PART 1 - GENERAL

1.1 DEFINITIONS

.1 The term "provide" means to supply and install as part of the work covered in this Section.

.2 The term "implement" means to develop and/or utilize a software and/or hardware component to meet the system criteria or system verification as part of the work covered in this section.

.3 The term "supply" means to supply only the requested item for installation by other Divisions.

.4 The term "install only" means to install under the work of this Section, equipment furnished by other Divisions, or by the Departmental Representative.

.5 The term "multi-vendor integration" when referenced herein shall imply the hardware equipment and software programs needed for communications to the various mechanical and/or electrical systems contained in the scope of work.

.6 "Energy Management Control System" (EMCS): the environmental monitoring and control system inclusive of all appurtenances required for the control and monitoring of the mechanical, electrical, or other systems unless specifically exempted within this specification. This definition includes both hardware devices and software components that are integrated to form a working system.

.7 The term "Controls contractor" is the successful bidder of the building automation system as specified in this Section.

.8 HVAC: Heating, Ventilating and Air Conditioning.

.9 Stand-alone System: Performs all control functions independently without direction from a central unit.

.10 Hardware: The physical components in the EMCS system.

.11 Point: A single monitoring or control device connected to the EMCS.

.12 Control Wiring: All wiring, 50volt or lower other than power wiring, required for the proper operation of the mechanical system and the EMCS. This includes applications where line voltage also serves as a control circuit such as interlocking with a damper. Coordinate with Division 26.

.13 Power Wiring: All 120/1/60 line voltage wiring to the mechanical and EMCS equipment that is required for proper operation of the equipment. Typically, this wiring will support voltage at 120 VAC and is connected to the equipment for the purpose of providing motive power. Power wiring will be coordinated with Division 26 and conform to the Division 26 specifications.

1.2 REFERENCES

.1 CAN/CSA C22.1-2015, Canadian Electrical Code.

.2 IEEE 260.1-04, Standard Letter Symbols for Units of Measurement.

.3 NFPA 90A-2015, Standard for the Installation of Air-Conditioning and Ventilation Systems.

1.3 ACCEPTABLE PRODUCT

.1 Delta Controls, Siemens, Johnson Controls.

1.4 SCOPE OF WORK

.1 The work included under this section of the specifications and drawings includes the complete installation of an Energy Management Control System (EMCS) utilizing stand-alone digital controllers. The system will include, but not be limited to, control of the following equipment:
- .1 Heat Recovery Ventilation Units.
- .2 Pumps
- .3 Exhaust Fans
- .4 Low voltage and line voltage thermostats
- .5 HVAC Equipment
- .6 Lighting Control Systems

.2 Furnish and install all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification and on the drawings. All software required will be turned over to the Departmental Representative ready for use including all operating parameters, setpoints, and schedules.

.3 Refer to the control schematics on the Project Drawings.

.4 Conformance to Specification:
- .1 The Sequence of Operation in this specification and the associated drawings, identify those points that are to be addressed by the digital controllers and incorporated into the new stand-alone EMCS system.
- .2 The Drawings and Specifications are not intended to show all details. The Contractor shall secure satisfactory information before submitting a tender and include in the tender a sum sufficient to cover all items of labour and material required for the complete installation of the devices and systems described.
- .3 All work performed under this section of the specifications will comply with all codes, laws, regulations and governing bodies. If the drawings and/or specifications are in conflict with governing codes, submit a proposal with appropriate modifications to the project to satisfy code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern.
- .4 Provide complete operating and maintenance manuals and field training of operators, programmers, and maintenance personnel.
- .5 Perform acceptance tests and technical support during commissioning.
- .6 Provide full documentation for all software and equipment.
- .7 Allow for future expansion capability a minimum of 10% of the total capacity % point of each type will be available in each on control panel.

.5 Responsibilities of Contractor:
- .1 The Controls contractor will obtain and pay for all necessary construction permits and licenses.
- .2 The Controls contractor will execute their work in such a manner as to cause the minimum interference to the other trades on site.

.6 Division of Work:
- .1 The Controls contractor shall furnish all control valves and automatic dampers indicated on control drawings. Installation will be by the Mechanical Contractor. Coordinate prior to tender closing.
- .2 The Controls contractor will provide all actuators including necessary linkages, wire, and power wiring.
- .3 The Controls contractor will furnish all immersion sensor wells for installation by the Mechanical contractor. Coordinate prior to tender closing.
- .4 The Controls contractor will provide all necessary control wiring, and 115/1/60 power wiring. Power to the controllers by the Controls contractor. FT6 wiring acceptable in ceiling spaces. Coordinate with the

Electrical contractor for the installation of empty EMT conduit in the partition walls complete with wall boxes for use by the Controls contractor to install the room temperature sensors.

.7 Service:

.1 The Controls contractor must have the necessary facilities and personnel to provide training and service of the system. Upon substantial completion, the contractor shall offer the Departmental Representative a contract inclusive of 24 hours/day, seven days/week emergency repair service. Third party service or service only during specific working hours is unacceptable.

