PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 01 91 13 – General Commissioning Requirements.
.3 Section 21 05 00 - Common Work Results for Fire Suppression.
.4 Section 22 05 00 - Common Work Results for Plumbing.
.5 Section 23 05 00 - Common Work Results – Mechanical.
.6 Section 23 05 01 – Facility Mechanical Commissioning – General.
.7 Section 23 05 02 – Facility Commissioning – Mechanical.
.8 Section 25 05 01 – EMCS: General Requirements.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SUMMARY

.1 Section Includes:

.1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:
.1 Start-up testing and verification of systems.
.2 Check out demonstration or proper operation of components.
.3 On-site operational tests.

1.4 DEFINITIONS

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

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

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

.1 Outage of main power supply in excess of back-up power sources, provided that:
  .1 Automatic initiation of back-up was accomplished.
  .2 Automatic shut-down and re-start of components was as specified.

.2 Failure of communications link, provided that:
  .1 Controller automatically and correctly operated in stand-alone mode.
  .2 Failure was not due to failure of any specified EMCS equipment.

.3 Functional failure resulting from individual sensor inputs or output devices, provided that:
  .1 System recorded said fault.
  .2 Equipment defaulted to fail-safe mode.
  .3 AEL of total of all input sensors and output devices is at least 99% during test period.

1.5 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.

1.6 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 02 – EMCS: Submittals and Review Process.

.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 77 00 – Closeout Procedures.
.5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.7 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 77 00 – Closeout Procedures.

1.8 COMMISSIONING

.1 Do commissioning in accordance with:
- .1 Section 01 91 13 – General Commissioning Requirements;
- .2 Section 01 91 31 – Commissioning Cx Plan.
- .3 Section 01 91 33 – Commissioning Forms.
- .4 Section 01 91 41 – Commissioning Training.
- .5 Section 23 05 01 – Facility Mechanical Commissioning – General.
- .6 Section 23 05 02 – Facility Commissioning - Mechanical.
- .7 Section 25 05 01 – EMCS: General Requirements.

.2 Carry out commissioning under direction of Departmental Representative and Commissioning Authority.

.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.

1.9 COMPLETION OF COMMISSIONING

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

1.10 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 Agent.

.3 Commission integrated systems using procedures prescribed by Commissioning Agent.

.4 Debug system software.

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

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

3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.

- .1 General: consists of field tests of equipment just prior to installation.
- .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.
- .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and two (2) sets of Building Controller's including MCU's, LCU's, and TCU's.
- .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
- .5 Additional instruments to include:
  - .1 DP transmitters.
  - .2 VAV supply duct SP transmitters.
  - .3 DP switches used for dirty filter indication and fan status.
- .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source and to BECC.
- .7 After setting, test zero and span in 10% increments through entire range while both increasing and decreasing pressure.
- .8 Departmental Representative to mark instruments tracking within 0.5% in both directions as "approved for installation".

.9 Transmitters above 0.5% error will be rejected.
.10 DP switches to open and close within 2% of setpoint.

.2 Completion Testing:

.1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
.2 Include following activities:
.1 Test and calibrate field hardware including stand-alone capability of each controller.
.2 Verify each A-to-D convertor.
.3 Test and calibrate each AI using calibrated digital instruments.
.4 Test each DI to ensure proper settings and switching contacts.
.5 Test each DO to ensure proper operation and lag time.
.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
.7 Test operating software.
.8 Test application software and provide samples of logs and commands.
.9 Verify each CDL including energy optimization programs.
.10 Debug software.
.11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
.12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space for Commissioning Technician and Departmental Representative. This document will be used in final start-up testing.

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

.1 Two (2) technical personnel capable of re-calibrating field hardware and modifying software.
.2 Detailed daily schedule showing items to be tested and personnel available.
.3 Departmental Representative acceptance signature to be on executive and applications programs.
.4 Commissioning to commence during final start-up testing.
.5 O&M personnel to assist in Commissioning procedures as part of training.
.6 Commissioning to be supervised by qualified supervisory personnel.
.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 Agent 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 Agent and 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 Division 01 and Division 25.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 01 91 13 – General Commissioning Requirements.
.3 Section 21 05 00 - Common Work Results for Fire Suppression.
.4 Section 22 05 00 - Common Work Results for Plumbing.
.5 Section 23 05 00 - Common Work Results – Mechanical.
.6 Section 23 05 01 – Facility Mechanical Commissioning – General.
.7 Section 23 05 02 – Facility Commissioning – Mechanical.
.8 Section 25 05 01 – EMCS: General Requirements.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.4 SUMMARY

.1 Section Includes:

.1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.

1.5 DEFINITIONS

.1 CDL - Control Description Logic.

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

1.6 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 – Submittal Procedures; 25 05 02 – EMCS: Submittals and Review Process as well as supplemented and modified by requirements of this Section.

.2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipated date of beginning of training:

.1 List name of trainer, and type of visual and audio aids to be used.
.2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.

.3 Submit reports within one (1) week after completion of Phase 1 and Phase 2 of the training program, that training has been satisfactorily completed.

1.7 QUALITY ASSURANCE

.1 Provide in English, competent instructors thoroughly familiar with aspects of EMCS installed in facility.

.2 Departmental Representative reserves right to approve instructors.

1.8 INSTRUCTIONS

.1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.

.2 Training to be project-specific.

1.9 TIME FOR INSTRUCTION

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

1.10 TRAINING MATERIAL

.1 Submit O & M Manual in accordance with Section 01 77 00 – Closeout Procedures.

.2 Provide equipment, visual and audio aids, and materials for classroom training.

.3 Supply manual for each trainee, describing in detail data included in each training program.

.1 Review contents of manual in detail to explain aspects of Operation and Maintenance Manual (O&M).

1.11 TRAINING PROGRAM

.1 To be in 2 phases over 6-month period.

.2 Phase 1: One (1) day program to begin before 30-day test period at time mutually agreeable to Contractor, Departmental Representative and Commissioning Agent:

.1 Train O&M personnel in functional operations and procedures to be employed for system operation.
.2 Supplement with on-the-job training during 30 day test period.
.3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
.4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

.3 Phase 2: Two (2) day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers:

.1 Provide multiple instructors on pre-arranged schedule. Include at least following: Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
.2 Equipment maintenance training: provide personnel with training within two (2) day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.
.3 Programmers: provide personnel with training within two (2) day period in following subjects in approximate percentages of total course shown:
- Software and architecture: 10%
- Application programs: 15%.
- Controller programming: 50%.
- Trouble shooting and debugging: 10%.
- Colour graphic generation: 15%.

1.12 ADDITIONAL TRAINING

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

1.13 MONITORING OF TRAINING

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

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 NOT USED

END

PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results for Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.
.6 Section 25 05 02 - EMCS: Submittals and Review Process.
.7 Section 25 05 60 - EMCS: Field Installation.
.8 Section 25 08 20 - EMCS: Warranty and Maintenance.
.9 Section 25 30 01 - EMCS: Building Controllers.
.10 Section 25 30 02 - EMCS: Field Control Devices.
.11 Section 25 73 15 - EMCS: Variable Speed Drives.
.12 Section 25 90 01 - EMCS: Site Requirements, Application and System Sequences of Operation.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SUMMARY

.1 Section Includes:

.1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to EMCS Sections.
.2 Sustainable requirements for construction and verification.

