PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 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.

1.3 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.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

1.5 COMMISSIONING

.1 Do commissioning in accordance with Section 01 91 13 - General Commissioning Requirements.

.2 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative and PWGSC Commissioning Manager.

.3 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.

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

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

.6 Load system with project software.

.7 Perform tests as required.

1.6 COMPLETION OF COMMISSIONING

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

1.7 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

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

PART 2 - PRODUCTS

2.1 EQUIPMENT

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

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

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

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

.5 Application: to conform to normal industry standards.

PART 3 - EXECUTION

3.1 PROCEDURES

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

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

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

.4 Debug system software.

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

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

3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.
- .1 General: consists of field tests of equipment just prior to installation.
- .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.
- .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.
- .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
- .5 Transmitters above 0.5% error will be rejected.
- .6 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 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 the list for the commissioning technician and Departmental Representative. This document will be used in final start-up testing.
- .3 Final Start-up Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and PWGSC Commissioning Manager 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 start-up testing.
  - .5 O&M personnel to assist in commissioning procedures as part of training.
  - .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
  - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
  - .8 Operate systems as long as necessary to commission entire project.
  - .9 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
  .1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics 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.
  .4 System will be accepted when:
    .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
    .2 Requirements of Contract have been met.
  .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
  .6 Correct defects when they occur and before resuming tests.
.5 Departmental Representative to verify reported results.

3.3 ADJUSTING

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

3.4 DEMONSTRATION

.1 Demonstrate to Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00 - Demonstration and Training for Building Commissioning.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 DEFINITIONS

.1 CDL - Control Description Logic.

.2 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.

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 Phase 1: 1 day program to begin before 30 day test period at time mutually agreeable to Contractor, Departmental Representative and PWGSC Commissioning Manager.
- .1 Train O&M personnel in functional operations and procedures to be employed for system operation.
- .2 Supplement with on-the-job training during 30 day test period.
- .3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
- .4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

1.8 ADDITIONAL TRAINING

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

1.9 MONITORING OF TRAINING

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

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

.2 Section 25 05 54 - EMCS: Identification.

1.2 REFERENCE STANDARDS

.1 The Instrumentation, Systems and Automation Society (ISA).
- .1 ISA 5.5-1985, Graphic Symbols for Process Displays.

.2 Institute of Electrical and Electronics Engineers (IEEE).
- .1 IEEE 260.1-2004 (R2010), 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 135-2016, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).
- .1 CAN/CSA-Z234.1-00 (R2011), Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA).
- .1 CEA-709.1-D-2014, Control Network Protocol Specification.

1.3 ACRONYMS AND ABBREVIATIONS

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

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

1.4 DEFINITIONS

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

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

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

.4 DO (digital output).
.5 Pulse inputs.

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

1.5 SYSTEM DESCRIPTION

.1 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.

.2 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.
.5 Metric references: in accordance with CAN/CSA Z234.1.

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

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

1.7 EXISTING- CONTROL COMPONENTS

.1 Re-use field control devices that are usable in their original configuration provided that they conform to applicable codes, standards specifications.
  .1 Do not modify original design of existing devices without written permission from Departmental Representative.
  .2 Provide for new, properly designed device where re-usability of components is uncertain.

.2 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.
  .1 Furnish test report within 40 days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair by Departmental Representative.
  .2 Failure to produce test report will constitute acceptance of existing devices by contractor.

.3 Non-functioning items:
  .1 Provide with report specification sheets or written functional requirements to support findings.
  .2 Departmental Representative will repair or replace existing items judged defective yet deemed necessary for EMCS.

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

.5 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Departmental Representative.
  .1 Be responsible for items repaired or replaced by Departmental Representative.
  .2 Be responsible for repair costs due to negligence or abuse of equipment.
  .3 Responsibility for existing devices terminates upon final acceptance of EMCS by Departmental Representative.

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

1.8 DESIGNATED CONTRACTOR

.1 Hire the services of Ainsworth to complete the work of all EMCS sections.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 & ASHRAE 135.

2.2 ADAPTORS

.1 Provide adaptors between metric and imperial components.

PART 3 - EXECUTION

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

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.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

1.5 SHOP DRAWING REVIEW

.1 Submit 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 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:

- .1 Sensing element type and location.
- .2 Transmitter type and range.
- .3 Associated field wiring schematics, schedules and terminations.
- .4 Complete Point Name Lists.
- .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
- .6 Software and programming details associated with each point.
- .7 Manufacturer's recommended installation instructions and procedures.
- .8 Input and output signal levels or pressures where new system ties into existing control equipment.

.10 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and floor plans.

.11 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.

.12 Listing of time of day schedule.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

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

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

1.2 DEFINITIONS

.1 BECC - Building Environmental Control Centre.

.2 OWS - Operator Work Station.

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 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 Specifications and Drawings as well as addenda and contract extras.
- .2 Changes to interface wiring.
- .3 Routing of conduit, wiring and control air lines associated with EMCS installation.
- .4 Locations of obscure devices to be indicated on drawings.
- .5 Listing of alarm messages.
- .6 Panel/circuit breaker number for sources of normal/emergency power.
- .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
- .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- .9 Basic system design and full documentation on system configuration.

.2 Submit for final review by Departmental Representative.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International).
  .1 CSA C22.1-18, The Canadian Electrical Code, Part I , Safety Standard for Electrical Installations (24th Edition).

