PART 1 - GENERAL

1.1 DEFINITIONS

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

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

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

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

1.2 DESIGN REQUIREMENTS

.1 Confirm with Departmental Representative that Design Criteria and Design Intents are still applicable.

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Final Report: submit report to Departmental Representative.

- .1 Include measurements, final settings and certified test results.
- .2 Bear signature of commissioning technician and supervisor
- .3 Report format to be approved by Departmental Representative before commissioning is started.
- .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.
- .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.4 CLOSEOUT SUBMITTALS

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

1.5 COMMISSIONING

.1 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.

.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 Commissioning Manager & Departmental Representative.

.3 Commission integrated systems using procedures prescribed by Commissioning Manager & Departmental Representative.

.4 Debug system software.

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

3.2 FIELD QUALITY CONTROL

.1 Completion Testing.
- .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
- .2 Include following activities:
  - .1 Test and calibrate field hardware including stand-alone capability of each controller.
  - .2 Verify each A-to-D converter.
  - .3 Test and calibrate each AI using calibrated digital instruments.
  - .4 Test each DI to ensure proper settings and switching contacts.
  - .5 Test each DO to ensure proper operation and lag time.
  - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
  - .7 Test operating software.
  - .8 Test application software and provide samples of logs and commands.
  - .9 Verify each CDL including energy optimization programs.
  - .10 Debug software.
  - .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
  - .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Departmental Representative . This document will be used in final startup testing.
- .3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and 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 startup testing.
  - .5 O&M personnel to assist in commissioning procedures as part of training.
  - .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
  - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
  - .8 Operate systems as long as necessary to commission entire project.
  - .9 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
  .1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics 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 Commissioning Manager & Departmental Representative to verify reported results.

3.3 ADJUSTING

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

3.4 DEMONSTRATION

.1 Demonstrate to Commissioning Manager & Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 91 13 - General Commissioning Requirements.

END OF SECTION

PART 1 - GENERAL

1.1 DEFINITIONS

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

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

.3 Downtime: results whenever EMCS is unable to fulfil 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.
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  - .1 Controller automatically and correctly operated in stand-alone mode.
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- .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
  - .1 System recorded said fault.
  - .2 Equipment defaulted to fail-safe mode.
  - .3 AEL of total of all input sensors and output devices is at least 99% during test period.

1.2 DESIGN REQUIREMENTS

.1 Confirm with Departmental Representative that Design Criteria and Design Intents are still applicable.

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Final Report: submit report to Departmental Representative.

- .1 Include measurements, final settings and certified test results.
- .2 Bear signature of commissioning technician and supervisor
- .3 Report format to be approved by Departmental Representative before commissioning is started.
- .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.
- .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.4 CLOSEOUT SUBMITTALS

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

1.5 COMMISSIONING

.1 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.

.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 Commissioning Manager & Departmental Representative.

.3 Commission integrated systems using procedures prescribed by Commissioning Manager & Departmental Representative.

.4 Debug system software.

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

3.2 FIELD QUALITY CONTROL

.1 Completion Testing.
- .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
- .2 Include following activities:
  - .1 Test and calibrate field hardware including stand-alone capability of each controller.
  - .2 Verify each A-to-D converter.
  - .3 Test and calibrate each AI using calibrated digital instruments.
  - .4 Test each DI to ensure proper settings and switching contacts.
  - .5 Test each DO to ensure proper operation and lag time.
  - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
  - .7 Test operating software.
  - .8 Test application software and provide samples of logs and commands.
  - .9 Verify each CDL including energy optimization programs.
  - .10 Debug software.
  - .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
  - .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Departmental Representative . This document will be used in final startup testing.
- .3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and 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 startup testing.
  - .5 O&M personnel to assist in commissioning procedures as part of training.
  - .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
  - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
  - .8 Operate systems as long as necessary to commission entire project.
  - .9 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
  .1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics 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 Commissioning Manager & Departmental Representative to verify reported results.

3.3 ADJUSTING

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

3.4 DEMONSTRATION

.1 Demonstrate to Commissioning Manager & Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 91 13 - General Commissioning Requirements.

END OF SECTION

PART 1 - GENERAL

1.1 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 CSA Group (CSA).
- .1 CAN/CSA-Z234.1-00 (R2011), Canadian Metric Practice Guide.