1.5 ABBREVIATIONS AND SYMBOLS

.1 Symbols and Abbreviations: Letter symbols and engineering unit abbreviations utilized to conform to IEEE 260.1.

1.6 LOCKABLE PANELS

.1 All panels must be EEMAC rated to room environment requirements with hinged doors and equipped with standard keyed-alike cabinet locks.

1.7 IDENTIFICATION AND NAMEPLATES

.1 Provide nameplates for all items listed or shown approved control diagrams. Each inscription will identify its function, such as "mixed air output transducer", "cold deck sensor".

.2 Identify all panels and items mounted on panel faces by laminated plastic nameplates 3mm thick melamine plastic white with black centre core. Surface to be a matte finish. All corners will be square. The lettering shall be accurately aligned and engraved into the white core. Size of nameplates shall be 25mm by 62mm minimum. Lettering must be minimum 6mm high normal black lettering.

.3 Identify field sensors, controlled devices, and interior panel components by 50mm x 100mm plastic enclosed cards attached to the device by chain. Data to include point name, schematic drawing designation number, model number, capillary length, size, range, set point and other pertinent data. Print to be 6mm high and produced from a laser printer in dark black.

.4 Room sensing elements are to be similarly identified by stick on labels on the inside cover. Display the point name on the face of the cover by engraved or laminated nameplates.

.5 Submit samples of identification tags and lists of wording proposed for approval.

.6 All Controller and companion cabinet interior components must be labelled.

.7 Warning signage: provide each motor starter under remote automatic control (DO point on I/O Summary Sheet) with orange coloured signage warning of automatic starting under control of EMCS (i.e." Caution - this equipment is under automatic remote control of EMCS).

1.8 WIRING IDENTIFICATION

.1 Provide numbered tape markings on all branch control wiring.

.2 Colour coding of wiring to CSA C22.1.

.3 At all junction boxes, splitter, cabinets and outlet boxes, maintain identification system.

.4 Use colour coded wires in communication cables, matched throughout system.

.5 Identify all power sources at each panel location.

1.9 CONDUIT IDENTIFICATION

.1 Colour code all EMCS conduits.

.2 Locate coding on all conduits and cables exposed after completion of construction in all locations including suspended removable ceilings, tunnels and shafts.

.3 Coding to be plastic tape or paint at all points where conduit or cable enters wall, ceiling, or floor, and at 15m intervals.

.4 Coding to be 50mm wide, and fluorescent orange. Confirm colour with Departmental Representative at commencement of the project.

1.10 MANUFACTURERS AND CSA LABELS

.1 Manufacturers' nameplates and CSA labels to be visible and legible after equipment is installed.

1.11 TESTING

.1 Test and verify all major subsystems of the complete EMCS including all field components.

.2 Do testing in phases, submit documentation to the Departmental Representative.

.3 Provide all test equipment including two (2) way radios.

.4 Have all test equipment such as digital thermometers, humidistat, voltmeters and milliamp and volt meters shall be certified as accurate by an independent testing laboratory no earlier than two (2) months prior to the tests.

.5 Notify the Departmental Representative in writing at least 14 days before testing is to take place stating the following:
- .1 Location and part of the system to be tested.
- .2 Describe testing procedure, names of testing personnel and anticipated results.

.6 Obtain approval of testing procedure and personnel before proceeding.

.7 Provide all necessary personnel and coordination with other trades.

.8 Demonstrate the proper operation of each component.

.9 Correct any deficiencies and re- test until designated part of the system performs satisfactorily.

.10 Submit satisfactory test reports in the O&M Manuals.

.11 Pre-installation Tests:

.1 This refers to equipment that is to be field tested just prior to their installation.

.2 Instruments shall be: differential pressure transmitters and pressure differential switches used for dirty filter indication and fan status.

.3 Provide, additional test equipment, inclined manometer, digital micromanometer, milliamp meter, a source of adjustable air pressure.

.4 After setting, the zero and span transmitters are to be tested in 10% increments through their entire range both on an increase and decrease of pressure.

.5 Transmitters tracking in both directions within 5% shall be marked acceptable. Transmitters above 5% error are to be rejected.

.6 Pressure differential switches shall open and close within 10% of set point.

.12 Completion Tests:

.1 After installation of each part of the system and completion of mechanical and electrical hook-up, perform tests to confirm correct installation and functioning of equipment.

.2 Test and calibrate all field and OWS hardware including stand-alone capabilities of each Controller.

.3 Verify each A to D convertor.

.4 Check and calibrate each AI using a calibrated digital thermometer, humidistat, volumeter or transducer.

.5 Check each DI to confirm proper settings and switching contacts.

.6 Check each DO to confirm proper operation and lag time.

.7 Check each AO to confirm proper operation of valves and dampers. Verify tight closing and input out signals.

.8 Check all operating software. Check all application software. Provide samples of all logs and commands.

.9 Verify each CDL including energy optimization programs.

.10 Debug all software.

.11 Blow out flow measuring and static pressure stations with high pressure air at 100 psi.

