 Presentation of alarms to include features identified under applicable report definitions of Report Module paragraph.
 - .3 Alarm reports.
 - .1 Summary of points in critical, cautionary or maintenance alarm. Include at least point name, alarm type, current value, limit exceeded.
 - .2 Analog alarm limit summary: include point name, alarm limits, deviation limits.
 - .3 Summary of alarm messages: include associated point name, alarm description.
 - .4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.
 - .5 EMCS to notify operator of occurrence of alarms originating at field device within following time periods of detection:
 - .1 Critical - 5seconds.
 - .2 Cautionary - 10seconds.
 - .3 Maintenance - 10seconds.
 - .6 Display alarm messages in English .
 - .7 Primary alarm message to include as minimum: point identifier, alarm classification, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide secondary messages giving further information (telephone lists, maintenance functions) on per point basis.

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- .8 System reaction to alarms: provide alarm annunciation by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device. Acknowledgment of alarm to be time, date and operator stamped and stored in General Event Log. Steady state visual indicator to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of alarm not to impede notification of subsequent alarms or function of Controller's/CDL. Do not allow random occurrence of alarms to cause loss of alarm or over-burden system. Do not allow acknowledgment of one alarm as acknowledgement of other alarms.
 - .9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:
 - .1 Controller not responding - where possible delineate between controller and communication line failure.
 - .2 Controller responding - return to normal.
 - .3 Controller communications bad - high error rate or loss of communication.
 - .4 Controller communications normal - return to normal.
 - .10 Digital alarm status to be interrogated every 2 seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.
 - .14 Archiving and Restoration Module.
 - .1 Primary OWS to include services to store back-up copies of controller databases. Perform complete backup of OWS software and data files at time of system installation and at time of final acceptance. Provide backup copies before and after Controller's revisions or major modifications.
 - .2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of need to download copy data base to restore proper operation.
 - .3 Ensure data base back-up and downloading occurs over LAN without specialized operator technical knowledge. Provide operator with ability to manually download entire controller data base, or parts thereof as required.
 - .15 CDL Generator and Modifier Module.
 - .1 CDL Generator module to permit generation and modification of CDLs.
 - .2 Provide standard reference modules for text based systems module that will permit modification to suit site specific applications. Module to include cut, paste, search and compare utilities to permit easy CDL modification and verification.
 - .3 Provide full library of symbols used by manufacturer for system product installed accessible to operators for systems using graphical environment for creation of CDLs Module to include graphic tools required to generate and create new object code for downloading to building controllers.
 - .4 Module to permit testing of code before downloading to building controllers.

3. EXECUTION

3.1 **Installation Requirements**

- .1 Provide necessary power as required from local 120 V branch circuit panels for OWS's and peripheral equipment.
 - .1 Install tamper locks on breakers of circuit panels.

End of Section

1. GENERAL

1.1 References

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE 2003, Applications Handbook, SI Edition.
- .2 Canadian Standards Association (CSA International).
 - .1 C22.2 No.205-M1983(R1999), Signal Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE).
 - .1 IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
- .4 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.
 - .1 MD13800-September 2000, 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 Description

- .1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.
 - .1 Provide sufficient controllers to meet intents and requirements of this section.
 - .2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.
- .2 Controllers: stand-alone intelligent Control Units.
 - .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
 - .2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.
 - .3 Capable of interfacing with operator interface device.
 - .4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
 - .1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
- .3 Interface to include provisions for use of dial-up modem for interconnection with remote modem.
 - .1 Dial-up communications to use 56 Kbit modems and voice grade telephone lines.

- .2 Each stand-alone panel may have its own modem or group of stand-alone panels may share modem.

1.4 Design Requirements

- .1 To include:
 - .1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
 - .2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
 - .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
 - .4 Control of systems as described in sequence of operations.
 - .5 Execution of optimization routines as listed in this section.
- .2 Total spare capacity for MCUs and LCUs: at least 25 % of each point type distributed throughout the MCUs and LCUs.
- .3 Field Termination and Interface Devices:
 - .1 To: CSA C22.2 No.205.
 - .2 Electronically interface sensors and control devices to processor unit.
 - .3 Include, but not be limited to, following:
 - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
 - .2 Power supplies for operation of logics devices and associated field equipment.
 - .3 Lockable wall cabinet.
 - .4 Required communications equipment and wiring (if remote units).
 - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
 - .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
 - .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
 - .4 AI interface equipment to:
 - .1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.
 - .2 Provide for following input signal types and ranges:
 - .1 4 - 20 mA;
 - .2 0 - 10 V DC;
 - .3 100/1000 ohm RTD input;
 - .3 Meet IEEE C37.90.1 surge withstand capability.
 - .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
 - .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
 - .5 AO interface equipment:
 - .1 Convert digital data from controller processor to acceptable analog output signals using 8bit 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 5amps at 220 V AC using optional interface relay.
- .4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.
- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
 - .1 Provide for conduit entrance from top, bottom or sides of panel.
 - .2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
 - .3 Mounting details as approved by Departmental Representative for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

1.5 Action and Informational Submittals

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

1.6 Maintenance

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

2. PRODUCTS

2.1 Acceptable Product

- .1 The EMCS controllers must be provided by Reliable Controls. No equivalent substitute.