1.4 REFERENCES

.1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA):

.1 ANSI/ISA 5.5-2009, Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE):

.1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):

.1 ASHRAE STD 135-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International):

.1 CAN/CSA-Z234.1-00(R2006), Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA):

.1 CEA-709.1-B-2002, Control Network Protocol Specification.

.6 Department of Justice Canada (Jus):

.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.7 Electrical and Electronic Manufacturers Association (EEMAC):

.1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

.8 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.1 Material Safety Data Sheets (MSDS).

.9 Transport Canada (TC):

.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.5 ACRONYMS AND ABBREVIATIONS

.1 Acronyms used in EMCS:

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

.18 HVAC - Heating, Ventilation, Air Conditioning.
.19 IDE - Interface Device Equipment.
.20 I/O - Input/Output.
.21 ISA - Industry Standard Architecture.
.22 LAN - Local Area Network.
.23 LCU - Local Control Unit.
.24 MCU - Master Control Unit.
.25 NAFTA - North American Free Trade Agreement.
.26 NC - Normally Closed.
.27 NO - Normally Open.
.28 OS - Operating System.
.29 O&M - Operation and Maintenance.
.30 OWS - Operator Work Station.
.31 PC - Personal Computer.
.32 PCI - Peripheral Control Interface.
.33 PCMCIA - Personal Computer Micro-Card Interface Adapter.
.34 PID - Proportional, Integral and Derivative.
.35 RAM - Random Access Memory.
.36 SP - Static Pressure.
.37 ROM - Read Only Memory.
.38 TCU - Terminal Control Unit.
.39 USB - Universal Serial Bus.
.40 UPS - Uninterruptible Power Supply.
.41 VAV - Variable Air Volume.
.42 ARP: Address Resolution Protocol.
.43 CORBA: Common Object Request Broker Architecture.
.44 CSMA/CD: Carrier Sense Multiple Access/Collision Detect.
.45 DDE: Dynamic Data Exchange.
.46 FTT: Free Topology Transceivers.
.47 HTTP: Hyper Text Transfer Protocol.
.48 IIOP: Internet Inter-ORB Protocol.
.49 LAN: Local Area Network.
.50 LON: Echelon Communication – Local Operating Network.
.51 MS/TP: Master Slave Token Passing.
.52 ODBC: Open Database Connectivity.
.53 ORB: Object Request Broker.
.54 SNVT: Standard Network Variables Types.
.55 SQL: Structured Query Language.
.56 UDP: User Datagram Protocol.
.57 XML: eXtensible Markup Language.

1.6 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 Include additional point identifier expansion fields of equal capacity for each point name.

.4 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.

.3 Point Object Type: points fall into following object types:

.1 AI (analog input).
.2 AO (analog output).
.3 DI (digital input).
.4 DO (digital output).
.5 Pulse inputs.

.4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5:

.1 Printouts: to ANSI/IEEE 260.1.
.2 Refer to Division 25.

1.7 SCOPE OF WORK

.1 The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. All components of the system – workstations, servers, application controllers, unitary controllers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2004. No gateways shall be used for communication to controllers furnished under this section.

1.8 SYSTEM DESCRIPTION

.1 In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.

.2 Administration and Programming Workstation(s): The BAS Contractor shall furnish one (1) Administration and Programming Workstation Computers as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.

.3 Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. A minimum of 25 licenses are to be provided. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.

.4 Ethernet-based Network Router and/or Network Server Controller(s): The BAS Contractor shall furnish one (1) Ethernet-based Network Server Controllers n. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).

.5 Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).

1.9 SYSTEM DESIGN

.1 Refer to control schematics for system architecture.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

- .1 Building Controllers.
- .2 Control devices as listed in I/O point summary tables.
- .3 OWS(s).
- .4 Data communications equipment necessary to effect EMCS data transmission system.
- .5 Field control devices.
- .6 Software/Hardware complete with full documentation.
- .7 Complete operating and maintenance manuals.
- .8 Training of personnel.
- .9 Acceptance tests, technical support during commissioning, full documentation.
- .10 Wiring interface co-ordination of equipment supplied by others.
- .11 Miscellaneous work as specified in these sections and as indicated.
- .12 Provide additional controls as described within this specification.
- .13 Measurement and verification as identified in Division 01.

.3 Design Requirements

- .1 Design and provide conduit and wiring linking elements of system.
- .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
- .3 Location of controllers as reviewed by Departmental Representative prior to installation.
- .4 Provide utility power to EMCS and emergency power to EMCS as indicated.
- .5 Metric references: in accordance with CAN/CSA Z234.1.

.4 Language Operating Requirements

- .1 Provide English operator selectable access codes.
- .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
- .3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English
- .4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
- .5 Include, in English:
  - .1 Input and output commands and messages from operator-initiated functions and field related changes and alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS and to be able to operate terminal in English. Point name expansions in English.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.10 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 02 – EMCS: Submittals and Review Process.

.2 Co-ordinate submittal requirements and provide submittals as required.

.3 Submit for review:

.1 Equipment list and systems manufacturers within 48 h within ten (10) days after award of contract.

.2 List existing field control devices to be re-used included in bid tender, along with unit price.

.4 Quality Control

.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to Inspection Authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 02 EMCS: Submittals and Review Process. Label or listing of specified organization is acceptable evidence.

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

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

.6 Permits and fees: in accordance with Section 01 10 10 – General Instructions as well as General Conditions of Contract.

.7 Submit Certificate of Acceptance from authority having jurisdiction to Departmental Representative.

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

1.11 QUALITY ASSURANCE

.1 Ensure trained personnel is capable of providing instruction, routine maintenance and emergency service on systems.

.2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.

.3 Ensure qualified supervisory personnel continuously direct and monitor work and attend site meetings on a regular basis.

.4 Health and Safety:

.1 Complete construction occupational health and safety in accordance with Division 01.

.2 Sustainable Requirements:

.1 Construction requirements: in accordance as Division 01.
.2 Verification: contractor's verification in accordance with Division 01.

1.12 DELIVERY, STORAGE AND HANDLING

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

PART 2 PRODUCTS

2.1 EQUIPMENT

.1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 ASHRAE STD 135 “Native BACnet”.

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

2.2 ADAPTERS

.1 Provide adaptors between metric and imperial components.

PART 3 EXECUTION

3.1 MANUFACTURER’S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Division 01.

.1 Materials and resources.
.2 Storage and collection of recyclables.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results – Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SUMMARY

.1 Section Includes:

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

1.4 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following contractor and systems information:

.1 Location of local office.
.2 Description and location of installing and servicing technical staff.
.3 Location and qualifications of programming design and programming support staff.
.4 List of spare parts.
.5 Location of spare parts stock.
.6 Names of sub-contractors and site-specific key personnel.
.7 Sketch of site-specific system architecture.
.8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
.9 Descriptive brochures.
.10 Sample CDL and graphics (systems schematics).

.11 Response time for each type of command and report.
.12 Item-by-item statement of compliance.
.13 Proof of demonstrated ability of system to communicate utilizing BACnet.

1.5 SUBMITTALS

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

.2 Submit preliminary design document within five (5) working days after tender closing and before contract award, for review by Departmental Representative.