.13 Final Operational Acceptance Test:

.1 Conduct a final operational test of not less than thirty (14) consecutive days, twenty-four (24) hours per day, on the complete and total system.

.2 Demonstrate that it is functioning properly in accordance with all requirements of this specification.

.3 Demonstrate the correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control algorithms, diagnostics, and all other software.

.4 If the equipment operates at an average effectiveness level (AEL) of at least 99% during the performance test period, it will be deemed to have met Standard of Performance, and final acceptance of the system shall be made, provided the contractor has satisfied all other requirements of this specification.

.5 In the event the required AEL is not reached during the initial test period, the final operational acceptance test period will be extended on a day-to- day basis until the required AEL is reached for thirty (30) consecutive calendar days. The average effectiveness level (AEL) is defined as the ratio between the total thirty-day test period less any system downtime accumulated within that period, and the thirty-day test period.

.6 Downtime to result whenever the EMCS is unable to fulfill all required functions detailed within this specification due to any malfunction of either hardware or software. Any defect of hardware or software shall be corrected when it occurs before the test may be resumed.

.7 System downtime for each incident will be measured by those intervals during the performance period between the time that the Contractor or duly authorized representative is notified of equipment failure and the time that the system is returned to proper operating condition. Notification of down time will be by means of operator work station located in the Contractor's office and a modem to the system. Downtime of the system resulting from the causes as follows will not be considered as system failures:

.1 Downtime resulting from an outage of the main power supply in excess of the capability of any back- up power source(s), provided that the automatic initiation of all back-up sources was accomplished and provided that the automatic shutdown and restart of components fulfills the requirements of this specification.
.2 Failure of a communications link, provided that the Controllers automatically and correctly operates in the stand-alone mode and provided that the failure was not due to a failure of contractor furnished equipment.
.3 A functional failure resulting from an individual sensor or controller provided that the system has recorded the fault, the mechanical equipment is defaulted to the fail- safe mode, and that the AEL of the total of sensors and controllers is at least 99% during the thirty-day test period.

1.12 COORDINATED WORK

.1 Manufacturers' nameplates and CSA labels must be visible and legible after equipment is installed.

.2 The Controls contractor must cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor must consult the drawings and specifications for all trades to determine the nature and extent of other work and ensure the Controls contractor tender is complete.

.3 It will be the duty of the Contractor to work in cooperation with the Departmental Representative and with such other contractors and employees rendering such assistance and so arrange his work such that the entire project will be delivered complete in the best possible condition within the project schedule/allotted time.

1.13 WARRANTY

.1 Warrant the EMCS to be free from defects in workmanship and material for a period of one (1) year from the date of final acceptance.

.2 During the warranty period, furnish all labour and material to replace or repair all items or components which failed due to defects in workmanship or material.

.3 The above warranty must include system and application software.

1.14 SERVICE CONTRACT

.1 Provide a complete full service contract for a period of 12 months from the date of acceptance.

.2 During this service contract, maintain an in-house "on line" monitoring of the system through a modem to the system.

.3 Complete repair and servicing of the system in 24 hours after detecting a fault.

1.15 SUBMITTALS

.1 Prepare all shop drawings on AutoCAD software or equivalent. In addition to the drawings, furnish a DVD/CD-Rom containing the identical information.

.2 Shop drawings must include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also include individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typicals will be allowed where appropriate.

.3 Submittal data must contain manufacturer's data on all hardware and software products required by the specification. In addition, submittals must include:
- .1 Valve schedules with pipe sizes, flow rates, design and actual pressure drops.
- .2 Damper schedule with duct size, operator type/size, free area, flow rates, and pressure drops.
- .3 Descriptive point list.
- .4 Sequence of operation using descriptive prose and fully annotated English language flow charts.
- .5 Complete description of graphics, reports, alarms and configuration of the workstation software.

.4 Submit shop drawings to the Departmental Representative for review prior to ordering or fabrication of the equipment in accordance with Section 01 33 00. Check all documents for accuracy prior to submitting.

.5 The Departmental Representative will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. Repeat this procedure until all corrections are made to the satisfaction of the Departmental Representative and the submittals are fully approved.

1.16 CONSTRUCTION RECORDS

.1 During the installation phase, all changes to the scope of work must include a written change order inclusive of pricing before work is to proceed. Change orders must be signed by the Departmental Representative.

1.17 SYSTEM START-UP

.1 After all field connections have been made and control power is available to each control panel, notify the Departmental Representative and enable the control system by the EMCS contractor. Do any software loading at this time and the start-up of the mechanical or electrical system shall commence.

1.18 TESTING

.1 Test each point in the system for both hardware and software functionality. In addition, each mechanical and electrical system under control of the EMCS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test constitutes the beginning of the warranty period. Submit a written report to the Departmental Representative indicating that the installed system functions in accordance with the plans and specifications.