2.2 Master Control Unit (MCU)

- .1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.
- .2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.
 - .1 MCU must support Proprietary Protocol BACnet.

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- .3 MCU local I/O capacity as follows:
 - .1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.
 - .2 LCUs may be added to support system functions.
 - .4 Central Processing Unit (CPU).
 - .1 Processor to consist of minimum 16 bit microprocessor capable of supporting software to meet specified requirements.
 - .2 CPU idle time to be more than 30 % when system configured to maximum input and output with worst case program use.
 - .3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
 - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
 - .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.
 - .4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.
 - .5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise specified in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.
 - .1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Departmental Representative.
 - .2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.
 - .3 Display simultaneously minimum of 16 point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English French.
 - .4 Functions to include, but not be limited to, following:
 - .1 Start and stop points.
 - .2 Modify setpoints.
 - .3 Modify PID loop parameters.
 - .4 Override PID control.
 - .5 Change time/date.
 - .6 Add/modify/start/stop weekly scheduling.
 - .7 Add/modify setpoint weekly scheduling.
 - .8 Enter temporary override schedules.
 - .9 Define holiday schedules.
 - .10 View analog limits.
 - .11 Enter/modify analog warning limits.
 - .12 Enter/modify analog alarm limits.
 - .13 Enter/modify analog differentials.

- .5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.
- .6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.
- .7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.
- .8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.3 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.

2.4 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.

2.5 Software

- .1 General.
 - .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
 - .2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
 - .3 Include initial programming of Controllers, for entire system.
- .2 Program and data storage.
 - .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
 - .2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.
- .3 Programming languages.
 - .1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.
 - .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.
- .4 Operator Terminal interface.
 - .1 Operating and control functions include:
 - .1 Multi-level password access protection to allow user/manager to limit workstation control.
 - .2 Alarm management: processing and messages.
 - .3 Operator commands.
 - .4 Reports.
 - .5 Displays.
 - .6 Point identification.
- .5 Pseudo or calculated points.
 - .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
 - .2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).
- .6 Control Description Logic (CDL):
 - .1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Departmental Representative must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.

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- .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
 - .3 Perform changes to CDL on-line.
 - .4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.
 - .5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.
 - .6 MCU to be able to perform following pre-tested control algorithms:
 - .1 Two position control.
 - .2 Proportional Integral and Derivative (PID) control.
 - .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.
- .7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.
- .8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.
- .1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:
 - .1 Time of day scheduling.
 - .2 Calendar based scheduling.
 - .3 Holiday scheduling.
 - .4 Temporary schedule overrides.
 - .5 Optimal start stop.
 - .6 Night setback control.
 - .7 Enthalpy (economizer) switchover.
 - .8 Peak demand limiting.
 - .9 Temperature compensated load rolling.
 - .10 Fan speed/flow rate control.

- .11 Cold deck reset.
- .12 Hot deck reset.
- .13 Hot water reset.
- .14 Chilled water reset.
- .15 Condenser water reset.
- .16 Chiller sequencing.
- .17 Night purge.
- .2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.
- .3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.
- .9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.
 - .1 MCUs to accumulate and store automatically run-time for binary input and output points.
 - .2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.
 - .3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.
 - .4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.
 - .5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWh, litres, tonnes, etc.).
 - .6 Store event totalization records with minimum of 9,999,999 events before reset.
 - .7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.6 Levels of Address

- .1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.
 - .1 Display analog values digitally to 1 place of decimals with negative sign as required.
 - .2 Update displayed analog values and status when new values received.
 - .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
 - .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.7 Point Name Support

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

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 as directed by Departmental Representative.
- .2 Provide necessary power from local 120V branch circuit panel for equipment.
- .3 Install tamper locks on breakers of circuit breaker panel.

End of Section

1. GENERAL

1.1 Summary

.1 Section Includes:

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

1.2 References

.1 American National Standards Institute (ANSI).

- .1 ANSI C12.7-1993(R1999), Requirements for Watt-hour Meter Sockets.
- .2 ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.

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

- .1 ASTM B148-97(03), Standard Specification for Aluminum-Bronze Sand Castings.

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

- .1 NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).

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

- .1 AMCA Standard 500-D-98, Laboratory Method of Testing Dampers for Rating.