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

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

1.6 DETAIL SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 30 working days after award of contract and before start of installation and include following:
.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
.2 Wiring diagrams.
.3 Piping diagrams and hook-ups.
.4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
.5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
.6 Sensing element type and location.
.7 Transmitter type and range.
.8 Associated field wiring schematics, schedules and terminations.
.9 Complete Point Name Lists.
.10 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
.11 Software and programming details associated with each point.
.12 Manufacturer's recommended installation instructions and procedures.
.13 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
.14 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.
.15 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
.16 Listing and example of specified reports.
.17 Listing of time of day schedules.
.18 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.

.19 Type and size of memory with statement of spare memory capacity.
.20 Full description of software programs provided.
.21 Sample of “Operating Instructions Manual” to be used for training purposes.
.22 Outline of proposed start-up and verification procedures.
.23 Sample outputs for all measurement and verification points.

1.7 QUALITY ASSURANCE

.1 Preliminary Design Review Meeting: Convene meeting within 15 working days of award of contract to:

.1 Undertake functional review of preliminary design documents, resolve inconsistencies.
.2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
.3 Review interface requirements of materials supplied by others.
.4 Review "Sequence of Operations".

.2 Contractor's programmer to attend meeting.

.3 Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to Departmental Representative.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 NOT USED

END

PART 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for building Energy Monitoring and Control System (EMCS) Work.

1.2 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results – Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.
.6 Section 25 05 02 - EMCS: Submittals and Review Process.

1.3 DEFINITIONS

.1 BECC - Building Environmental Control Centre.

.2 OWS - Operator Work Station.

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

1.4 SUBMITTALS

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

.2 Submit Record Documents As-built drawings Operation and Maintenance Manual to Departmental Representative in English.

.3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.

.1 Binders to be 2/3 maximum full.
.2 Provide index to full volume in each binder.
.3 Identify contents of each manual on cover and spine.
.4 Provide Table of Contents in each manual.
.5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.5 AS-BUILTS

.1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:

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

.2 Submit for final review by Departmental Representative. Provide before acceptance 4 Hard and 1 electronic copy incorporating changes made during final review.

1.6 O&M MANUALS

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

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

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

.4 Functional description to include:

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

.5 System operation to include:

.1 Complete step-by-step procedures for operation of system including required actions at each OWS.
.2 Operation of computer peripherals, input and output formats.
.3 Emergency, alarm and failure recovery.

.4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.6 Software to include:

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

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

.8 System configuration document:

.1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.
.2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

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

PART 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

1.2 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results – Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International):

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

1.4 DEFINITIONS

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

1.5 SYSTEM DESCRIPTION

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

1.6 SUBMITTALS

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

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

PART 2 PRODUCTS

2.1 NAMEPLATES FOR PANELS

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

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

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

.2 Sizes: 50 x 100 mm minimum.

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

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

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

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by stick-on labels using point identifier.

.2 Location: as directed by Departmental Representative.

.3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

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

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

2.5 WIRING

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

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

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

2.6 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

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

PART 3 EXECUTION

3.1 NAMEPLATES AND LABELS

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

3.2 EXISTING PANELS

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

END

PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results – Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.
.6 Section 26 05 00 - Common Work Results for Electrical.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/ Demolition Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI/ASME B16.22-2001, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
.2 ANSI C2-1990, National Electrical Safety Code.
.3 ANSI/NFPA 70-2008, National Electrical Code.

.2 Canadian Standards Association (CSA)

.1 CSA C22.1-2006, Canadian Electrical Code, Part 1.
.2 CAN/CSA C22.3No.1-M87, Overhead Systems.

1.4 SYSTEM DESCRIPTION

.1 Electrical

.1 Provide circuits from existing emergency power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
.2 Hard wiring between field control devices and EMCS field panels by EMCS.
.3 Communication wiring between EMCS field panels and OWSs including main control centre BECC by EMCS.

.4 Modify existing starters to provide for EMCS.

.5 Refer to wiring diagrams included as part of flow diagrams in section. Trace existing control wiring installation and provide updated wiring schematics including additions and/or deletions to control circuits for approval by Departmental Representative before commencing work.

.2 Mechanical

.1 Pipe Taps Required for EMCS equipment will be supplied and installed by Mechanical Contractor.

.2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by Mechanical Contractor.

.3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by. Costs to be carried by designated trade.

.3 VAV Terminal Units

.1 Air flow probe for VAV boxes to be supplied and installed.

.2 Air flow DP sensor, actuator and associated VAV controls to be supplied by EMCS to terminal Unit vendor and installed by terminal unit supplier.

.3 Tubing from air probe to DP sensor as well as installation and adjustment of air flow sensors and actuators to be the responsibility of EMCS contractor.

.4 Coordinate air flow adjustments with balancing trade.

.4 Variable speed drives to be supplied by EMCS to AHU manufacturer for installation in AHU factory and available for full integration by EMCS vendor. Confirm with Div. 23 Contractor to coordinate this requirement.

1.5 PERSONNEL QUALIFICATIONS

.1 Qualified supervisory personnel to:

.1 Continuously direct and monitor all work.

.2 Attend site meetings.

PART 2 PRODUCTS

2.1 WIRING

.1 As per requirements of Division 26.

.2 Division 26 will leave four (4) at 20 V, 20 amp breakers in Power Panels throughout the building. Section 25 05 01 - EMCS: General Requirements will use these as power source and be responsible for providing power to EMCS equipment to standard set out in Division 26.

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

.4 Sizes

.1 120V Power supply: to match or exceed breaker, size #12 minimum.

.2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
.3 Field wiring to digital device: #18AWG 20AWG stranded twisted pair.
.4 Analog input and output: shielded #18 minimum solid copper #20 minimum stranded twisted pair. Wiring must be continuous without joints.
.5 More than 4 conductors: #22 minimum solid copper.

.5 Terminations

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

2.2 CONDUIT

.1 As per requirements of Division 26.

.2 Electrical metallic tubing to CSA C22.2 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 56. Rigid steel threaded conduit to CSA C22.2 45.

.3 Junction and Pull Boxes

.1 Welded Steel:
.1 Surface mounting cast FS: screw-on flat covers.
.2 Flush mounting: covers with 25 mm minimum extension all round.

.4 Cabinets

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

.5 Outlet Boxes

.1 100 mm minimum, square.

.6 Conduit Boxes, Fittings

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

.7 Fittings for Rigid Conduit

.1 Couplings and Fittings: threaded type steel.
.2 Double Locknuts and Insulated Bushings: use on sheet metal boxes.
.3 Use factory "ells" where 90° bends required for 25mm and larger conduits.

.8 Fittings for Thin Wall Conduit

.1 Connectors and couplings: steel, set screw type.

2.3 WIRING DEVICES AND COVER PLATES

.1 Starters are generally by Division 26 except where indicated otherwise all VFD’s are to by Section 25 05 01 - EMCS: General Requirements.

.2 Conform to CSA.

.3 Receptacles

.1 Duplex: CSA type 5-15R.
.2 Single: CSA type 5-15R.
.3 Cover plates and blank plates: finish to match other plates in area.

2.4 STARTERS AND CONTROL DEVICES

.1 Across-The-Line Magnetic Starters

.1 Enclosures: CSA Type 1, except where otherwise specified (refer also to Variable Speed Drives).
.2 Size, Type and Rating: to suit motors.

.2 Starter Diagrams

.1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for Operation and Maintenance Manual.