1.19 TRAINING

.1 The EMCS DDC Control contractor will provide both on-site and classroom training to the Departmental Representative and maintenance personnel per the following description:
- .1 On-site training shall consist of a minimum of 15 hours of hands- on instruction geared at the operation and maintenance of the systems. The curriculum shall include:
  - .1 System Overview
  - .2 System Software and Operation - System access - Software features overview - Changing

setpoints and other attributes - Scheduling
- .1 Editing programmed variables
- .2 Displaying colour graphics
- .3 Running reports
- .4 Workstation maintenance
- .5 Application programming

.3 Operational sequences including start-up, shutdown, adjusting and balancing.

.4 Equipment maintenance.

.2 Training will include one 7.5 hour follow up session after system start- up. Session to be scheduled by maintenance/operating staff and the Controls contractor.

1.20 OPERATING AND MAINTENANCE MANUALS

.1 The operation and maintenance manuals must contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire EMCS. This documentation includes specific part numbers and software versions and dates. Include a complete recommended spare parts inventory list with the lead time and expected frequency of use of each part clearly identified.

1.21 RECORD DRAWINGS

.1 Following project completion and testing, submit record drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software both in written form and on DVD/CD-Rom.

1.22 QUALITY ASSURANCE

.1 The equipment and software proposed by the supplier must be currently in manufacture. No custom products will be allowed unless required by the specification. All products must be supported by the manufacturer for a minimum of ten (10) years, including spare parts, board repairs and software revisions.

1.23 OPERATING ENVIRONMENT

.1 All controllers must operate in an environment of 0 to 150F and 10-95% relative humidity.

1.24 CODE COMPLIANCE

.1 All electrical components must be approved, listed or certified for its intended use by an agency accredited by the Standards Council of Canada and the Nova Scotia Provincial Inspection Authority.

.2 All equipment, piping, or conduit used in conditioned air streams, spaces or return air plenums must comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.

.3 All wiring must conform to the Canadian Electrical Code.

.4 Provide EMCS components and ancillary equipment which are UL-listed and labeled.

.5 Provide enclosures and controls which comply with NEMA's Publication No. 250 and Standards ICS 1,2,3 and 6.

.6 Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

.7 Comply with FCC, Part 68 rules for telephone modems and data sets.

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROL OVERVIEW

.1 System to utilize intelligent distributed Stand-Alone Controllers (SAC) to interface sensors being monitored and equipment being controlled by the building management and control system. Each unit shall be micro-processor based and perform the following functions:

.1 Record, evaluate and report changes of state and/or value that occur among points associated with the remote unit.

.2 Locally perform direct digital control (DDC) of all common mechanical system functions. Such functions will be programmed using a sequential, numbered-statement programming language.

.3 Each stand-alone controller unit to execute all application programs, calculations and commands via a Central Processor Unit (CPU) resident in the unit. All databases for each unit and the operating system and all application programs for each unit shall be stored within the unit. The CPU permits floating point calculations to enable the performance of energy calculations. Each stand-alone controller shall contain a real- time clock to enable the unit to automatically perform time-based functions.

.4 Each control unit must be capable of full operation either as a completely independent unit or as a part of the building-wide control system. All units shall contain the necessary equipment for direct interface to the sensors and actuators connected to it.

.5 Control strategies to be definable from the controller mounted operator keypad or via modem from a remote computer. Each stand-alone controller must include its own micro-computer direct digital controller, power supply, input/output modules and battery. The battery must be self-charging and be capable of supporting all memory within the control unit if the commercial power to the unit is interrupted or lost for a minimum of thirty (30) hours.

.6 Each unit must perform continuous diagnostics and any malfunction to be annunciated at the panel mounted display as well as initiating an automatic alarm dial-out.

.7 Failure of any controller on the system must not affect the proper operation of the Control remaining system controllers.

.8 The system must be capable of phased start-up. That is, any unit must be capable of operating properly in a stand- alone fashion while remaining units are being installed.

.9 Provide surge transient protection in each unit for the purpose of suppressing induced voltage transients.

.10 All units must be listed by Underwriter's Laboratories Canada (ULC) and Canadian Standards Association (CSA) against fire and shock hazard as a signal system appliance unit.

.11 Units must have all metal cabinets. Each unit including cabinet, power supply, function cards and terminations modules shall be approved, listed or certified for its intended use by an agency accredited by the Standards Council of Canada and the Nova Scotia Provincial Inspection Authority. Each unit shall have a pin-hinged door and master keyed lock. Units shall be capable of proper operation in an ambient environment of 32 to 122 degrees Fahrenheit and 10% to 90% RH.

.12 It must be possible for each remote unit to monitor the following types of inputs, without the addition of equipment outside the remote unit cabinet: - Analog Inputs - 4-20 mA - Thermistors - Pulse Accumulator - Digital Inputs - Dry Contacts (N.O. or N.C.)

.13 The remote unit must directly control electric and electronic actuators and control devices. Each control unit to be capable of providing the following control out-puts without the addition of equipment outside the remote unit cabinet: - Digital Outputs - Analog Outputs - 4 - 20 mA - 0 - 10 VDC

.2 Operator Interface:

.1 The building management and control system must permit full operator communication including obtaining information about the performance of the system; allowing the operator to change the system operation; and diagnosing system malfunctions.