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTION

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

1.5 ACTION AND INFORMATIONAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 NAMEPLATES FOR PANELS

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

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by plastic tie.

.2 Sizes: 50 x 100 mm minimum.

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

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

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

2.3 NAMEPLATES FOR ROOM SENSORS

.1 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".

2.5 WIRING

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

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

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

2.6 PNEUMATIC TUBING

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

2.7 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

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

2.8 LIC MODULE AND VAV ID STICKERS

.1 Supply and install clear adhesive stickers with LIC module numbers and VAV box numbers printed onto sticker by a laser printer.

.2 Stickers to conform with those currently in use under the EMCS Project.

PART 3 - EXECUTION

3.1 NAMEPLATES AND LABELS

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

3.2 EXISTING PANELS

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

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.

1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain EMCS for warranty period of one year. Provide detailed preventative maintenance

.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 on site ready to service EMCS within 2 hours after receiving request for service.
- .5 Perform Work continuously until EMCS restored to reliable operating condition.

.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.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCE STANDARDS

.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 802-2008, 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 2018, 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-C-May 2012, 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, and CSA T530, TIA/EIA-569-A and 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.
- .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 100 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 Acceptable technologies: Ethernet over Category 6 plenum rated Un-shielded Twisted Pair (UTP) or single mode Fibre cable with Category 6 plenum rated jacket.
- .2 Network medium: shielded twisted cable, or fibre optic cable compatible with network protocol to be used within buildings..

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

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

1.2 REFERENCE STANDARDS

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

.2 Canadian Standards Association (CSA International).
- .1 CSA C22.2 No. 205-17, Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE).
- .1 IEEE C37.90.1-2012, 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

1.3 DEFINITIONS

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

1.4 DESCRIPTION

.1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.
- .1 Provide sufficient controllers to meet intents and requirements of this section.
- .2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.

.2 Controllers: stand-alone intelligent Control Units.
- .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
- .2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.
- .3 Capable of interfacing with operator interface device.

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

1.5 DESIGN REQUIREMENTS

.1 To include:
.1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
.2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
.3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
.4 Control of systems as described in sequence of operations.
.5 Execution of optimization routines as listed in this section.

.2 Total spare capacity for MCUs and LCUs: at least 25% of each point type distributed throughout the MCUs and LCUs.

.3 Field Termination and Interface Devices:
.1 To: CSA C22.2 No. 205.
.2 Electronically interface sensors and control devices to processor unit.
.3 Include, but not be limited to, following:
.1 Programmed firmware or logic circuits to meet functional and technical requirements.
.2 Power supplies for operation of logics devices and associated field equipment.
.3 Lockable wall cabinet.
.4 Required communications equipment and wiring (if remote units).
.5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
.6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
.7 Wiring terminations: use conveniently located screw type or spade lug terminals.
.4 AI interface equipment to:
.1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.
.2 Provide for following input signal types and ranges:
.1 4 - 20 mA;
.2 0 - 10 V DC;
.3 100/1000 ohm RTD input;
.3 Meet IEEE C37.90.1 surge withstand capability.
.4 Have common mode signal rejection greater than 60 dB to 60 Hz.
.5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
.5 AO interface equipment:
.1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.
.2 Provide for following output signal types and ranges:
.1 4 - 20 mA.
.2 0 - 10 V DC.
.3 Meet IEEE C37.90.1 surge withstand capability.

.6 DI interface equipment:
.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
.2 Meet IEEE C37.90.1 surge withstand capability.
.3 Accept pulsed inputs up to 2 kHz.
.7 DO interface equipment:
.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.
.2 Switch up to 5 Amps at 220 V AC using optional interface relay.

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

.5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
.1 Provide for conduit entrance from top, bottom or sides of panel.
.2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
.3 Mounting details as approved by Departmental Representative for ceiling mounting.

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

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

1.6 ACTION AND INFORMATIONAL SUBMITTALS

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

1.7 MAINTENANCE

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

PART 2 - PRODUCTS

2.1 MASTER CONTROL UNIT (MCU)

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

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

.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.

2.2 LOCAL CONTROL UNIT (LCU)

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

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

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

.4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:
.1 Include minimum 2interface ports for connection of local computer terminal.
.2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.
.3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
.4 Include power supplies for operation of LCU and associated field equipment.
.5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
.6 Provide conveniently located screw type or spade lug terminals for field wiring.

2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

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

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

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

2.4 SOFTWARE

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

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

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

.4 Operator Terminal interface.
.1 Operating and control functions include:
.1 Multi-level password access protection to allow user/manager to limit workstation control.
.2 Alarm management: processing and messages.
.3 Operator commands.
.4 Reports.
.5 Displays.
.6 Point identification.

.5 Pseudo or calculated points.
.1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
.2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).

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

.2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
.3 Perform changes to CDL on-line.
.4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.
.5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.
.6 MCU to be able to perform following pre-tested control algorithms:
.1 Two position control.
.2 Proportional Integral and Derivative (PID) control.
.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.

2.5 LEVELS OF ADDRESS

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

2.6 POINT NAME SUPPORT

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

PART 3 - EXECUTION

3.1 LOCATION

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

3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures as 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.

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

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

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

.4 Section 25 05 54 - EMCS: Identification.