.5 Canadian Standards Association (CSA International).

- .1 CSA-C22.1-02, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

1.3 Definitions

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

1.4 Action and Informational Submittals

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

.2 Pre-Installation Tests.

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

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

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, enclosure.
- .3 Operating conditions: 0 - 32°C with 10 - 90% RH (non-condensing) unless otherwise specified.
- .4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .5 Transmitters and sensors to be unaffected by external transmitters including walkie-talkies.
- .6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.
- .8 Devices installed in user occupied space not to exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.
- .9 Range: including temperature, humidity, and pressure, in accordance with normal operation of controlled networks, systems, equipment or components.

2.2 Temperature sensors

- .1 Temperature sensors must be RTD nickel series type with maximum 1,000 Ohms resistance at 21°C and linear variation for -46°C to 100°C temperature range (5.4 Ohms/°C). Accuracy: $\pm 0.18^\circ\text{C}$ at 21°C.
- .2 Active element must be in a stainless steel sealtight housing that can be cut to desired length to suit application.
- .3 Wall-mount room sensors with stainless steel cover, without set point..
- .4 Duct-mount sensors to be inserted into air ducts at any angle, 200 mm (8 in.) insertion probe.
- .5 Duct-mount sensors, 12 feet long, with several measuring points. For larger surface area ducts, apply 1 ft. sensor per ft² of series-parallel connected surface.

- .6 Outside air temperature complete with corrosion resistant screen designed to minimize effects from the sun.
- .7 Immersion temperature sensors for piping with brass thermowell filled with thermo-sensitive element, length adapted to pipe.
- .8 Wall-mount or surface-mount room sensors with local adjustment for set point and concealed behind a door that can be locked to avoid unauthorized usage. Screen displays room temperature. Momentary undercover contact to signal to the controller occupied mode outside regular occupancy hours. RJ11 jack for connection to portable terminal to display and adjust values and status of variables from any controller to which the temperature sensor is connected.

2.3 Combined relative humidity/temperature sensors

- .1 Relative humidity and temperature sensors are to have the following features:
 - .1 Duct-mount or exterior installation with 100% polymer sensing element offering higher corrosion resistance. Nickel temperature element.
 - .2 Range: 0 to 100% RH.
 - .3 Accuracy: 3% of 20–80% RH.
 - .4 12–30 VDC or 20–30 VAC.
 - .5 Signal: 0–10 VDC or 0–5 VDC with the possibility to modify $\pm 5\%$ sensor reading during calibration with respect to a reference value.

2.4 Air differential pressure transmitters

- .1 Transmitters must be designed for continuous contact with air, compressed air, water or steam, as applicable.
- .2 Output signal 4–20 mA into 800 Ohm or 0–5 VDC maximum load or 24 VDC unregulated.
- .3 Accuracy (combined non-linearity, hysteresis, repeatability) $\pm 1\%$ full scale. Temperature effect $\pm 0.033\%$ full scale degrees Celsius.
- .4 Zero and span adjustment. Uni-directional and bi-directional measuring range as applicable.

2.5 Differential pressure switches

- .1 Switch sensing fan operation to specify or protect electric coils and humidifiers.
- .2 With adjustable set point from 12 to 1,250 Pa and switch differential increasing with set point. SPDT relay with 2 A, 24 VAC contact.

2.6 Current transducer

- .1 Used to detect electrical motor operations.
- .2 Split core installation.

- .3 4-20 mA or 0-10VDC analog output.

2.7 Low temperature switch

- .1 Circuit opens when the temperature falls below the set point (adjustable from 2 to 70°C).
- .2 6 m sensing element to detect lowest temperature along a 300 mm (12 in.) capillary length.
- .3 For larger ducts, several thermostats can be connected in series.

2.8 High temperature switch

- .1 Circuit opens when the temperature exceeds the set point.
- .2 2 m sensing element.

2.9 High humidity switch

- .1 For in duct usage.
- .2 SPDT relay with 15 A, 24 to 250 VAC contact.
- .3 External dial for set point adjustment.
- .4 Ambient temperature usage: -10°C do 65°C.
- .5 Functional humidity range: 10 to 99% HR non-condensing.

2.10 Electric duct thermostat

- .1 Electric thermostat, sealed SPDT switch.
- .2 -35°C to 40°C temperature control range.
- .3 Temperature sensing element is inserted at the end of a 2.4 m capillary lead.

2.11 Point leak detector sensor (water)

- .1 Sealed SPDT switch.
- .2 24 VAC.

2.12 Gas sensor (CO2)

- .1 UL and CSA certified system complete with sensors and transmitters.
- .2 For indoor, in duct and outdoor usage.