.3 User Programmability:

.1 All temperature control strategies and energy management routines to be definable by operator via panel mounted operator keypad and display modem from a remote computer. Provide the system complete with all equipment and documentation necessary to allow a trained operator to independently perform the functions listed below:

.1 Read the value of the measured variable (i.e. temperature).
.2 Start or stop equipment.
.3 Monitor the status of equipment being controlled.
.4 Read the set point of a control loop.
.5 Determine the control strategies that have been defined for a specific piece of equipment.
.6 Generate displays of control strategies.
.7 Add/delete control loops to the system.
.8 Add/delete points to the system
.9 Create, modify or delete control strategies.
.10 Assign sensors and/or actuators to a control strategy.
.11 Tune control loops through the adjustment of control loop parameters.
.12 Enable or disable control strategies.
.13 Generate hardcopy records of control strategies on a printer
.14 Select points to be alarmable and define alarm states.

.4 Self-Diagnostics and Alarm Reporting:

.1 Each stand-alone unit must contain self diagnostics that continuously monitor the proper operation of the unit. A malfunction of the unit will be reported, and will inform the operator of the nature of the malfunction and control unit affected.

.5 It must be possible to remotely monitor the operation of the control system by assigning an internet protocol address to the systems operators terminal and logging into the terminal in "Remote Desktop" mode.

2.2 OVERALL SYSTEM ARCHITECTURE

.1 The building management and control system must possess a fully modular architecture, permitting expansion through the addition of more stand-alone controllers, sensors, actuators and operator terminals.

.1 The building management and control system to consist of:

.1 A network of independent, stand-alone direct digital control units.
.2 Distributed Processing:

.1 Each stand- alone controller shall be capable of performing all specified control functions in a completely independent manner. "Independent" shall be defined as follows:

.1 If any one control unit or communication processor malfunctions within the system, all other control units will continue to control, monitor, have the ability to be accessed or programmed without being in a degraded mode.

.2 Networking:

.1 Each stand-alone controller must be capable of sharing point information with other such units, such that control sequences or control loops executed at one control unit may receive input signals from sensors connected to other units within the network. If the network communication link fails or the originating control unit malfunctions, the control loop will continue to function using the last value received from the failed stand-alone control unit.

.2 Failure of one stand-alone controller shall have no other effect upon any of the remaining units on the

network.

2.3 TRANSMISSION NETWORK

.1 Transmission to be asynchronous and utilize a token-pass networking method. The system must utilize a cyclic redundancy check or dual transmission with parity check to ensure signal reliability. The network must support up to 32 stand-alone controllers.

.2 The transmission network must utilize a twisted shielded pair. The transmission speed must be a minimum of 500 Kbps.

.3 The EMCS network must be accessible from the main building data network.

2.4 SOFTWARE

.1 Each stand-alone control unit must be capable of independently performing the following pre-tested control algorithms:
- .1 Proportional, Integral plus Derivative Control (PID)
- .2 Self Tuning PID
- .3 Two Position Control
- .4 Digital Filter
- .5 Raton Calculator
- .6 Equipment Cycling Protection

.2 Mathematical functions: each controller must be capable of performing basic mathematical functions (+,-,*,/), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five (5) parentheses deep.

.3 Energy management applications: control units must have the ability to perform any or all of the following energy management routines:
- .1 Time of Day Scheduling
- .2 Calendar Based Scheduling
- .3 Holiday Scheduling
- .4 Temporary Schedule Overrides
- .5 Optimal Start
- .6 Optimal Stop
- .7 Night Setback Control
- .8 Enthalpy Switchover (Economizer)
- .9 Peak Demand Limiting
- .10 Temperature Compensated Duty Cycling
- .11 CFM Tracking
- .12 Heating/Cooling Interlock
- .13 Hot/Cold Deck Reset
- .14 Free Cooling
- .15 Hot Water Reset
- .16 Psychrometric calculations.

.4 History logging: each controller must be capable of logging any system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, flags, etc.) can be logged in history. A minimum of 32767 values can be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logs can be automatic or

manual. Logged data must be downloadable to the Operator Workstation for long term archiving based upon user- defined time intervals, or manual command.

.5 Alarm management: for each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the control units and can result in the display of one or more alarm messages or reports.
.1 Up to eight (8) alarms can be configured for each point in the controller.
.2 Messages and reports can be sent to a local terminal, to the front-end workstation(s), or via modem to a remote- computing device.
.3 Alarms will be generated based on their priority.

.6 Reporting: control unit must be able to generate user-definable reports to a locally connected printer or terminal. The report shall contain any combination of text and system variables. Report templates must be able to be created by users in a word processing environment. Reports can be displayed based on any logical condition or through a user command.