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

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

1.2 REFERENCE STANDARDS

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

.2 Canadian Standards Association (CSA International).
- .1 CSA-C22.1-18, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (24th Edition).
- .2 CSA C22.3 No. 7-10 (R2015), Underground systems.
- .3 CSA C22.2 No. 45--M1981 (R2008), Rigid Metal Conduit.
- .4 CSA C22.2 No. 56-17, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- .5 CSA C22.2 No. 83-M1985 (R2017), Electrical Metallic Tubing.

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

.4 National Fire Protection Association (NFPA)
- .1 NFPA (Fire) 70, National Electrical Code (NEC), 2017 Edition

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 in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

PART 2 - PRODUCTS

2.1 GENERAL

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

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

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

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

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

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

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

2.2 TEMPERATURE SENSORS

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

.2 Room temperature sensors and display wall modules.
- .1 Temperature sensing and display wall module.
  - .1 LCD display to show space temperature and temperature setpoint.
  - .2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
  - .3 Jack connection for plugging in laptop personal computer for access to zone bus.
  - .4 Integral thermistor sensing element 10,000 ohm at 24 degrees.
  - .5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
  - .6 Stability 0.02 degrees C drift per year.
  - .7 Separate mounting base for ease of installation.
- .2 Ceiling mounted temperature sensors to measure open space room temperature as indicated.
  - .1 Requirements:
    - .1 General purpose duct type.
    - .2 Length: 300 mm
    - .3 Probe shall be constructed of 304 stainless steel.
    - .4 To have threaded anchoring plate and cover plate to match lighting fixtures.

.3 Duct temperature sensors:
- .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm or as indicated.

2.3 STATIC PRESSURE SENSORS

.1 Requirements:
- .1 Multipoint element with self-averaging manifold.
  - .1 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).
- .2 Accuracy: plus or minus 1% of actual duct static pressure.
- .3 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
- .4 Calibrated span: not to exceed 150% of duct static pressure at maximum flow.
- .5 Accuracy: 0.4 % of span.
- .6 Repeatability: within 0.5% of output.
- .7 Linearity: within 1.5% of span.
- .8 Deadband or hysteresis: 0.1% of span.
- .9 External exposed zero and span adjustment.
- .10 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.4 SOLAR RADIATION SENSORS

.1 General:
- .1 Provide solar radiation sensors as required to measure available natural light as outlined on drawings and the input/output summary and sequence of operation to achieve the requirements specified herein.

.2 Requirements:
- .1 Detector: High-stability silicon photovoltaic detector (blue enhanced).
- .2 Output: 4-20 mA or 0-10VDC
- .3 Range: 0 to 1500W/m2
- .4 Spectral Response: 400 to 1100 nm
- .5 Accuracy: 1% of full scale
- .6 Operating Voltage: 10-36 VDC
- .7 Current Draw: Same as sensor output
- .8 Warm Up Time: 3 seconds minimum
- .9 Operating Temp: -40° to +55°C
- .10 Sensor Size: 75 mm diameter x 40 mm maximum.
- .11 Weight: 115 grams maximum.

2.5 OCCUPANCY SENSOR

.1 General:
- .1 Provide occupancy sensors as required to detect occupancy as outlined on drawings and the input/output summary and sequence of operation to achieve the requirements specified herein.
- .2 General purpose indoor transmitter/sensor assembly with passive infrared and ultrasonic technologies.
- .3 UL listed with minimum 5 year warranty.

.2 Requirements:
- .1 LED occupancy indication.
- .2 Isolated output relay for integration with BAS.
- .3 24 VDC/VAC.

2.6 ELECTRONIC CONTROL DAMPER ACTUATORS

.1 General:
- .1 Provide electronic damper actuators as required based on drawings and the input/output summary and sequence of operation to achieve the requirements specified herein.
- .2 Actuators shall be electric, direct-coupled type capable of being mounted over the shaft of the damper.
- .3 Electronic overload protection shall protect actuator motor from damage. If damper jams actuator shall not burnout. Internal end switch type actuators are not acceptable.
- .4 Actuators shall be UL listed and the manufacturer shall provide a 2-year unconditional warranty from the date of commissioning.

.2 Requirements:
- .1 Fail to "last position".
- .2 Modulating type. On/Off Floating or PWM type are not acceptable.
- .3 Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator nor 2 watts or 4 VA for VAV actuators.
- .4 Operating range: 0-10 VDC or 4-20 mA.
- .5 Damper actuator to be capable of driving damper from full open to full closed in less than 120 seconds.

2.7 ELECTRONIC VALVE ACTUATORS

.1 General:
- .1 Provide electronic valve actuators as required based on drawings and the input/output summary and sequence of operation to achieve the requirements specified herein.
- .2 Actuators must be from Spartan Peripheral Devices.
- .3 Actuators must be of type to suit existing Spartan valve bodies for perimeter heating. Model ME4340. Contractor to verify model with Spartan Peripheral Devices.

.2 Requirements:
- .1 Fail to "last position".
- .2 Modulating type. On/Off Floating or PWM type are not acceptable.

2.8 WIRING

.1 In accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 For wiring 70 V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.

.3 For wiring under 70 V, use FT4 wiring in conduit. With Departmental Representative's written approval use of FT6 rated cable may be used without conduit where service use is for sensor or contact monitoring (AI or BI). Where use of FT6 rated wiring is approved it shall follow building structure lines and be supported directly from structure (floor above). Maximum droop between support points not to exceed 70 mm.

.4 Wiring being used to power control devices to shall be limited to 10 meters and shall be limited to a maximum current draw of 2 amps per conductor.