- .3 Detection technology: infrared.
- .4 Detection span: 0-2000 ppm.
- .5 Precision: $\pm 3\%$
- .6 Output: 4-20 mA or 0-10 Vdc
- .7 Supplied with a calibration certificate.

2.13 Motorized dampers

- .1 Motorized dampers will be provided and installed by the Ventilation Contractor. The present Specialized Contractor will provide and install the required actuators.

2.14 Electronic control damper actuators

- .1 Direct mount electronic control actuator on damper shaft and spring return in case of actuator power failure. Torque suitable for specific application. Adjustment possible to field rotation direction.
- .2 Possible 90 degree angular rotation able to be mechanically locked. Manual engagement for positioning damper. Block protection in the case of supply voltage shutdown.
- .3 Two (2) auxiliary adjustable position switches for all rotation angles when required to achieve the control sequence or if specified on the drawings.
- .4 For a proportional model, possibility for zero point calibration (signal value required for start-up) and range (signal value providing maximum opening position required). 0–10 VDC positioning signal. Potentiometer indicating real position via 0–10 VDC signal.
- .5 Quantity and capacity of actuators for each motorized damper must be suitable for optimal damper functionality as per signal defined in operating sequence (on-off, 0–10 VDC).
- .6 Motor shall be brushless DC type.

2.15 Control valves

- .1 Provide control valves in compliance with mechanical discipline drawings and specifications (ventilation and plumbing). The Contractor is responsible for providing suitable valves meeting water network applications (differential pressure for modulating application, packing, operating temperatures, etc.).
 - .1 Valves 50 mm and smaller must be made of bronze, with screw connections. Valves 62 mm and greater must be made of cast iron, with flange connections.
 - .2 Packing must be made of stainless steel for valves 62 mm and larger, or if the network differential pressure is higher than 25 psi.

- .3 Valves must be sealtight; maximum allowable leak rate: 0.5% of nominal flow.
- .4 Valves must be “Normally Open” (NO), “Normally Closed” (NC) type, or 3-way type, as indicated.
- .5 Valves must have equal percentage flow control characteristics.
- .6 Valve rangeability: minimum 50:1.
- .7 Valve actuators:
 - .1 Provide electric valve actuators.
 - .2 Spring return to “Normally Open” (NO) or “Normally Closed” (NC) positions, as per application.
 - .3 Actuators must be of suitable size to protect valves against maximum pressure limits and dynamic closing pressure, whichever is greater.
 - .4 Provide and install all required installation accessories as per application.
 - .5 Actuators must be provided with end switches as shown on the drawings or if required to achieve the control sequence.
 - .6 Actuators must be equipped with a clutch mechanism to operate the valve without power.
 - .7 Command signals: modulating actuator, 4–20 mA or 0–10 VDC.

2.16 Control relays

- .1 DPDT relays, as per application.
- .2 Relay coils to operate at 120 V or 24 VAC.
- .3 Contacts must be designed for 10 A at 120 VAC.
- .4 Pluggable relays with terminal board.

2.17 Timer relays

- .1 Adjustable between 0 and 10 minutes.
- .2 Relay coils to operate at 120 V or 24 VAC.
- .3 Contacts must be designed for 10 A at 120 VAC.
- .4 Indicating light.

2.18 Manual timer switch

- .1 Manual dial with 0 to 4 hours span.
- .2 SPST contact, 20A at 120 vac.

2.19 Power relay

- .1 Used to start 120 V motors.

.2 DPST contact for 1 HP maximum motors.

.3 24 winding or 120 VAC.

2.20 Damper limit switch

.1 Mounted inside the duct.

.2 A detection head monitors the damper blades and snaps NO / NC auxiliary contacts.

.3 Water proof enclosure.

2.21 Indicator lights

.1 Interior indicating lights

.1 Model GE (Edwards) CR104PLG88, 24 vac. Refer to drawings for color selection.

.2 Each light must be supplied with five (5) backup bulbs, model GE (Edwards) GO-10GC.

.3 Lights must be mounted on a stainless steel plate or in front of a control panel.

.2 Exterior indicating lights

.1 Model GE (Edwards) 50CSIN-N5-40WH-92-GRD, 120 vac, continuous light. Refer to drawings for color selection.

.2 Each light must be supplied with two (2) backup bulbs, model GE (Edwards) 50-LMP-40WH.

2.22 Power supply

.1 Output current: 1.5 or 3A depending on device requirements.

.2 Stability: 2%.

2.23 Electric transformer

.1 Closed type.

.2 Capacity: 150% of maximum load.

.3 Fuse protection on primary and secondary loops.

2.24 Control panel

.1 All EMCS controllers, electric components and accessories must be installed in a NEMA1 control panel enclosure.

.2 Panels must be mounted near the controlled equipment.