2.5 OPERATOR WORKSTATION AND SOFTWARE

.1 Provide a new dual core desktop PC with 16 G.B. of Ram, 2 GHz quad core processors, 500 G.B. hard drive, 24 inch flat panel LCD, complete with windows 8 professional. Configure the workstations to monitor and program all new DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments. Programming of controllers shall be capable of being done either off- line or on-line from any operator workstation location. All information will be available in graphic or text displays.

.2 User security: The software must be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and only editable by, a system administrator. These sets of capabilities must range from view only, acknowledge alarms, enable/disable, change values, program, administrate. The system shall allow the above capabilities to be applied independently to each class of object. There shall be an inactivity timer adjustable in software that automatically logs off the current operator after the timer has expired.

.3 Colour graphic displays: The system must allow for the creation of user defined, colour graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics must contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators must be able to command equipment or change setpoints from a graphic through the use of the mouse. Set up graphics for all systems installed under this contract.

.4 Automatic monitoring: The software must allow for the automatic collection of data and reports from any controller through either a hardwire or modem communication link. The frequency of data collection must be completely user- configurable.

.5 Alarm management: The software must be capable of accepting alarms directly from controllers, or generating alarms based on polling of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgement, and have the option for displaying graphics, or reports. Alarm management features must include:
.1 The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

.6 Custom report generation: The software will contain a built-in custom report generator, featuring word processing tools for the creation of custom reports. These custom reports shall be able to be set up to

automatically run or be generated on demand. The existing workstation shall be able to associate reports with any word processing or spreadsheet program loaded on the machine. When the report is displayed, it will automatically spawn the associated report editor such as MS Word™, WordPerfect™, NotePad, or Lotus 123TM.

.1 Reports can be of any length and contain any point attributes from any controller on the network.

.2 Report generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

.3 Standard reports shall include:

- .1 Points in each controller
- .2 Points in alarm
- .3 Disabled points
- .4 Overridden points
- .5 Operator activity report
- .6 Alarm history log.
- .7 Program listing by controller with status
- .8 Network status of each controller.

.7 Scheduling: It must be possible to configure and download from the workstation schedules for any of the controllers on the network.

.1 Time of day schedules must be in a calendar style and be programmable up to one (1) year in advance. Each standard day of the week and user- defined day types shall be able to be associated with a colour so that when the schedule is viewed it is very easy, at-a- glance, to determine the schedule for a particular day even from the yearly view. To change the schedule for a particular day, a user will simply click on the day and then click on the day type.

.2 Each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.

.3 Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.

.8 Additional Software: Coordinate Installation of lighting controls software and energy metering software.

2.6 TEMPERATURE SENSORS

.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°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 to be unaffected by external transmitters (eg. 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 CSA 4X enclosures.

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

2.7 TEMPERATURE SENSORS

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

.2 Sensors:
- .1 Room type: wall mounting, in slotted type covers having brushed aluminum or brushed stainless steel finish, with guard in public areas. Element 10-50 mm long with ceramic tube or equivalent protection.
- .2 In private areas include setpoint adjustment, local indication, push button override for night set back function.
- .3 General purpose duct type: suitable for insertion into ducts at any angle, insertion length 450 mm.
- .4 Averaging duct type: continuous filament with minimum immersion length 6000 mm. Bend probe at field installation time to 100 mm radius at any point along probe without degradation of performance.
- .5 Outside air type: complete with probe length 100-150 mm long, non- corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in CSA 4X enclosure.
- .6 Temperature sensors located on an exterior wall shall include thermal insulation in the sensor assembly.
- .7 Use caulking or alternative sealing device to plug conduit connections to all sensors.

2.8 TEMPERATURE TRANSMITTERS

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

2.9 DIFFERENTIAL PRESSURE (KPA) TRANSMITTER

.1 Requirements:
- .1 Internal materials: suitable for continuous contact with industrial standard instrument air,

compressed air, water, steam, as applicable.
.2 Output signal: 4-20 mA into 500 ohm maximum load.
.3 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.
.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5% of full scale output over entire range.
.5 Integral zero and span adjustment.
.6 Temperature effects: not to exceed plus or minus 1.5% full scale/50°C.
.7 Over-pressure input protection to at least twice rated input pressure.
.8 Output short circuit and open circuit protection.
.9 The unit to have a NPT 1/2 conduit connection. The enclosure shall be an integral part of the unit.

2.10 DIFFERENTIAL PRESSURE (PA) TRANSMITTERS

.1 Requirements:
.1 Output signal: 4-20 mA into 500 ohm maximum load.
.2 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.
.3 Integral zero and span adjustment.
.4 Temperature effects: not to exceed plus or minus 1.5% full scale/50C.
.5 Output short circuit and open circuit protection.
.6 The unit to have a NPT 1/2 conduit connection. The enclosure shall be an integral part of the unit.
.7 Pressure ranges: see I/O Summaries.

2.11 FAN SYSTEM STATIC PRESSURE TRANSMITTERS

.1 Requirements:
.1 Output signal: 4-20 mA linear into 500 ohm maximum load.
.2 Calibrated span: not to exceed 150% of duct static pressure at maximum flow.
.3 Accuracy: 0.4% of span.
.4 Repeatability: within 0.5% of output.
.5 Linearity: within 1.5% of span.
.6 Deadband or hysteresis: 0.1% of span.
.7 External exposed zero and span adjustment.
.8 The unit to have a NPT 1/2 conduit connection. The enclosure shall be an integral part of the unit.