.5 Sizes:
- .1 120 V Power supply: to match or exceed breaker, size #12 minimum.
- .2 Wiring for safety/interlocks for starters, motor control centres, to be stranded, #14 minimum.
- .3 Field wiring to digital device: #18 AWG solid copper or #20 AWG stranded twisted pair.

.4 Analog input and output: shielded #18 AWG minimum solid copper or #20 AWG minimum stranded twisted pair.
.5 More than 4 conductors: #22 minimum solid copper.

.6 Terminations:
.1 Terminate all wires with screw terminal type connectors suitable for wire size, and number of terminations.

.7 Wiring must be continuous without joints.

2.9 CONDUIT

.1 In accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Electrical metallic tubing to CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 No. 56. Rigid steel threaded conduit to CSA C22.2 No. 45.

.3 Junction and pull boxes: welded steel.

.4 Surface mounting cast FS: screw-on flat covers.

.5 Flush mounting: covers with 25 mm minimum extension all round.

.6 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.

.7 Outlet boxes: 100 mm minimum, square.

.8 Conduit boxes, fittings:
.1 Bushings and connectors: with nylon insulated throats.
.2 With push pennies to prevent entry of foreign materials.

.9 Fittings for rigid conduit:
.1 Couplings and fittings: threaded type steel.
.2 Double locknuts and insulated bushings: use on sheet metal boxes.
.3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.

.10 Fittings for thin wall conduit:
.1 Connectors and couplings: steel, set screw type.

2.10 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

.1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.

.2 Hollow masonry walls, suspended drywall ceilings: toggle bolts.

.3 Exposed conduits or cables:
.1 50 mm diameter and smaller: one-hole steel straps.
.2 Larger than 50 mm diameter: two-hole steel straps.

.4 Suspended support systems:
.1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
.2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

PART 3 - EXECUTION

3.1 DEMOLITION

.1 Trace existing control wiring installation and provide updated wiring schematics including other discipline additions and/or deletions to control circuits for approval by Departmental Representative before commencing Work.

.2 Maintain current functionality of all existing controls which are not being replaced as part of Work.

.3 Remove all existing controllers, panels, field devices, equipment, wiring and conduit not identified for re-use.

.4 Turn over to Departmental Representative existing materials removed from Work when not identified for re-use.

3.2 INSTALLATION GENERAL

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

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

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

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

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

3.3 ELECTRICAL GENERAL

.1 Provide complete installation in accordance with requirements of:
.1 Section 26 05 00 - Common Work Results for Electrical.
.2 CSA 22.1 Canadian Electrical Code.
.3 NFPA (Fire) 70.
.4 ANSI C12.7.

.2 Provide normal or emergency power to equipment in concurrence with the power supplied to the controlled systems.

.3 Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.

.4 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.

.5 Do underground installation to CSA C22.3 No. 7, except where otherwise specified.

.6 Conform to manufacturer's recommendations for storage, handling and installation.

.7 Check factory connections and joints. Tighten where necessary to ensure continuity.

.8 Install electrical equipment between 1,000 and 2,000 mm above finished floor wherever possible and adjacent to related equipment.

.9 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.

.10 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.

.11 Install conduits, and sleeves prior to pouring of concrete.

.12 Holes through exterior wall and roofs: flash and make weatherproof.

.13 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

.14 Install cables, conduits and fittings, which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

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

3.4 CONDUIT SYSTEM

.1 Install communication, power, and control wiring in conduit unless otherwise indicated.
- .1 Provide complete conduit system to link field devices, power sources, building controllers, and OWS.
- .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.

.2 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.

.3 Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

.4 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.

.5 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.

.6 Bend conduit so that diameter is reduced by less than 1/10th original diameter.

.7 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

.8 Limit conduit length between pull boxes to less than 30 m.

.9 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.

.10 Fastenings and supports for conduits, cables, and equipment:
- .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
- .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
- .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.

.11 Install polypropylene fish cord in empty conduits for future use.

.12 Where conduits become blocked, remove and replace blocked sections.

.13 Pass conduits through structural members only after receipt of Departmental Representative's written approval.

.14 Conduits may be run in flanged portion of structural steel.

.15 Group conduits wherever possible on suspended or surface channels.

.16 Pull boxes:
- .1 Install in inconspicuous but accessible locations.
- .2 Support boxes independently of connecting conduits.
- .3 Fill boxes with paper or foam to prevent entry of construction material.
- .4 Provide correct size of openings. Reducing washers not permitted.
- .5 Mark location of pull boxes on record drawings.
- .6 Identify AC power junction boxes, by panel and circuit breaker.

.17 Install bonding conductor for 120 volts and above in conduit.

3.5 WIRING

.1 Install multiple conductors in ducts simultaneously.

.2 Do not pull spliced wiring inside conduits or ducts.

.3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.

.4 Tests: use only qualified personnel. Demonstrate that:
- .1 Circuits are continuous, free from shorts, unspecified grounds.
- .2 Resistance to ground of all circuits is greater than 50 Megohms.

.5 Provide Departmental Representative with test results showing locations, circuits, results of tests.

.6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.

.7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.

.8 Do not allow wiring to come into direct physical contact with compression screw.

.9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.6 GROUNDING

.1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.

.2 Install separate grounding conductors in conduit within building.

.3 Install ground wire in all PVC ducts and in tunnel conduit systems.

.4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.7 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.

3.8 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.