1.2 ABBREVIATIONS AND ACRONYMS

.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 Centre.
- .8 CAD - Computer Aided Design.
- .9 CDL - Control Description Logic.
- .10 CDS - Control Design Schematic.
- .11 COSV - Change of State or Value.
- .12 CPU - Central Processing Unit.
- .13 DI - Digital Input.
- .14 DO - Digital Output.
- .15 DP - Differential Pressure.
- .16 ECU - Equipment Control Unit.
- .17 EMCS - Energy Monitoring and Control System.
- .18 HVAC - Heating, Ventilation, Air Conditioning.
- .19 IDE - Interface Device Equipment.
- .20 I/O - Input/Output.
- .21 ISA - Industry Standard Architecture.
- .22 LAN - Local Area Network.
- .23 LCU - Local Control Unit.
- .24 MCU - Master Control Unit.
- .25 NAFTA - North American Free Trade Agreement.
- .26 NC - Normally Closed.
- .27 NO - Normally Open.
- .28 OS - Operating System.
- .29 O&M - Operation and Maintenance.
- .30 OWS - Operator Work Station.
- .31 PC - Personal Computer.
- .32 PCI - Peripheral Control Interface.
- .33 PCMCIA - Personal Computer Micro-Card Interface Adapter.
- .34 PID - Proportional, Integral and Derivative.
- .35 RAM - Random Access Memory.

.36 SP - Static Pressure.
.37 ROM - Read Only Memory.
.38 TCU - Terminal Control Unit.
.39 USB - Universal Serial Bus.
.40 UPS - Uninterruptible Power Supply.
.41 VAV - Variable Air Volume.

1.3 DEFINITIONS

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

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

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

.4 Symbols and engineering unit abbreviations utilized in displays: to ISA S5.5.
  .1 Printouts: to IEEE 260.1.

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

1.5 ACTION AND INFORMATIONAL SUBMITTALS

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

1.6 DESIGNATED CONTROLS CONTRACTOR

.1 The designated controls contractor is Regulvar.

PART 2 - PRODUCTS

2.1 DESIGNATED CONTRACTOR

.1 Retain the services of Regulvar or its authorized representative to complete the work of all building automation system sections.

2.2 MATERIALS

.1 There is an existing Regulvar system presently installed in the building. All material to selected to ensure compatibility with the existing Regulvar system.

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 26 05 00 - Common Work Results for Electrical.

.2 Section 26 27 26 - Wiring Devices.

1.2 REFERENCE STANDARDS

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

.2 CSA Group CSA Group.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 01 33 00 - Submittal Procedures.

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

1.4 EXISTING CONDITIONS

.1 Repair surfaces damaged during execution of Work.

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

PART 2 - PRODUCTS

2.1 GENERAL

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

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

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

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

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

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

.7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.

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

2.2 TEMPERATURE SENSORS

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

.2 Room temperature sensors and display wall modules.
- .1 Temperature sensing and display wall module.
  - .1 LCD display to show space temperature ed and temperature setpoint.
  - .2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
  - .3 Jack connection for plugging in laptop personal computer contractor supplied zone terminal unit, contractor supplied palm compatible handheld device for access to zone bus.
  - .4 Integral thermistor sensing element 10,000 ohm at 24 degrees.
  - .5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
  - .6 Stability 0.02 degrees C drift per year.
  - .7 Separate mounting base for ease of installation.

2.3 PANELS

.1 Free-standing or wall mounted enamelled steel cabinets with hinged and key-locked front door.

.2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as required by Departmental Representative without adding additional cabinets.

.3 Panels to be lockable with same key.

2.4 LOW VOLTAGE LIGHT SWITCHES

.1 Momentary contact switches 'ON' & 'OFF' with indicator lights - Red LED.

2.5 WIRING

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

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

.3 Wiring must be continuous without joints.

.4 Sizes:
- .1 Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.

.2 Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair.

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

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

.4 Electrical:
- .1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
- .3 Refer to electrical control schematics included as part of control design schematics in Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation and on drawings. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Departmental Representative before beginning Work.
- .4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
- .5 Install communication wiring in conduit.
  - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
  - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
  - .3 Maximum conduit fill not to exceed 40%.
  - .4 Design drawings do not show conduit layout.
- .6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

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

3.2 PANELS

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

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

.3 Identify wiring and conduit clearly.

3.3 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 two (2) 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.

.2 Occupied Mode:
- .1 Lights are turned "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 three (3) hourperiod. Before the lights turn "OFF" they flash in the same manner as a scheduled "OFF" as outlined above.

2.2 HVAC CONTROL

.1 Description:
- .1 The HVAC controls in each lighting control module are capable of controlling environmental conditions in up to two (2) sub-zones.
- .2 Functionality for all two (2) 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