.3 Auxiliary Control Devices

.1 Control Transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.
.2 Auxiliary Contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.
.3 Hand-Off-Automatic Switch: heavy duty type, knob lever operator.
.4 Double Voltage Relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.

.4 Finish For Starters

.1 Exterior: in accordance with Section 26 05 00 - Common Work Results for Electrical.
.2 Interior: white.

2.5 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

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

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

.2 Exposed Conduits or Cables

.1 50 mm Diameter and Smaller: one-hole steel straps.
.2 Larger than 50 mm Diameter: two-hole steel straps.

.3 Suspended Support Systems

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

PART 3 EXECUTION

3.1 INSTALLATION

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

3.2 MECHANICAL PIPING

.1 Install piping straight, parallel and close to building structure with required grades for drainage and venting.

.2 Ream ends of pipes before assembly.

.3 Copper tubing not to come into contact with dissimilar metal.

.4 Use non-corrosive lubricant or Teflon tape on male screwed threads.

.5 Clean ends of pipes, tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.

.6 Install di-electric couplings where dissimilar metals joined.

.7 Sleeves

- .1 Installation:
  - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
  - .2 Other floors: terminate 25 mm above finished floor.
  - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint.
- .2 Caulking:
  - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
  - .2 Elsewhere: provide space for firestopping. Maintain fire rating integrity.
  - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
  - .4 Ensure no contact between copper pipe or tube and sleeve.

.8 Pressure Tests

- .1 Pressure test all piping systems modified under this contract to 1-1/2 times maximum working pressure or 860 kPa (whichever is greater) for 4 h without loss of pressure. Test all piping systems modified under this contract by means of visual inspection of each connection.
- .2 Isolate equipment, components, not designed to withstand test pressure.

.9 Introduce system pressure carefully into new piping.

3.3 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:

- .1 Division 26 and this specification.
- .2 CSA 22.1 Canadian Electrical Code.
- .3 ANSI/NFPA 70.
- .4 ANSI C2.

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

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

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

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

.6 Install electrical equipment between 1000 mm and 2000 mm above finished floor wherever possible and adjacent to related equipment.

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

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

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

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

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

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

3.4 CONDUIT SYSTEM

.1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.

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

.3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Departmental Representative before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

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

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

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

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

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

.9 Fastenings and supports for conduits, cables, and equipment:

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

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

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

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

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

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

.15 Pull boxes:

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

.16 Install terminal blocks or strips as specified by Division 26.

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

3.5 WIRING

.1 Install multiple wiring in ducts simultaneously.

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

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

.4 Tests: use only qualified personnel. Demonstrate that:

.1 Circuits are continuous, free from shorts, unspecified grounds.

.2 Resistance to ground of all circuits is greater than 50 Megohms.

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

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

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

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

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

3.6 WIRING DEVICES AND COVER PLATES

.1 Receptacles:

.1 Install vertically in gang type outlet box when more than one receptacle is required in one location.

.2 Cover plates:

.1 Install suitable common cover plate where wiring devices are grouped.

.2 Use flush type cover plates only on flush type outlet boxes.

3.7 STARTERS AND CONTROL DEVICES

.1 Install and make power and control connections as indicated.

.2 Install correct over-current devices.

.3 Identify each wire, terminal for external connections with permanent number marking identical to diagram.

.4 Performance Verification:

.1 Operate switches and controls to verify functioning.

.2 Perform start and stop sequences of contactors and relays.

.3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

3.8 GROUNDING

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

.2 Install separate grounding conductors in conduit within building.

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

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

3.9 TESTS

.1 General:

- .1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.
- .2 Give 14 days written notice of intention to test.
- .3 Conduct in presence of Departmental Representative and authority having jurisdiction.
- .4 Conceal work only after tests satisfactorily completed.
- .5 Report results of tests to Departmental Representative in writing.
- .6 Preliminary Tests:
  - .1 Conduct as directed to verify compliance with specified requirements.
  - .2 Make needed changes, adjustments, replacements.
  - .3 Insulation resistance tests:
    - .1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.
    - .2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Departmental Representative and authority having jurisdiction.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results – Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SUMMARY

.1 Section Includes:

.1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).

1.4 DEFINITIONS

.1 BC(s) - Building Controller(s).

.2 OWS - Operator Work Station.

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

1.5 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 02 – EMCS: Submittals and Review Process.

.2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.

.3 Submit detailed Inspection Reports to Departmental Representative.

.4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:

.1 Point name and location.
.2 Device type and range.
.3 Measured value.
.4 System displayed value.
.5 Calibration detail.
.6 Indication if adjustment required.
.7 Other action taken or recommended.

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Records and Logs: in accordance with Division 01 and Section 25 05 02 – EMCS: Submittals and Review Process.

.1 Maintain records and logs of each maintenance task on site.
.2 Organize cumulative records for each major component and for entire EMCS chronologically.
.3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to Departmental Representative in accordance with Division 01. "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.6 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain EMCS for specified 12 month warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.

.2 Emergency Service Calls:

.1 Initiate service calls when EMCS is not functioning correctly.
.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
.3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
.4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.
.5 Perform work continuously until EMCS restored to reliable operating condition.

.3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on approved form and include:

.1 Serial number identifying component involved.
.2 Location, date and time call received.
.3 Nature of trouble.
.4 Names of personnel assigned.
.5 Instructions of work to be done.
.6 Amount and nature of materials used.
.7 Time and date work started.
.8 Time and date of completion.

.5 Provide system modifications in writing.

.1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

1.7 SERVICE CONTRACTS

.1 Provide in-depth technical expertise and assistance to Departmental Representative and Commissioning Agent in preparation and implementation of service contracts and in-house preventive maintenance procedures.

.2 Service Contracts to include:

.1 Annual verification of field points for operation and calibration.
.2 Four (4) visits per year.
.3 Responses to emergency calls during day, per year.
.4 Responses to emergency calls during silent hours per year.
.5 Silent hours defined as 18:00 to 07:00 h.
.6 Complete inventory of installed system.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

.1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative as described in Submittal article.

.2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:

.1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
.2 Check and Calibrate each field input/output device in accordance with Canada Labour Code - Part I and CSA Z204.
.3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.

.4 Minor inspections to include, but not limited to:

.1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
.2 Check equipment cooling fans as required.
.3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
.4 Review system performance with Departmental Representative to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:

.1 Minor inspection.
.2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.
.3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.
.4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
.5 Provide mechanical adjustments, and necessary maintenance on printers.
.6 Run system software diagnostics as required.
.7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
.8 Perform network analysis and provide report as described in Submittal article.

.6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.7 Continue system debugging and optimization.

.8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied:

.1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END

PART 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

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

1.2 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results – Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International):

.1 CSA T529-95(R2000), Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
.2 CSA T530-99(R2004), Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).

.2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements:

.1 IEEE Std 802.3™-2002, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

.3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA):

.1 TIA/EIA-568-March 2004, Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.
.2 TIA/EIA-569-A-December 2001, Commercial Building Standard for Telecommunications Pathways and Spaces.

.4 Treasury Board Information Technology Standard (TBITS):

.1 TBITS 6.9-2000, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

1.4 DEFINITIONS

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

1.5 SYSTEM DESCRIPTION

.1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529 TIA/EIA-568 and CSA T530 TIA/EIA-569-A and TBITS 6.9:

.1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.

.2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to include, but not limited to:

.1 EMCS-LAN.