3.9 IDENTIFICATION

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

3.10 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

PART 1 - GENERAL

1.1 NOT USED

.1 Not used.

PART 2 - PRODUCTS

2.1 LIGHTING CONTROL

.1 Description:
- .1 The lighting controls in each module are capable of controlling lighting levels in up to four (4) sub-zones.
- .2 Functionality for each sub-zone includes on/off commands to the lighting relay, status of the user light switch, status of the lighting relay, and dimming.
- .3 Lighting is turned "ON" and "OFF" based on a variety of conditions outlined below.
- .4 Lighting levels are adjusted automatically relative to available natural light where natural light is available.
- .5 The amount of available natural light is determined through photocells located on each façade.

.2 Occupied Mode:
- .1 Lights are turned "ON" only through operation of the user light switch. Lights do not turn "ON" according to an occupancy schedule.
- .2 Lights are turned "OFF" through operation of the user light switch during Occupied Mode.

.3 Unoccupied Mode:
- .1 Lighting for individual sub-zones is scheduled "OFF" based on independent Occupancy Schedules. The Occupancy Schedules are available and may be changed at the OWS. Typically these are linked to the Master Occupancy Schedule for the floor except in cases where there are special needs. Specifics to be determined during commissioning.
- .2 The Master Occupancy Schedule for the floor is scheduled "OFF" after normal working hours. The Master Occupancy Schedule is available and may be changed at the OWS. Specifics to be determined during commissioning.
- .3 Before the lights turn "OFF" based on the Occupancy Schedule for the sub-zone, the lights flash three (3) times to indicate to the users that the lights will turn off shortly. The flash cycle consists of dimming the lights to ten percent (10%) and returning them to the previous level over a two (2) second period followed by a three (3) second pause. After the lights flash (3) times they remain on for an additional fifteen (15) seconds to allow the user some time in which to over-ride the scheduled lights "OFF" by activating the user light switch.
- .4 During scheduled "OFF" time the user light switch allows the user to turn "ON" the lights for the sub-zone. Corresponding lighting sub-zones associated with exit way-finding also turn "ON" automatically.
- .5 Lights which have been manually turned "ON" during the unoccupied period automatically turn "OFF" after a one (1) hour period. Before the lights turn "OFF" they flash in the same manner as a scheduled "OFF" as outlined above.

.4 Light Harvesting:
- .1 Lighting sub-zones with access to natural light are subject to Light Harvesting.
- .2 Photocells determine the available natural light at several locations on each façade of the floor. Refer to drawings to determine locations and relationships with other field devices.

.3 Maximum Lighting Level for all sub-zones is available and can be changed at the OWS. Typically this value is linked to the Master Maximum Lighting Level for the entire floor except in cases where there are special needs. Specifics to be determined during commissioning.

.4 Master Maximum Lighting Level is available and can be changed at the OWS. Initial value for Master Maximum Lighting Level is seventy-five percent (75%). All final values to be determined during commissioning.

.5 Minimum Lighting Level for all sub-zones in open structural bays at the building perimeter with access to natural light is thirty percent (30%). Final values to be determined during commissioning. Minimum Lighting Level for all sub-zones is available and can be changed at the OWS.

.6 Minimum Lighting Level for all sub-zones in open structural bays adjacent to those at the building perimeter with access to natural light is forty-five percent (45%). Final values to be determined during commissioning. Minimum Lighting Level for all sub-zones is available and can be changed at the OWS.

.7 Minimum Lighting Level for all sub-zones in open structural bays or closed spaces in the core of the building with access to natural light is sixty percent (60%). Final values to be determined during commissioning. Minimum Lighting Level for all sub-zones is available and can be changed at the OWS.

.8 Minimum Lighting Level for all sub-zones with indirect access to natural light is equal to the Maximum Lighting Level for the sub-zone minus ten percent (-10%). Final values to be determined during commissioning. Minimum Lighting Level for all sub-zones is available and can be changed at the OWS.

.9 Minimum Lighting Level for all sub-zones without access to natural light is equal to the Maximum Lighting Level for the sub-zone. Final values to be determined during commissioning. Minimum Lighting Level for all sub-zones is available and can be changed at the OWS.

.10 All sub-zone lighting levels are controlled according to the natural light available at the corresponding façade. The relationship between sub-zone lighting levels and available natural light at the corresponding façade is according to the following scale:

Available Natural Light	Sub-Zone Lighting Level
100 lux	Maximum Lighting Level
500 lux	Minimum Lighting Level

The scale is available and can be and can be changed at the OWS.
Final values to be determined during commissioning.

.11 The amount of available natural light at each façade is determined by taking a five (5) minute running average of light levels at all photo cells located on the façade. This accounts for effects such as rolling cloud cover. During Occupied Mode lighting levels are adjusted at a rate no faster than five percent per minute (<5%/min).

.5 Fire Alarm:

.1 In the case of a Fire Alarm, all lighting turns ON and all lighting levels are set to 100%.

2.2 HVAC CONTROL

.1 Description:

.1 The HVAC controls in each lighting control module are capable of controlling environmental conditions in up to four (4) sub-zones.

.2 Functionality for all four sub-zones includes up to four (4) temperature sensors and up to eight (8) attenuator box damper actuators.

.3 Sensors and actuators are grouped such that any sensor can control any or all actuators.