- .3 Panels can be wall mounted or floor mounted. If wall mounted, a grey painted fireproof plywood sheet must be installed prior to the panel installation.
- .4 Each panel must have a lockable hinge door. The same key shall unlock any EMCS control panel in the building.
- .5 EMCS electrical conduits shall intersect with the enclosure top or bottom side.
- .6 All wires inside the enclosure must be clearly identified and hidden inside a slotted trunking.
- .7 All components inside the enclosure must be clearly identified with labels.
- .8 An identification plate must be installed on the panel facade.

2.25 Wiring

- .1 In accordance with 26 27 26 - Wiring Devices.
- .2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
- .3 Wiring must be continuous without joints.
- .4 Sizes:
 - .1 Field wiring to digital device: #18AWG 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, humidity 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 for Electrical.

- .2 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
- .3 Install communication wiring in conduit.
 - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
 - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
 - .3 Maximum conduit fill not to exceed 40%.
 - .4 Design drawings do not show conduit layout.
- .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.

3.2 Temperature and Humidity Sensors

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
 - .1 Protect from solar radiation and wind effects by non-corroding shields.
 - .2 Install in NEMA 4 enclosures.
- .4 Duct installations:
 - .1 Do not mount in dead air space.
 - .2 Locate within sensor vibration and velocity limits.
 - .3 Securely mount extended surface sensor used to sense average temperature.
 - .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
 - .5 Support sensor element separately from coils, filter racks.
- .5 Averaging duct type temperature sensors.
 - .1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
 - .2 Wire multiple sensors in series for low temperature protection applications.
 - .3 Wire multiple sensors separately for temperature measurement.
 - .4 Use software averaging algorithm to derive overall average for control purposes.
- .6 Thermowells: install for piping installations.
 - .1 Locate well in elbow where pipe diameter is less than well insertion length.
 - .2 Thermowell to restrict flow by less than 30%.
 - .3 Use thermal conducting paste inside wells.

- .7 All room thermostats must be connected to the EMCS for remote control and monitoring purposes.

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

1. GENERAL

1.1 References

- .1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.
 - .1 MD13800-September 2000, Energy Management and Control Systems (EMCS) Design Manual. English:
<ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>

1.2 Sequencing

- .1 Present sequencing of operations for systems in accordance with MD13800 – Energy Management and Control Systems (EMCS) Design Manual.
- .2 Sequencing of operations for systems as described hereafter.
 - .1 General
 - .1 Consult Departmental Representative in order to obtain all schedules of events and schedules of the various modes, and perform programming.
 - .2 All operating parameters such as set points, data of adjusting tables, proportional, integral and derivative gains, etc., shall be programmed as variables in order to allow easy modification without having to modify programming.
 - .3 All proportional, integral and derivative gains shall be adjusted until each control loop is approved by Consultant.
 - .4 Each motor to include programmable parameters allowing sequential start-up of all motors upon return of power after failure, in order to avoid overloads. Departmental Representative to approve parameters that are programmed and demonstrate that the sequence is complied with upon power return (Emergency and Normal). Furthermore, the running time of each motor is to be calculated and displayed at operator's request. The running time of a motor is reset to zero based on operator's command.
 - .5 Supply, installation and connection of all electrical relays, interlocks, converters and other accessories required in order to meet operation sequences described in this section are the responsibility of present Contractor.
 - .6 Any transition of operation mode set point to another shall be made progressively in order to avoid abrupt operations. Transition time shall be adjustable according to application.
 - .7 All alarms related to a system shall be deactivated when system is off. Moreover, adjustable delay shall allow delay of activation of alarm function upon system start-up.
 - .8 All flow values mentioned on drawings and in this section shall not be considered as accurate. Contractor shall obtain accurate values from ventilation drawings.

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- .9 When two or more components are to be used to perform the same task, an alternating sub-routine shall allow equal wear of both components. Moreover, operator shall be able to provide each component with desired operation priority.
 - .10 Provide alarm parameter list to be reviewed and approved by Departmental Representative.
 - .11 Program all alarms related to the relative humidity of rooms following the parameter list.
 - .12 Program high and low temperature alarms for all temperature inputs and non-programmed shut-off states of all systems. All points connected to the control system must be monitored and the programming of alarms must be included.
 - .13 The Control Contractor shall be responsible for verifying the operation of each instrument he is controlling, even if supplied by others.
 - .14 **All EMCS functions will be accessible to the user via a Web navigator and the Departmental Representative's intranet with equivalent EMCS access control.**
 - .15 Provide and install the required exterior indicating lights and horn as shown on the drawings and in the control sequence. The installation must comply with Nunavut's good building practice.
 - .16 The following equipment must be integrated into the EMCS through network communication (BACnet, Modbus or other). All available points must be accessible through the EMCS for control and monitoring purpose:
 - .1 Hot water boilers
 - .2 Variable frequency drives
 - .3 Any other equipment shown on the drawings
 - .17 Carry all control electrical interlocks required to achieve functionality and safety:
 - .1 Variable frequency drive
 - .2 Hot water boiler
 - .3 Damper end switch
 - .4 Temperature limit switch
 - .5 High humidity limit switch
 - .6 Flow switch
 - .7 Domestic hot water tank aquastat
 - .8 All other equipment interlock shown on the drawings
 - .18 The systems provided must be compatible with the Departmental Representative automated control systems. The Contractor must plan for all necessary accessories and wiring (receptacle, network, software, etc.). **The EMCS must be provided by Reliable Controls.**
 - .1 All other components such as temperature sensors, duct sensors, level sensors, thermostats, etc., may be another brand on the condition that they are compatible with the digital controllers.