.2 Modems.

.3 Network interface cards.

.4 Network management hardware and software.

.5 Network components necessary for complete network.

1.6 SYSTEM DESCRIPTION

.1 The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, XML and HTTP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.

.2 The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

.3 The system shall enable an open architecture that utilizes EIA standard 709.1, ASHRAE Standard 135-2004, BACnet functionality to assure interoperability between all system components. Native support for the ASHRAE Standard 135-2004, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.

.4 The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE Standard 135-2004, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

.5 The software tools required for network management of the ANSI / ASHRAE Standard 135-2004, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Departmental Representative. BACnet clients shall comply with the BACnet Operator Workstation (B-OWS) device profile; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP.

1.7 DESIGN REQUIREMENTS

.1 EMCS Local Area Network (EMCS-LAN):

.1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.
.2 EMCS-LAN to: BACnet.
.3 Each EMCS-LAN to be capable of supporting at least 50 devices.
.4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.
.6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access:

.1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.
.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium:

.1 Network medium: shielded twisted cable, or fibre optic cable compatible with network protocol to be used within buildings.

PART 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results for Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SUMMARY

.1 Section Includes:
  .1 Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS), including primary, secondary, portable and remote OWS's.

1.4 DEFINITIONS

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

1.5 OWS SYSTEM DESCRIPTION

.1 Consists of commercially available personal computer in current production, with sufficient memory and processor capacity to perform functions specified.

.2 Primary OWS to include:

  .1 Colour graphics printer.
  .2 Desks, furniture.

.3 Portable Laptop.

1.6 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 02 - EMCS: Submittals and Review Process.

1.7 OPERATIONS AND MAINTENANCE MATERIALS

.1 Submit operations and maintenance materials in accordance with Section 01 77 00 - Closeout Procedures.

1.8 ENVIRONMENTAL CONDITIONS

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

PART 2 PRODUCTS

2.1 OWS HARDWARE

.1 PC System to include:

- .1 Processor:
  - .1 Operating at minimum clock speed of 3.0 Gigahertz minimum, capable of supporting software necessary to perform functions specified in this section. System backplane bus (x 3200 Megahertz) to support PCI expansion boards.
- .2 Internal Clock:
  - .1 Uninterruptible Clock: accuracy of plus or minus 5 seconds/month, capable of deriving year/month/day/hour/minute/second.
  - .2 Rechargeable Batteries: to provide minimum 48 h clock operation in event of power failure.
- .3 Asynchronous interfaces for connection to listed peripheral devices including LAN and remote devices.

.2 Power supply unit to accept 120 V 60 Hz source and include line surge and low voltage protection for processor and its peripherals.

.3 Include UPS to provide 5 minutes minimum operation of PC, monitor, and communication and peripheral devices; applies to fixed (non-portable) OWSs and peripherals.

2.2 OWS PC COMPONENTS

.1 Primary OWS

- .1 CPU compatible with the following as a minimum:
  - .1 3.0 GHz microprocessor
  - .2 Operating System: Windows 10pro, 64 bit.
  - .3 Memory: Min. 8GB, 2400 MHZ, DDR4
  - .4 Hard Drive: 500GB, 7200RPM Drive SATA
  - .5 Optical Drive: 8x DVD +/- RW Optical Disk Drive

.6 Video Card: min. 2GB
.7 Ports: 4 - USB 2
1 - RJ45 Network Port
1 - DisplayPort 1.2
1 - HMDI 1.4
1 - Serial Port
.8 Network Card: 1000 Mbps minimum, plug-in or integrated.
.9 Power Supply: 425W
.10 Colour monitor: 24". Flat panel display, resolution 1920 x 1080 resolution, 5 ms response time.
.11 Enhanced Keyboard.
.12 Optical Mouse.

2.3 PRINTERS

.1 Report printer: Include following features:

.1 Laser printer.
.2 Accommodate 8.5 X 14" and 8.5 X 11" paper.
.3 Minimum 1200 by 1200 dpi resolution.
.4 Minimum 16 MB RAM, expandable to minimum 72 MB RAM.
.5 Minimum 18 pages per minute print speed.

.2 Colour graphics printer include following features:

.1 Ink-jet technology capable of printing high quality colour images at speed of [4] pages per minute.
.2 Black cartridge to be separate cartridge from red green blue cartridge.
.3 Minimum colour resolution 2400 by 1200 dpi.
.4 Minimum black and white resolution 1200 by 1200 dpi.
.5 Minimum 8 MB RAM.

.3 Include one box of 8.5 X 11" and one box of 8.5 X 14" paper.

2.4 OPERATING SYSTEM (OS) OR EXECUTIVE

.1 OS to support complement of hardware terminals and software programs specified.

.2 OS to be true multitasking operating environment:

.1 MS DOS or PC DOS based software platforms not permitted.

.3 OWS software to operate in "Windows" based operating environment:

.1 Windows 10 based system.

2.5 OWS CONTROL SOFTWARE

.1 OWS is not to form part of real-time control functions either directly or indirectly or as part of communication link. Real-time control functions to reside in MCUs, LCUs, and TCUs with peer to peer communication occurring at MCU to MCU device level.

.2 Time Synchronization Module

- .1 System to provide Time Synchronization of real-time clocks in controllers.
- .2 System to perform this feature on regular scheduled basis and on operator request.

.3 User Display Interface Module

- .1 OWS software to support "Point Names" as defined in Section 25 05 02 - EMCS: General Requirements.
- .2 Upon operator's request in either text, graphic or table mode, system to present condition of single point, system, area, or connected points on system to OWS.
  - .1 Display analog values digitally to one (1) place of decimal with negative sign as required.
  - .2 Update displayed analog values and status when new values received.
  - .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
  - .4 For systems supporting COSV, refresh rate of screen data not to exceed 5 seconds from time of field change and system is to execute supervisory background scan every 20 seconds to verify point data value.
  - .5 For other systems refresh rate not to exceed 5 seconds for points displayed.
  - .6 Initial display of new system graphic display (with up to 30 active points), including presentation of associated dynamic data not to exceed 8 seconds.

.4 General Event Log Module

- .1 To record system activities occurring at OWS or elsewhere in system including:
  - .1 Operator Log-in from user interface device.
  - .2 Communication messages: errors, failures and recovery.
  - .3 Event notifications and alarms by category.
  - .4 Record of operator initiated commands.

.5 General Event Log

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

.6 Operator Control Software Module

- .1 To support entry of information into system from keyboard and mouse, disk, or from another network device; display of information to user; dynamic displays, textual displays, and graphic displays to display logging and trending of system information and following tasks:
  - .1 Automatic logging of digital alarms and change of status messages.
  - .2 Automatic logging of alarms.
  - .3 System changes: alarm limits, set-points, alarm lockouts.
  - .4 Display specific point values, states as selected.
  - .5 Provide reports as requested and on scheduled basis when required.
  - .6 Display graphics as requested, and on alarm receptions (user's option).
  - .7 Display list of points within system.
  - .8 Display list of systems within building.
  - .9 Direct output of information to selected peripheral device.

.10 On-line changes:
- .1 Alarm limits.
- .2 Setpoints.
- .3 Deadbands.
- .4 Control and change of state changes.
- .5 Time, day, month, year.
- .6 Control loop configuration changes for controller-based CDLs.
- .7 Control loop tuning changes.
- .8 Schedule changes.
- .9 Changes, additions, or deletions, of points, graphics, for installed and future systems.