.4 The required volume of conditioned air is supplied through a VAV box. Supply air is typically 16°C-18°C during all seasons.
.5 Attenuator box damper actuators modulate to maintain environmental conditions in closed spaces through cooling only.
.6 Not all attenuator box branches require damper actuators. In cases where no damper actuator is required, for example open spaces, the damper is locked fully open. In cases where not all diffuser branches exist, for example perimeter spaces, the attenuator box outlet is blocked. Refer to drawings to determine locations and relationships with other field devices.
.7 Temperature sensors are not always required. In cases where the VAV box supplies an open area only, environmental conditions are managed through the VAV controller. Refer to Section 2.3 VAV CONTROL INTERIOR.
.8 The controller has available point connections for future additions of temperature sensors up to a total of four (4) and damper actuators up to a total of eight (8) to allow for future modifications due to space fit-ups.

.2 Normal Operation:
.1 Attenuator box damper actuators modulate between twenty-five percent (25%) and one hundred percent (100%) to maintain room temperature at setpoint. Minimum and maximum damper positions are available and may be changed at the Operator Work Station.
.2 Room temperature setpoint during heating season is between eighteen degrees and twenty-two degrees (18°C-22°C). Initial setpoint is twenty degrees (20°C). Room temperature setpoint during cooling season is between twenty degrees and twenty-four degrees (20°C-24°C). Initial setpoint is twenty-two degrees (22°C). Setpoints are available and may be changed at the Operator Work Station.

2.3 VAV CONTROL INTERIOR

.1 Description:
.1 The VAV controls mounted on each VAV box are capable of controlling environmental conditions on a zone basis.
.2 Functionality includes up to one (1) temperature sensor, one (1) air flow sensor, and one (1) VAV damper actuator.
.3 In cases where the VAV box supplies air to a zone which includes only open space the temperature sensor connected to the VAV controller is used to determine environmental conditions.
.4 In cases where the VAV box supplies air to a zone which includes both open and closed spaces the temperature sensor connected to the VAV controller and temperature sensors located in the closed spaces are used to determine environmental conditions. Temperature information for the closed spaces (room temperature and room temperature setpoint) is transferred from HVAC controllers in the lighting control modules via the BACnet network.
.5 In cases where the VAV box supplies air to a zone which includes only closed spaces the temperature sensor normally connected to the VAV controller is not required and temperature sensors located in the closed spaces are used to determine environmental conditions. Temperature information for the closed spaces (room temperature and room temperature setpoint) is transferred from HVAC controllers in the lighting control modules via the BACnet network.
.6 Conditioned air is supplied from one of two Compartmental Unit Fans. Supply air is typically 16°C-18°C during all seasons.
.7 VAV damper actuators modulate to maintain environmental conditions through cooling only.

.2 Normal Operation:
.1 Air flow is maintained between minimum and maximum flow per the VAV box schedule found on drawings. Minimum and maximum flow rates are available and can be changed at the Operator Work Station.
.2 The VAV damper actuator modulates to maintain air flow at setpoint.

.3 Air flow setpoint is determined based on Cooling Demand.
.4 Cooling Demand is defined as the difference between room temperature and room temperature setpoint. Numbers can be both positive and negative.
.5 Setpoint for Cooling Demand is zero degrees (0°C). This occurs when room temperature equals room temperature setpoint.
.6 In cases where the VAV box provides air to open space only, the Cooling Demand is the difference between room temperature and room temperature setpoint as measured at the temperature sensor connected to the VAV controller.
.7 Room temperature setpoint during heating season is between eighteen degrees and twenty-two degrees (18°C-22°C). Initial setpoint is twenty degrees (20°C). Room temperature setpoint during cooling season is between twenty degrees and twenty-four degrees (20°C-24°C). Initial setpoint is twenty-two degrees (22°C). Setpoints are available and may be changed at the Operator Work Station.
.8 In cases where the VAV box provides air to both open space and closed space, the overall Cooling Demand determines the VAV box airflow setpoint. The overall Cooling Demand is the weighted sum of all constituent Cooling Demands.
.9 The contribution from each space to overall Cooling Demand is weighted in relationship to the total air flow to each space based on the diffuser flow rate found on drawings. For example
    .1 If a temperature sensor is influenced by air from one diffuser which can supply 1/10th of the total air available through the VAV box then it contributes to 1/10th of the overall Cooling Demand. This is typical of a small closed office.
    .2 If a temperature sensor is influenced by air from several diffusers which can supply 1/3rd of the total air available through the VAV box then it contributes to 1/3rd of the overall Cooling Demand. This is typical of executive offices and boardrooms.
.10 Example CDL:
    .1 Open Space Temperature = 21°C
    .2 Open Space Temp Setpoint = 22°C
    .3 Open Space Cooling Demand %
        = (Sum Open Space Diffuser Air Flow / VAV Maximum Air Flow)
        = (400 l/s / 500 l/s) for example
        = 80%
    .4 Open Space Cooling Demand
        = (Open Space Temp - Open Space Temp Setpoint)
        * (Open Space Cooling Demand %)
        = (21°C - 22°C)*80%
        = -0.8°C
        = less cooling required
    .5 Room A Temperature = 24°C
    .6 Room A Temp Setpoint = 22°C
    .7 Room A Cooling Demand %
        = (Sum Room A Diffuser Air Flow / VAV Maximum Air Flow)
        = (100 l/s / 500 l/s) for example
        = 20%
    .8 Room A Cooling Demand
        = (Room A Temp - Room A Temp Setpoint)
        * (Room A Cooling Demand %)
        = (24°C -22°C)*0.2
        = 0.4
        = more cooling required
    .9 Overall Cooling Demand
        = Open Space Cooling Demand + Room A Cooling Demand
        = -0.8°C + 0.4°C
        = -0.4°C
        = overall less cooling required

.11 In the above example the larger open space needs less cooling and the smaller closed space needs more cooling. The overall Cooling Demand is a small negative number. The VAV controller responds by providing less cool air through the VAV box. This addresses the issue of too much cooling to the large open space.