- .19 The Contractor is responsible for consulting all documents, drawings and specifications in architecture, structural, mechanical and electrical disciplines in order to become familiar with the overall project.

2. SEQUENCES OF OPERATION

2.1 Oil Distribution System

- .1 Exterior oil tank FOT-1:
 - .1 If a low level is detected, the amber interior and exterior indicators must light up and an alarm must be displayed at the control station.
 - .2 If a very low level is detected, the amber interior and exterior indicators must light up. The OEM oil controller must stop the transfer pumps (PFO-1 or PFO-2) and activate the trouble indicator light on the pump control panel. An alarm must be displayed at the control station.
- .2 Interior oil tank FOT-2:
 - .1 Stop/start of pumps PFO-1 and PFO-2 is to be activated by high and low levels, respectively.
 - .2 If a very low level is detected, the amber interior indicator must light up and the transfer pumps (PFO-1 or PFO-2) must stop. The OEM oil panel must activate the indicator light on the pump control panel. An alarm must be displayed at the control station.
- .3 Oil transfer pumps:
 - .1 Pump alternation must be controlled by the alternation relay in the OEM pump control panel.
 - .2 Pumps PFO-1 and PFO-2 must alternate once a week. If a default occurs following pump alternation, the pump OEM control panel must restart the pump that was operating prior to alternation and the amber "low level" interior and exterior indicators must light up. The default pump indicator light (on the pump control panel) must turn on. An alarm must be displayed at the control station.
- .4 Monitoring/alarm:
 - .1 Low tank level.
 - .2 OEM oil panel, general alarm.

2.2 Boilers BOIL-1 and BOIL-2

- .1 Boiler control
 - .1 The programmable digital controller must start the boiler stages, in accordance with a predetermined heating demand and based on the outside temperature.
 - .2 The related hot water pumps must be started and confirmed in operation prior to granting authorization to start the boiler.
 - .1 Pump sets HP1-1 / HP1-2 and HP2-1 / HP2-2 must alternate once a week. If a default occurs following pump alternation, the pumps'

OEM control panel must restart the pump that was operating prior to alternation. An alarm must be displayed at the control station.

- .3 Pumps sets HP1-1 / HP1-2, HP2-1 / HP2-2 must always be enabled when a boiler is in operation.
- .4 The lead boiler must be alternated by the programmable digital controller in accordance with a weekly schedule.
- .5 If a boiler default is detected, the lag boiler must be automatically started. An alarm must be displayed at the control station.

.2 Combustion air

- .1 A signal from the boilers' OEM control panel must open the combustion air register. A damper limit switch enables the boilers to start once the register is confirmed open.

.3 Supply temperature control:

- .1 The programmable digital controller is used to activate the number of boiler heating stages required to maintain the supply temperature at the re-adjusted set point, which is based on the outside temperature:

Outdoor air temperature	Supply temperature
-40°C	72°C
0°C	60°C

- .2 In unoccupied mode, the boilers must be activated as needed to maintain the coldest control room sensor at the unoccupied set point of 17°C (adjustable).

.4 Domestic hot water:

- .1 The Aquastat water heater must be connected to the boiler's control panel. If required, the boiler and pump set must be started to maintain a temperature of 60°C in the tank.

.5 Monitoring/alarm:

- .1 Lead pump failure – no status when commanded on.
- .2 Lead boiler failure.
- .3 Low/high supply temperature.
- .4 The boiler's OEM panel must be integrated with the EMCS network. All available read/write objects must be available to the EMCS for remote control and monitoring.

2.3 Radiant floor heating system

- .1 Radiant floor heating must always be enabled.
- .2 Pumps BSP-1, BPS-2, BSP-3 and BSP-4 must always be enabled.