2.12 TEMPERATURE SWITCHES

.1 Requirements:
.1 Range: see I/O summaries.

.2 Temperature sensor: liquid, vapour or bimetallic type. Operate automatically. Reset automatically, except as follows:
.1 Freeze protection: manual reset. Optional if software does not auto restart.
.2 Fire detection: manual reset. Optional if software does not auto restart.
.3 Duct Heater: high limit manual reset in addition to automatic reset.

.3 Adjustable setpoint and differential.

.4 Accuracy: plus or minus 1°C.

.5 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and EMCS connections.

.6 Type as follows:
- .1 Room: for wall mounting on standard electrical box with or without protective guard as indicated.
- .2 Duct, general purpose: insertion length = 460 mm.
- .3 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.
- .4 Freeze detection: continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 300 mm length.
- .5 Strap-on: with helical screw stainless steel clamp.

2.13 AIR PRESSURE GAUGES

.1 Diameter: 38 mm minimum.

.2 Range: zero to two times operating pressure of measured pressure media to nearest standard range.

2.14 ELECTRICAL RELAYS

.1 Double voltage, DPDT, plug-in type with termination base.

.2 Coils: rated for 120VAC or 24V DC. Other voltage: provide transformer.

.3 Contacts: rated at 5 amps at 120 VAC.

.4 Relay to have visual status indication.

2.15 SOLID STATE RELAYS

.1 Requirements:
- .1 CSA approved.
- .2 Suitable to the application as recommended by manufacturer.
- .3 Voltage range: 75-265 VAC.
- .4 Panel mounting.
- .5 Suitable for AC or DC loads
- .6 Output surge absorbing element for inductive on/off loads.
- .7 Input capacitor/resistor circuit for pulse noise absorption.
- .8 For input inductive noise use twisted-pair wires for electromagnetic noise and shielded cable for static noise.

2.16 CURRENT TRANSDUCERS

.1 Requirements:
- .1 Range: in accordance with Equipment Schedules.
- .2 Purpose: measure line current and produce proportional signal in one of following ranges:
  - .1 4-20 mA DC
  - .2 0-1 volt DC.
  - .3 0-10 volts DC.
  - .4 2-10 volts DC.
- .3 Frequency insensitive from 10-80 hz.
- .4 Accuracy to 0.5% full scale.
- .5 Zero and span adjustments. Field adjustable range to suit motor applications.
- .6 Adjustable mounting bracket to allow for secure/safe mounting inside the MCC or starter enclosure.

2.17 CURRENT SENSING RELAYS

.1 Requirements:
.1 Complete with metering transformer ranged to match load, plug-in base and shorting shunt to protect current transformer when relay is removed from socket.
.2 Suitable for single or 3 phase metering into single relay.
.3 Adjustable latch level, adjustable delay on latch and minimum differential of 10% of latch setting between latch level and release level.
.4 3-Phase application: provide for discrimination between phases.
.5 Adjustable latch level to allow detection of worst case selection. To be powered from control circuit of motor starter being metered. Relay and base to be mounted in adjacent auxiliary cabinet only if control circuit power to be brought into auxiliary cabinet. Adjustments to be accessible from auxiliary cabinet.
.6 Relay contacts: capable of handling 10 amps at 240 V AC.
.7 Relays shall be factory installed in motor control or shall be a listed field installable accessory by the controller manufacturer.

2.18 CONTROL DAMPERS

.1 Refer to Section 23 33 15 for Control Dampers.

2.19 ELECTRONIC CONTROL DAMPER OPERATORS

.1 Requirements:
.1 Push-pull proportional type as indicated.
.2 Spring return for "fail- safe" in Normally Open or Normally Closed position as indicated.
.3 Operator: size so as to control dampers against maximum pressure or dynamic closing pressure (whichever is greater).
.4 Power requirements: 5 VA maximum at24 V AC.
.5 Operating range: 0 - 20 V Dc.
.6 Manufacturers: Belimo, Siemens, Johnson, Honeywell.

2.20 PANELS

.1 Either free-standing or wall mounted enameled steel cabinets with hinged and key-locked front door.

.2 Modular multiple panels as required to handle requirements with additional space to accommodate future capacity as required by Departmental Representative without adding additional cabinets.

.3 Panels must be lockable with same key.

PART 3 - EXECUTION

3.1 MOUNTING AND INSTALLATION PRACTICES

.1 Wall-mounted sensors to include thermal conducting compound within the well to insure good heat transfer to the sensor.

.2 Dampers will be furnished by the Building Automation contractor and installed by the Mechanical contractor.

.3 Firmly mount actuators to give positive movement and linkage will be adjusted to give smooth continuous

movement throughout 100 percent of the stroke.