.12 To address the issue of not enough cooling in the small closed space, the local HVAC controller in the lighting control module responds by opening the attenuator box damper actuators to provide more cool air to diffusers located in the small closed space. Refer to Section 2.2 HVAC CONTROL.

2.4 VAV CONTROL PERIMETER

.1 Description:
- .1 Refer to Section 2.3 VAV CONTROL INTERIOR.
- .2 Radiator valve actuators modulate to maintain environmental conditions through heating only. Valve actuators do not exist in all cases. Refer to drawings to determine locations and relationships with other field devices.

.2 Normal Operation:
- .1 Refer to Section 2.3 VAV CONTROL INTERIOR.
- .2 Radiator valve actuators modulate between zero percent (0%) and one hundred percent (100%) to maintain overall Cooling Demand at minus zero point two degrees (-0.2°C).
- .3 The deadband between the Cooling Demand setpoint used for VAV damper actuator modulation and the Cooling Demand setpoint used for radiator valve actuator modulation ensures that cooling and heating will not occur simultaneously.

2.5 BOARDROOM CONTROL

.1 Description:
- .1 The boardroom controls are capable of controlling environmental conditions in one boardroom.
- .2 Functionality includes an occupancy sensor, temperature sensor & fan powered mixing box c/w , supply air damper actuator.
- .3 The required volume of conditioned air is supplied from Compartmental Unit Fans. Supply air is typically 16°C -18°C during all seasons.

.2 Occupied Mode:
- .1 Occupied mode occurs when occupancy is detected by the occupancy sensor.
- .2 Fan powered mixing box starts. Minimum run time for the fan is ten (10) minutes.
- .3 Room temperature is controlled per Section 2.2 HVAC CONTROL or Section 2.3 VAV CONTROL INTERIOR to suit the installed boardroom HVAC configuration.

.3 Unoccupied Mode:
- .1 Unoccupied mode occurs when occupancy has not been detected by the occupancy sensor for a period greater than ten (10) minutes.
- .2 Supply air damper actuators modulated between zero percent (0%) and one hundred percent (100%) to maintain room temperature at setpoint.
- .3 Fan powered mixing box is off.

2.6 AC UNITS

.1 Description:
- .1 The Air Conditioning Units are supplied with integrated manufacturer supplied controls.

.2 Controls maintain conditions of temperature and humidity as well as providing leak detection.
.3 Controls are configured per manufacturer recommendations.
.4 Connection to the BACnet network is for monitoring of space temperature and alarm purposes (general fault alarm) only.

PART 3 - EXECUTION

3.1 SITE PREPARATION

.1 Lighting Control Module Co-ordination Requirements:
- .1 Contractor is responsible for any work required to be done by the lighting control supplier to configure the lighting control module to accept the Lighting and HVAC controllers. Contractor to co-ordinate with lighting control module supplier for the integration of HVAC and lighting controllers into the lighting control modules.
- .2 All HVAC and Lighting controllers will be provided by the contractor to the lighting control module supplier for mounting, internal wiring, and factory testing prior to shipping assembled unit to site.
- .3 The contractor will provide co-ordination with the lighting control module supplier for all internal wiring for the HVAC and lighting controllers to be completed and tested at the lighting control module supplier's factory. This includes but is not limited to pre- testing to ensure lighting relays are in the ON position and to verify control functions. The HVAC and lighting controllers must use multipoint slip-on connectors, which will facilitate replacement of a failed controller and eliminate the need for screw terminals for reconnection of individual sensors or other field wiring. The contractor will witness factory testing and accept the completed lighting control modules for installation. Lighting control modules to be installed by Division 26.
- .4 All required MS/TP LAN cable will be provided by the contractor to the lighting control module supplier for armouring, connectorization, and factory testing prior to shipping assembled cables to site. General network schematic can be found on drawings. Floor plans indicating lighting control module and VAV box locations can be found on drawings. Connection details can be found on drawings.
- .5 The contractor will provide co-ordination with the lighting control module supplier for fabrication of MS/TP LAN wiring to be completed and tested at the lighting control module supplier's factory. The contractor will assist by providing MS/TP LAN installation co-ordination drawings indicating the required cable segments and required cable segment lengths.
- .6 The contractor will provide co-ordination with the lighting control module supplier to have the cables armoured and connectorized and shipped to site. The contractor will witness the verification of the MS/TP LAN cabling and accept the cabling for installation. The contractor will install the cabling.
- .7 All required Lighting field devices, cables, and connectors are the responsibility of Division 26, with the exception of photocells. Photocell equipment, cabling, and connectors are the responsibility of Division 25.
- .8 The contractor will provide all required HVAC field device equipment, cables, and connectors. Requirements for field devices, cables and connectors are outlined on drawings and in specification.
- .9 The contractor will provide the recommended cable for power and signal connections to all field devices and controllers. The contractor will provide pre- cut and pre-identified cables. Contractor is responsible for the fabrication of all required field device cabling including cabling components. contractor is responsible for coordinating with the lighting control module supplier for connectorization and factory testing prior to shipping assembled cables to site. Floor plans indicating field device locations can be found on drawings. Connection requirements and mounting details can be found on drawings.
- .10 The contractor will provide co-ordination with the lighting control module supplier to have the cables connectorized and shipped to site. The contractor will witness the verification of the field device cabling and accept the cabling for installation. The contractor will install the cabling.