- .3 The radiant floor is divided into five separate distribution panels (manifolds) Each distribution panel contains an OEM control unit and control valves The valve's actuators are pre-wired to the OEM controller and are to be commanded on or off depending on the zone demand.
- .4 Each manifold is associated with a pump and a three way modulating valve (except for manifold 4 and 5 which are both associated to pump BSP-4).
- .5 The three-way mixing valve must modulate to maintain the manifold's supply temperature set point:

Outdoor temperature	Supply temperature
9 °C	23 °C
-10 °C	27 °C

- .6 Each manifold contains up to nine (9) two-way valves control valves which supply different control loops. A radiant heating zone may be associated to more than one loop.
- .7 Each radiant heating zone must be monitored with a slab temperature sensor. The slab sensor must restrict the loops' supply temperature to 28°C.
- .8 Each radiant zone is associated with a room thermostat. The EMCS is wired to the distribution panel OEM controller's inputs and each input is associated with a heating zone. The valve and zone association is pre-programmed in the OEM controller. Depending on the thermostat's demand, the EMCS will close or open a dry contact on the OEM controller's input. The OEM controller will then open or close the heating zone's corresponding two-way control valves. Refer to room control sequence for more details.
- .9 Monitoring/alarm:
 - .1 Recirculating pump failure – no status when commanded on.
 - .2 High temperature in radiant heating zone (28°C).

2.4 Air handling system AHU-1 and heat recovery unit VRE-1

- .1 System description:
 - .1 Air handling unit AHU-1 is connected downstream of heat recovery unit VRE-1.
- .2 System stop:
 - .1 Heat recovery unit VRE-1's activation contact must be disabled and its isolation dampers must be closed.
 - .2 Air handling unit AHU--1's supply fan must be disabled.
 - .3 Air handling unit AHU--1's fresh air damper and the return damper must be closed.
 - .4 Air handling unit AHU--1's heat coil valve must modulate to maintain a temperature (adjustable) of 20°C inside the unit.

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- .3 Heat recovery unit VRE-1
 - .1 General:
 - .1 System operates with 100% fresh air.
 - .2 System can operate in recovery mode, free cooling mode and recirculating mode:
 - .1 In recovery mode, the air exchanger dampers are switched every 60 seconds.
 - .2 In free cooling mode, the air exchanger dampers are switched every 3 hours.
 - .3 In recirculating mode, the air exchangers are bypassed.
 - .2 Occupied/unoccupied mode:
 - .1 System is only enabled during occupied hours.
 - .3 System start:
 - .1 Heat recovery unit VRE-1's activation contact is enabled.
 - .2 The heat recovery unit's OEM controller opens the internal dampers. The dampers are positioned in recovery or free cooling mode, depending on the outside temperature conditions.
 - .3 The building sanitary exhaust damper must open.
 - .4 Following a 15-second delay (adjustable), the supply and exhaust fans are started.
 - .4 Fan speed control:
 - .1 Fans shall work at a constant speed to maintain the static pressure set point (determined during balancing works).
 - .2 The reference sensor for the return fan is located in the building sanitary exhaust.
 - .3 The reference sensor for the supply fan is located at the discharge of the unit.
 - .4 If the kitchenette hood H-1 is operating (refer to kitchen room exhaust system control sequence), the supply fan pressure set point is adjusted in order to keep the building at a positive pressure. The pressure setpoint adjustment shall be determined during the balancing phase by comparing the supply flow rate when the kitchenette is extracted by the hood versus the building general exhaust.
 - .5 Operating mode selection:
 - .1 Recovery mode is activated when the outdoor temperature is higher than 15°C or under 6°C (dead-band 2°C).
 - .2 Free cooling mode is activated when the outdoor temperature is between 8°C and 13°C (dead-band 2°C).
 - .3 A 10-minute delay is applied between changes in mode to prevent cycling.
 - .6 Protection:
 - .1 If the supply temperature is lower than 4°C for more than 2 minutes, the system is forced into recirculating mode.
 - .2 If the supply temperature reaches 3°C, the system must be stopped by an electrical interlock. A software reset is required at the EMCS control station.

- .3 High limit pressure switch PSH-1 stops the supply fan if pressure exceeds 450 Pa (adjustable). A software reset is required to restart the system.
- .4 High limit pressure switch PSH-2 stops the exhaust fan if pressure exceeds 350 Pa (adjustable). A software reset is required to restart the system.
- .5 Low limit pressure switch PSL-1 stops the supply fan if the pressure is lower than -450 Pa (adjustable). A software reset is required to restart the system.