.4 Relay outputs will include transient suppression across all coils. Suppression devices must limit transients to 150% of the rated coil voltage.

3.2 LOCATION

.1 The location of sensors are per the mechanical schematics/drawings.

.2 Space temperature sensors or thermostats will be mounted away from machinery generating heat, direct light and diffuser air streams.

.3 Mount outdoor air sensors on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.

.4 Locate field enclosures immediately adjacent to the controller panel(s) to which it is being interfaced.

3.3 IDENTIFICATION

.1 All I/O field devices (except space sensors) identified with name plates.

.2 Identification to match all documentation and identify the function (i.e. mixed air temperature sensor).

.3 Calibration settings shall be marked with paint or indelible ink.

.4 Tag each terminal strip termination with an identification that matches the control drawings.

.5 Identify the outside of each FIP with a bakelite label matching the identification name shown on the drawings.

.6 Identify all control wires with labelling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

.7 Identify all field enclosures, other than controllers, with a bakelite nameplate. The lettering must be in white against a black or blue background.

.8 Mark junction box covers to indicate that they are a part of the EMCS system.

3.4 CONTROLS CONTRACTOR RESPONSIBILITIES

.1 Installation of the building automation system will be performed by the Contractor or a subcontractor. However, all installation must be under the personal supervision of the Controls contractor. The Controls contractor will certify all work as proper and complete and shall reflect actual installation on the project record documentation. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

3.5 COMPLIANCE

.1 Install all wiring in accordance with all applicable electrical codes and comply with equipment manufacturer's recommendations.

3.6 WIRING AND CONDUIT

.1 All wire must be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Insulation Class
Power	12 Gauge	300 or 600V as required
Class One	14 Gauge Std.	300 or 600V as required
Class Two	18 Gauge Std.	300 Volt
Communications	Per Mfr.	

.2 Power and Class One wiring servicing the same equipment may be run in the same conduit provided they are insulated to the same voltage level. Class Two wiring must be run in separate conduits from power and Class 1 circuits.

.3 Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers in accordance with CEC.

.4 Where wiring is required to be installed in conduit, use EMT. Conduit to be minimum 16mm galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal- off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

.5 Use flexible metallic conduit (max. 1.0m) for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Use liquid-tight flexible conduit in exterior locations and interior locations subject to moisture.

.6 Provide junction boxes at all cable splices, equipment terminations, and transitions from EMT to flexible conduit. Interior dry location J- boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes must be cast alloy FS boxes with threaded hubs and gasketed covers.

.7 Where the space above the ceiling is a supply or return air plenum, the wiring must be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system must be in conduit.

3.7 SOFTWARE INSTALLATION

.1 Provide all labour necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

3.8 DATABASE INSTALLATION

.1 Provide all labour to configure those portions of the database that are required by the points list and sequences of operation.

3.9 COLOR GRAPHIC SLIDES

.1 Unless otherwise directed by the Departmental Representative, provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall

contain the associated points identified in the point list and allow for setpoint changes as required by the Departmental Representative.

3.10 REPORTS

.1 Configure a minimum of six (6) reports for the Departmental Representative as listed below:
- .1 Ventilation Room Status Report
- .2 Heat Reclaim Status Report
- .3 Energy Consumption Report
- .4 Space Temperature Report
- .5 Specialty Equipment Status Report

3.11 RECOMMENDATION

.1 As built software documentation to include the following:
- .1 Descriptive point lists
- .2 Application program listing
- .3 Application programs with comments Printouts of
- .4 Printouts of all reports

.2 Alarm list.

.3 Printouts of all graphics.

3.12 CLEANUP

.1 At the completion of the work, check all equipment and thoroughly clean, clean around equipment. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.

.2 Upon final completion of work in an area, vacuum and/or damp wipe all finished room surfaces and furnishings.

.3 At the completion of Work at the end of each day, remove from the building, premises, and surrounding streets, etc. all rubbish and debris resulting from the operations and leave all equipment spaces clean and ready for use.

3.13 INSTALLATION PRACTICES

.1 A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.

.2 Attach wires to the building proper at regular intervals such that wiring does not droop. Do not affix wires to or support by pipes, conduit, etc.

.3 Conduit, in finished areas, will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. The exception: metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.

.4 Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.

.5 Keep wires a minimum of 75mm from hot water piping.

3.14 POWER WIRING

.1 120V/1/60 power wiring required for EMCS control panels to be supplied and installed by Controls contractor.

.2 120V/1/60 power or 24V/1/60 control wiring to fan and pump starters to be supplied and installed by Controls contractor.

.3 120V/1/60 power wiring or 24 volt control wiring required for room control shall be supplied and installed by the Controls contractor.

.4 Obtain the power from dedicated circuits on the nearest available 120 V panel and clearly labelled. Power for any EMCS equipment that is controlling equipment that operates under emergency power shall be obtained from emergency power panels.

.5 Provide power circuits serving EMCS equipment complete with an insulated (green) bonding conductor that originates at the ground bus of the panel containing the branch circuit overcurrent device.

END OF SECTION