.11 Certain devices including but not limited to photocells, occupancy sensors, carbon dioxide sensors, and exhaust fan starters are required as outlined on drawings, points lists, and sequence of operations. The contractor is responsible for the configuration of spare connection points on the lighting control modules as required.
.12 The contractor is responsible for any effort required by the lighting control module supplier to configure the spare connection points to accept the required field devices.
.13 The contractor will provide co-ordination with the lighting control module supplier for all internal wiring for the spare connection points to be completed and tested at the lighting control module supplier's factory. The contractor will witness factory testing and accept the completed lighting control modules for installation.
.14 The contractor is responsible for field device cabling for Spare point connections. The field device cabling for spare point connections is to conform to the same requirements for all typical HVAC field devices as outlined above.

.2 Field Installation General:
.1 When not specifically outlined in this section, field installation to conform with Section 25 30 02 - EMCS: Field Control Devices.

.3 Lighting Control for Perimeter Offices:
.1 Perimeter offices are equipped with manual dimming controls.
.2 No automatic control is required for dimming functions in perimeter offices equipped with manual dimmers.

.4 EMCS Network:
.1 The EMCS Ethernet network exists on all floors of the building, including the required switches.
.2 All new master control units shall be BACnet. Connect all master control units to the EMCS Ethernet network. Refer to network schematic on drawings.
.3 All new terminal and equipment control units shall be BACnet. Connect all terminal and equipment control units to a master control unit using BACnet MS/TP. lighting control modules and VAV controllers to be linked in series. Refer to network schematic on drawings.
.4 Existing Compartmental Unit controller integration:
.1 All system points (BACnet Objects), both virtual and physical, must be readable.
.2 All system setpoints must be both readable and writeable.
.3 All daily, weekly, monthly, & seasonal scheduling must be both readable and writeable. 4 All sequences of operation must be programmed as outlined in Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.
.4 All system sequence programming must reside on installed controllers. No sequence programming may reside on either the Operator Work Stations or Engineering Work Stations.
.5 AC Unit and Leak Detection BACnet Interface:
.1 Contractor will install, connect and program the BACnet interface module for the integrated controls of all AC Units and Leak Detection Systems.
.2 Contractor will install, connect and configure the communication network between the AC Units, Leak Detection Systems and the BACnet Interface.
.3 BACnet Interface module will be connected to the EMCS Ethernet network.
.4 Execution of work will conform with manufacturer's instructions and recommendations.
.5 The contractor is responsible for any co-ordination required with AC Unit and Leak Detection supplier to successfully install, connect and configure the BACnet Interface.
.6 The contractor is responsible for any co-ordination required with the BACnet Interface supplier to establish the communication network.

.5 Fire Alarm Devices:
.1 Addressable fire alarm devices by other are located in each compartmental fan mechanical room.

.2 Addressable fire alarm devices to be connected to compartmental unit controller. Sequencing to include but not be limited to fan shut down and returning all lighting to 100%.

.6 AC Unit Integrated Controls:
- .1 Contractor will install, connect and program the integrated controls for all the AC Units.
- .2 The contractor is responsible for any co-ordination required with AC Unit supplier to successfully install, connect and program the integrated controls.
- .3 Execution of work will conform with manufacturer's instructions and recommendations.

.7 Leak Detection Systems:
- .1 Contractor will install, connect and program the control components of the leak detection systems for all the AC Units.
- .2 The contractor is responsible for any co-ordination required with AC Unit supplier to successfully install, connect and program the control components of the leak detection systems.
- .3 Execution of work will conform with manufacturer's instructions and recommendations.

3.2 GRAPHICS PROGRAMMING

.1 Produce all the graphics at the OWS. Graphics shall be the same type as the existing ones and shall be incorporated into the logical tree. Modify existing graphics as required to represent the new modified systems.

.2 All inputs, outputs, set points, calculated variables, schedules, alarms and all other points that need to be modified by the operator, shall be available for reading and writing from the OWS.

.3 Use the points description acronym structure outlined in Section 3 - I/O POINT SUMMARY TABLES.

.4 Program the graphics to include at a minimum:
- .1 A general view of the building.
- .2 Floor layout including architectural structure.
- .3 One graphic minimum per main system.
- .4 One alarm page.
- .5 Text version the sequence of operations.
- .6 All the physical points and set points.
- .7 Access to schedules and trends.
- .8 Items outlined in the sequences of operations as being available at the OWS.

.5 The control diagrams for these systems are to be all encompassing to illustrate the complete air, heating/cooling water, networks. These all encompassing diagrams and their associated controller(s) may require that the OWS Graphics and the logical functions be subdivided in multiple sub-groupings by the Contractor. The breakdown of the functions and resulting schematics will however remain subject to the approval of the Commissioning Authority and may be rearranged to meet operational and functional serviceability and reliability. The regrouping of these points and functions must not compromise the standalone functionality of the system. It may also be necessary to duplicate pertinent point values on associated displays for operation and information display purposes.

END OF SECTION