.11 According to assigned user privileges (password definition) following functions are to be supported:
- .1 Permit operator to terminate automatic (logic based) control and set value of field point to operator selected value. These values or settings to remain in effect until returned to automatic (logic based) control by Operator.
- .2 Requests for status, analog values, graphic displays, logs and controls to be through user interface screens.

.12 Software and tools utilized to generate, modify and configure building controllers to be installed and operational on the OWS.

.7 Host Module for Off Site OWS's

.1 Operators at OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.

.2 Operator to be able to access remote buildings by selection of facility by its logical name. Module to maintain user-definable cross-reference of buildings and associated telephone numbers without manual dialing.

.3 Local OWS may serve as host for remotely connecting OWSs, remote controllers or networks. Alarms and data file transfers handled transactions must not interfere with local LAN activity.

.8 Message Handling Module - and Error Messages

.1 To provide message handling for following conditions:
- .1 Message and alarm buffering to prevent loss of information.
- .2 Error detection correction and retransmission to guarantee data integrity.
- .3 Informative messages to operator for data error occurrences, errors in keyboard entry, failure of equipment to respond to requests or commands and failure of communications between EMCS devices.
- .4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event of faulty designated OWS.

.9 Access Control Module

.1 Minimum 5 levels of password access protection to limit control, display, or data base manipulation capabilities. Following is preferred format of progression of password levels:
- .1 Guest: no password data access and display only.
- .2 Operator Level: full operational commands including automatic override.
- .3 Technician: data base modifications.
- .4 Programmer: data base generation.

.5 Highest Level: system administration - password assignment addition, modification.

.2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = 3 minutes.

.10 Trend Data Module

.1 Includes historical data collection utility, trend data utility, control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate:

.1 Historical Data Collection Utility:

.1 Collect concurrently operator selected real or calculated point values at operator selectable rate 30-480 minutes.

.2 Samples to include for each time interval (time-stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point.

.3 Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator.

.4 Temporary storage to have at least 6 month capacity.

.2 Trend Data Utility:

.1 Continuously collect point object data variables for variables from building controllers as selected by operator, including at minimum; present value of following point object types - DI, DO, AI, AO set points value, calculated values.

.2 Trend data utility to have capacity to trend concurrently points at operator-selectable rate of 05 seconds to 3600 seconds, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on minimum 96h basis in temporary storage until removed from trend data list by operator.

.3 Option to archive data before overwriting to be available.

.3 Control Loop Plot Utility:

.1 For AO Points provide for concurrent plotting of Measured value input - present value, present value of output, and AO setpoint.

.2 Operator selectable sampling interval to be selectable between 1 second to 20 seconds.

.3 Plotting utility to scroll to left as plot reaches right side of display window. Systems not supporting control loop plot as separate function must provide predefined groups of values.

.4 Each group to include values for one control loop display.

.4 Trend Data Module:

.1 To include display of historical or trend data to OWS screen in X Y plot presentation.

.2 Plot utility to display minimum of 6 historical points or 6 trend points concurrently or 1 Control Loop Plot.

.3 For display output of real time trend data, display to automatically index to left when window becomes full.

.4 Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.

.2 Provide Separate Reports for each trend utility.

.3 Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials.

.4 Implement reports using report module.

.5 Ensure trend data is exportable to third party spreadsheet or database applications for PCs.

.11 Report Module:

.1 Reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level.

.1 Reports to include time, day, month, year, report title, operator's initials.

.2 Software to provide capability to:

.1 Generate and format reports for graphical and numerical display from real time and stored data.

.2 Print and store reports as selected by operator.

.3 Select and assign points used in such reports.

.4 Sort output by area, system, as minimum.

.2 Periodic/Automatic Report:

.1 Generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device.

.2 Software to permit modifying periodic/automatic reporting profile at any time.

.3 Reports to include:

.1 Power demand and duty cycle summary: see application program for same.

.2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.

.3 Run Time Summary:

.1 Summary of accumulated running time of selected equipment.

.2 Include point name, run time to date, alarm limit setting.

.3 Run time to accumulate until reset individually by operator.

.4 Summary of Run Time Alarms:

.1 Include point name, run time to date, alarm limit.

.5 Summary of Start/Stop Schedules:

.1 Include start/stop times and days, point name.

.6 Motor status summary.

.4 Report Types:

.1 Dynamic Reports:

.1 System to printout or display of point object data value requested by operator.

.2 System to indicate status at time of request, when displayed, updated at operator selected time interval.

.3 Provide option for operator selection of report type, by point name, and/or output device.

.4 Ensure reports are available for following point value combinations:

.1 Points in accessible from this OWS (total connected for this location), multiple "areas".

.2 Area (points and systems in area).

.3 Area system (points in system).

.4 System (points by system type).

.5 System point (points by system and point object type).

.6 Area point (points by system and point object type).
.7 Point (points by point object type).

.2 Summary Reports:
.1 Printout or display of point objet data value selected by operator.
.2 Report header to indicate status at time of request. Ensure reports are available on same basis as dynamic reports.
.3 Provide option as to report type, point name, output device.
.4 Include preformatted reports as listed in Event/Alarm Module.

.12 Graphics Display Module:

.1 Graphics software utility to permit user to create, modify, delete, file, and recall graphics required by Division 25:
.1 Provide capacity for 100% expansion of system graphics. Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlayed with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.
.2 Display Specific System Graphics: provide for manual and/or automatic activation (on occurrence of an alarm). Include capability to call up and cancel display of graphic picture.
.3 Library of pre-engineered screens and symbols depicting standard air handling components (fans, coils, filters, dampers, VAV), complete mechanical system components (chillers, boilers, pumps), electrical symbols.
.4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:
.1 Modify portion of graphic picture/schematic background.
.2 Delete graphic picture.
.3 Call up and cancel display of graphic picture.
.4 Define symbols.
.5 Position and size symbols.
.6 Define background screens.
.7 Define connecting lines, curves.
.8 Locate, orient, size descriptive text.
.9 Define, display colours of elements.
.10 Establish co-relation between symbols or text and associated system points or other graphic displays.

.2 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.

.3 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.

.4 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress. If interface is unable to display several different types of display at same time, provide at minimum 2 OWS's.

.5 Utilize graphics package to generate system schematic diagrams as required in Section 25 90 01- EMCS: Site Requirements, Applications and System Sequences of Operation, and as directed by Departmental Representative. In addition provide graphics for schematic depicted on mechanical plan flow diagrams, point lists and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location. Departmental Representative to provide CAD floor layouts.

.6 Provide complete directory of system graphics, including other pertinent system information. Utilize mouse or pointing device to "point and click@ to activate selected graphic.

.7 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS. Provide access to sequence of operation graphic by link button on each system graphic. Provide translation of sequence of operation, a concise explanation of systems operation, from control descriptive logic into plain English.

.13 Event/Alarm Module: displays in window alarms as received and stored in General Event log.

.1 Classify alarms as "critical", "cautionary", "maintenance". Alarms and alarm classifications to be designated by personnel requiring password level.

.2 Presentation of alarms to include features identified under applicable report definitions of Report Module paragraph.

.3 Alarm reports:

.1 Summary of points in critical, cautionary or maintenance alarm. Include at least point name, alarm type, current value, limit exceeded.