.4 Air handling unit AHU-1

.1 Occupied mode

- .1 Fresh air and return damper must be open.
- .2 Supply fan must be started.
- .3 Once the fan is operating, the following sequences must be activated:
 - .1 Supply temperature control:
 - .1 The heating coil control valve modulates to maintain the supply temperature set point between 13°C and 25°C. The supply temperature set point can be adjusted to maintain an average temperature of 21°C (adjustable) in the rooms.
 - .2 Static supply pressure control:
 - .1 A pressure sensor must be installed in the supply duct.
 - .2 The sensor must modulate the fan to maintain the static pressure set point (determined during balancing works).
 - .3 Humidity control:
 - .1 The humidifier control valve modulates to maintain the building return humidity sensor set point in accordance with the outdoor temperature:

Outdoor temperature	Humidity set point
-25°C	18%
0°C	30%

- .4 CO₂ monitoring:
 - .1 A CO₂ sensor is located in the building return duct for monitoring purpose only.
- .2 Unoccupied mode
 - .1 The system must restart in recirculation mode if the temperature in a room drops below 17°C during the unoccupied period.
 - .2 A manual timer (0 to 4 hours) must allow the system to temporary switch back to occupied mode.
- .3 Protection
 - .1 A low limit temperature switch must stop the system using an electrical interlock when the supply temperature drops below 3°C.
 - .2 A high limit humidity switch must deactivate the humidifier if the supply humidity is higher than 85%.

- .3 A pressure switch must deactivate the humidifier if there is no flow detected in the supply duct.

.5 Monitoring/alarm:

- .1 Fan failure – no status when commanded on.
- .2 Low supply temperature.
- .3 High CO₂ in building return (1000 ppm).
- .4 Local pressure sensors must indicate when the pressure drops through the air filters. An alarm must be displayed at the EMCS control station when a filter needs to be replaced.
- .5 Variable frequency drives must be integrated into the EMCS network. All available read/write objects must be available to the EMCS for remote control and monitoring.

2.5 Mechanical room 203 ventilation system

- .1 A unit heater must be enabled when the room temperature is lower than 15 °C and must be stopped when the temperature reaches 18 °C.
- .2 Monitoring/alarm:
 - .1 Room temperature – High (25°C) / low (5°C).

2.6 Boiler room 113 ventilation system

- .1 The system must always be enabled.
- .2 Fresh air, return and exhaust dampers must modulate to maintain the supply temperature to its set point of 15°C (adjustable).
- .3 If the system is stopped manually, the fresh air and exhaust dampers close and the return damper opens.
- .4 A unit heater must be enabled when the room temperature is lower than 15 °C and must be stopped when the temperature reaches 18 °C.
- .5 Monitoring/alarm:
 - .1 Room temperature – High (25°C) / low (5°C).
 - .2 Fan failure – no status when commanded on.
 - .3 Local pressure sensors must indicate when the pressure drops through the air filters. An alarm must be displayed at the EMCS control station when a filter needs to be replaced.

2.7 Kitchenette System H-1

- .1 The hood exhaust fan and damper are provided by OEM controls and must be started locally.
- .2 A wall mounted stainless steel plate complete with a “maintained operation” push button and a green led is installed inside the kitchenette.

- .3 When the hood exhaust is turned on, the operator must activate the pushbutton on the stainless steel plate.
- .4 A green LED must light up when the general room exhaust damper is confirmed closed. A dry contact wired to the EMCS must confirm that the room exhaust damper is fully closed.
- .5 When the hood exhaust is turned off, the operator must release the button. The LED must turn off to confirm that the room exhaust damper is opened.

2.8 Crawl space heat exchanger AE-1 and unit heaters

- .1 The heat exchanger is always enabled and operates through its OEM controls.
- .2 A supply temperature sensor must modulate the heating coil valve to maintain an air temperature of -15 °C before entering the heat exchanger.
- .3 The supply and exhaust dampers are interlocked with the unit.
- .4 The unit heaters must be enabled when the room temperature is lower than 15 °C and must be stopped when the temperature reaches 18 °C.
- .5 Monitoring/alarm:
 - .1 Supply temperature – Low (-16°C).
 - .2 Crawl space temperature – High (25°C) / low (5°C).

2.9 Room Control

- .1 Operation:
 - .1 Occupation: occupied/unoccupied modes.
 - .2 Baseboard radiators.
 - .3 Terminal heating coils.
- .2 Temperature control:
 - .1 Ambient temperature must be maintained at its set point (summer: 24°C, winter: 22°C) by opening or closing the radiant heating zone control valves.
 - .2 Baseboard heaters (room 104 and 105)
 - .1 If the room set point cannot be reached with the radiant floor alone, the EMCS must gradually open the baseboard heating valve to maintain the room set point.
 - .3 Terminal heating (room 114,115, 118, 120, 204, 207 and 209)
 - .1 If the room set point cannot be reached with the radiant floor alone, the EMCS must gradually open the terminal heating coil valve to maintain the room set point.
 - .4 All room temperatures are displayed at the EMCS system.

End of Section