.2 Analog alarm limit summary: include point name, alarm limits, deviation limits.

.3 Summary of alarm messages: include associated point name, alarm description.

.4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.

.5 EMCS to notify operator of occurrence of alarms originating at field device within following time periods of detection:

.1 Critical - 5 seconds.

.2 Cautionary - 10 seconds.

.3 Maintenance – 10 seconds.

.6 Display alarm messages in English and/or French.

.7 Primary alarm message to include as minimum: point identifier, alarm classification, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide secondary messages giving further information (telephone lists, maintenance functions) on per point basis.

.8 System reaction to alarms: provide alarm annunciation by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device.

Acknowledgment of alarm to be time, date and operator stamped and stored in General Event Log. Steady state visual indicator to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of alarm not to impede notification of subsequent alarms or function of Controller's/CDL. Do not allow random occurrence of alarms to cause loss of alarm or over-burden system. Do not allow acknowledgment of one alarm as acknowledgement of other alarms.

.9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:

.1 Controller not responding - where possible delineate between controller and communication line failure.

.2 Controller responding - return to normal.

.3 Controller communications bad - high error rate or loss of communication.

.4 Controller communications normal - return to normal.

.10 Digital alarm status to be interrogated every 2 seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.

.14 Archiving and Restoration Module

.1 Primary OWS to include services to store back-up copies of controller databases. Perform complete backup of OWS software and data files at time of system installation and at time of final acceptance. Provide backup copies before and after Controller's revisions or major modifications.

.2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of need to download copy data base to restore proper operation.

.3 Ensure data base back-up and downloading occurs over LAN without specialized operator technical knowledge. Provide operator with ability to manually download entire controller data base, or parts thereof as required.

.15 CDL Generator and Modifier Module

.1 CDL Generator module to permit generation and modification of CDLs.

.2 Provide standard reference modules for text based systems module that will permit modification to suit site specific applications. Module to include cut, paste, search and compare utilities to permit easy CDL modification and verification.

.3 Provide full library of symbols used by manufacturer for system product installed accessible to operators for systems using graphical environment for creation of CDLs Module to include graphic tools required to generate and create new object code for downloading to building controllers.

.4 Module to permit testing of code before downloading to building controllers.

2.6 ADDITIONAL UTILITY SOFTWARE

.1 Supply and install on primary OWS, following CAD software products by Autodesk Inc. and include:

.1 AutoCAD LT latest version.

.2 Include special drivers, fonts, to ensure complete and proper functioning of software packages specified. Deliver system complete with full set of User Manuals.

.3 Enter soft copy submissions, including "Record" drawings specified in Division 01 and Section 25 05 02 – EMCS: Submittals and Review Process in OWS.

.4 Enter soft copy of Architectural, Electrical, Mechanical systems plans and "Record" drawings in OWS. Plans and drawings to be provided by Department Representative.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

.1 Provide necessary power as required from local 120 V emergency power branch circuit panels for OWS's and peripheral equipment:

.1 Install tamper locks on breakers of circuit panels.
.2 Refer to UPS requirements stated under OWS Hardware in PART 2.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results – Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SUMMARY

.1 Section Includes
  .1 Materials and installation for building automation controllers including:
  .2 Master Control Unit (MCU).
  .3 Local Control Unit (LCU).
  .4 Equipment Control Unit (ECU).
  .5 Terminal Control Unit (TCU).

1.4 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE)
  .1 ASHRAE 2003, Applications Handbook, SI Edition.
  .2 Canadian Standards Association (CSA International):
  .3 C22.2 No.205-M1983(R1999), Signal Equipment.
  .4 Institute of Electrical and Electronics Engineers (IEEE):
  .5 IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

1.5 DEFINITIONS

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

1.6 SYSTEM ARCHITECTURE

.1 General

.1 The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of SDCU's, LCU's, ECU's or TCU's Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.

.2 An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.

.3 The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.

.4 For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows based computer. The Reports Server can be installed on the same computer as the Enterprise Server.

.5 The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP.

.2 BACnet MS/TP and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported. A sub-network of SDCUs using the BACnet MS/TP, protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

.3 TCP/IP Level

.1 The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

.4 Fieldbus Level with Standalone Digital Control Units (SDCUs)

.1 The fieldbus layer shall support all of the following types of SDCUs:

.1 BACnet SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2004. The NSCs shall be capable of at least two BACnet MS/TP field buses for a total capability of 254 SDCUs per NSC.

.5 Standard Network Support

.1 All NSCs, Workstation(s) and Servers shall be capable of residing directly on the Departmental Representative's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the Departmental Representative may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the Departmental Representative's Information Systems Department as all devices utilize standard TCP/IP components.

.6 Support For Open Systems Protocols

.1 All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP.

1.7 SYSTEM DESCRIPTION

.1 General

.1 Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications:

.1 Provide sufficient controllers to meet intents and requirements of this section.

.2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.

.2 Controllers

.1 Stand-alone intelligent Control Units:

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

.3 Capable of interfacing with operator interface device.

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

.5 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

.3 Interface to include provisions for interconnection with remote modem:

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

1.8 DESIGN REQUIREMENTS

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

.2 Total spare capacity for MCUs and LCUs: at least 25 % of each point type distributed throughout the MCUs and LCUs. Capabilities of adding spare points shall be built into each MCUs and LCUs to avoid having to add additional MCUs and LCUs in future for minor additions to EMCS points.

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

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

.5 AO Interface Equipment:
- .1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.
- .2 Provide for following output signal types and ranges:
  - .1 4 - 20 mA.
  - .2 0 - 10 V DC.

.3 Meet IEEE C37.90.1 surge withstand capability.

.6 DI Interface Equipment
- .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
- .2 Meet IEEE C37.90.1 surge withstand capability.
- .3 Accept pulsed inputs up to 2 kHz.

.7 DO Interface Equipment
- .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.
- .2 Switch up to 5 amps at 220 V AC using optional interface relay.

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

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

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

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

1.9 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Submit product data sheets for each product item proposed for this project.

1.10 MAINTENANCE PROCEDURES

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 EMCS: Project Record Documents in accordance with Section 01 77 00 - Closeout Procedures.

PART 2 PRODUCTS

2.1 MASTER CONTROL UNIT (MCU)

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

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

.3 MCU Local I/O Capacity
  .1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.
  .2 LCUs may be added to support system functions.

.4 Central Processing Unit (CPU)
  .1 Processor to consist of minimum 16 bit microprocessor capable of supporting software to meet specified requirements.
  .2 CPU idle time to be more than 30% when system configured to maximum input and output with worst case program use.
  .3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
    .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
    .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.
  .4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.

.5 Local Operator Terminal (OT):
  .1 Provide OT for each MCU unless otherwise specified in Section 25 90 01 - EMCS: Site Requirements, Application and System Sequences of Operation.
  .2 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Departmental Representative.
  .3 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.
  .4 Display simultaneously minimum of 16 point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English and French.
  .5 Functions to include, but not be limited to, following:
    .1 Start and stop points.
    .2 Modify setpoints.
    .3 Modify PID loop parameters.
    .4 Override PID control.
    .5 Change time/date.
    .6 Add/modify/start/stop weekly scheduling.
    .7 Add/modify setpoint weekly scheduling.
    .8 Enter temporary override schedules.
    .9 Define holiday schedules.
    .10 View analog limits.
    .11 Enter/modify analog warning limits.

.12 Enter/modify analog alarm limits.
.12 Enter/modify analog differentials.
.14 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.

.6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.

.7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.

.8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.2 LOCAL CONTROL UNIT (LCU)

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

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

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

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

2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

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

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

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

2.4 SOFTWARE

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

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

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

.4 Operator Terminal Interface
- .1 Operating and control functions include:
  - .1 Multi-level password access protection to allow user/manager to limit workstation control.
  - .2 Alarm management: processing and messages.
  - .3 Operator commands.
  - .4 Reports.
  - .5 Displays.
  - .6 Point identification.
- .2 Pseudo or Calculated Points:
  - .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.

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

.3 Control Description Logic (CDL):

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

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

.3 Perform changes to CDL on-line.

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

.5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.

.6 MCU to be able to perform following pre-tested control algorithms:

.1 Two position control.

.2 Proportional Integral and Derivative (PID) control.

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

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

.9 Power Fail Restart:

.1 Upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary.

.2 Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

.5 Event and Alarm management:

.1 Use management by exception concept for Alarm Reporting.

.2 This is system wide requirement.

.3 This approach will insure that only principal alarms are reported to OWS.

.4 Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported.

.5 Such event sequence to be identified in I/O Summary and sequence of operation.

.6 Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported.

.7 Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

.6 Energy Management Programs:

.1 Include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature:

.1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:

.1 Time of day scheduling.
.2 Calendar based scheduling.
.3 Holiday scheduling.
.4 Temporary schedule overrides.
.5 Optimal start stop.
.6 Night setback control.
.7 Enthalpy (economizer) switchover.
.8 Peak demand limiting.
.9 Temperature compensated load rolling.
.10 Fan speed/flow rate control.
.11 Cold deck reset.
.12 Hot deck reset.
.13 Hot water reset.
.14 Chilled water reset.
.15 Condenser water reset.
.16 Boiler/Heat Pump Plant sequencing.
.17 Night purge.

.2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.

.7 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month:

.1 MCUs to accumulate and store automatically run-time for binary input and output points.

.2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.

.3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.

.4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWH, litres, tonnes, etc.).

.6 Store event totalization records with minimum of 9,999,999 events before reset.

.7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.5 LEVELS OF ADDRESS

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

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

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

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

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

2.6 POINT NAME SUPPORT

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

PART 3 EXECUTION

3.1 LOCATION

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

3.2 INSTALLATION

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

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

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

END

PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results – Mechanical.
.5 Section 23 33 15 - Dampers - Operating.
.6 Section 25 05 01 – EMCS: General Requirements.
.7 Section 25 05 02 - EMCS: Submittals and Review Process.
.8 Section 25 90 01 - EMCS: Site Requirements, Application and System Sequence of Operation.
.9 Section 26 05 00 - Common Work Results for Electrical.
.10 Section 26 27 26 - Wiring Devices.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SUMMARY

.1 Section Includes

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

1.4 REFERENCES

.1 American National Standards Institute (ANSI):

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

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

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

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

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

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

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

.5 Canadian Standards Association (CSA International):

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

1.5 DEFINITIONS

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

1.6 SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 01 33 00 – Submittals and Section 25 05 02 – EMCS: Submittals and Review Process.

.2 Pre-Installation Tests:

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

.3 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions for specified equipment and devices.

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°C - 32°C with 10- 90% RH (non-condensing) unless otherwise specified.

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

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

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

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

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

.9 Range: including temperature, humidity and pressure as indicated in Section 25 90 01 - EMCS: Site Requirements, Application and System Sequences of Operation.

.10 Sensors located in public areas shall be stainless steel plate or vandal proof. Sensors located in offices to be complete with temperature setpoint adjustment current temperature indication and pushbutton override.

2.2 TEMPERATURE SENSORS

.1 General

.1 Except for room sensors to be resistance or thermocouple type to following requirements:

.1 Thermocouples: limit to temperature range of 200°C and over.

.2 RTD's: 100 or 1000 ohm at 0°C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires.

.3 Coefficient of Resistivity: 0.00385 ohms/ohm°C.

.4 Sensing Element: hermetically sealed.

.5 Stem and Tip Construction: copper or Type 304 stainless steel.

.6 Time Constant Response: less than 3 seconds to temperature change of 10 °C.

.7 Immersion Wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 - 150 mm as indicated.

.2 Room Temperature Sensors and Display Wall Modules

.1 Temperature sensing and display wall module:

.1 LCD display to show space temperature and temperature setpoint.

.2 Buttons for occupant selection of temperature setpoint and occupied/ unoccupied mode.

.3 Jack connection for plugging in laptop personal computer 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°.

.5 Accuracy 0.2°C over range of 0°C to 70° C.

.6 Stability 0.02°C drift per year.

.7 Separate mounting base for ease of installation.

.3 Room Temperature Sensors

.1 Wall mounting, in slotted type covers having brushed aluminum brushed stainless steel finish, with guard as indicated.

.2 Element 10-50 mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2°C.

.4 Duct Temperature Sensors

.1 General Purpose Duct Type: suitable for insertion into ducts at various orientations, insertion length 460 mm or as indicated.

.2 Averaging Duct Type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.

.5 Outdoor Air Temperature Sensors

.1 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 NEMA 4 enclosure.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements

.1 Input Circuit: to accept 3-lead, 100 or 1000 ohm at 0°C, platinum resistance detector type sensors.

.2 Power Supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01° C per volt change.

.3 Output Signal: 4 - 20 mA into 500 ohm maximum load.

.4 Input and output short circuit and open circuit protection.

.5 Output Variation: less than 0.2% of full scale for supply voltage variation of plus or minus 10%.

.6 Combined Non-Linearity, Repeatability, Hysteresis Effects: not to exceed plus or minus 0.5% of full scale output.

.7 Maximum Current to 100 or 1000 ohm RTD Sensor: not to exceed 25 mA.

.8 Integral zero and span adjustments.

.9 Temperature Effects: not to exceed 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.

2.4 HUMIDITY TRANSMITTERS

.1 Room and Duct Requirements

.1 Range: 5 - 90 % RH minimum.

.2 Operating Temperature Range: 0 – 60°C.

.3 Absolute Accuracy:

.1 Duct Sensors: plus or minus 3%.

.2 Room Sensors: plus or minus 2%.

.4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.

.5 Maximum Sensor Non-Linearity: plus or minus 2% RH with defined curves.

.6 Room Sensors: locate in air stream near RA grille wall mounted as indicated.

.7 Duct Mounted Sensors: locate so that sensing element is in air flow in duct.

.2 Outdoor Humidity Requirements

.1 Range: 0 - 100% RH minimum.
.2 Operating Temperature Range: -40/ -50°C.
.3 Absolute Accuracy: plus or minus 2%.
.4 Temperature Coefficient: plus or minus 0.03% RH/ °C over 0 to 50°C.
.5 Must be unaffected by condensation or 100% saturation.
.6 No routine maintenance or calibration is required.

2.5 HUMIDITY SENSORS

.1 Requirements

.1 Input signal: from RH sensor.
.2 Output signal: 4 - 20 mA onto 500 ohm maximum load.
.3 Input and output short circuit and open circuit protection.
.4 Output variations: not to exceed 0.2% of full scale output for supply voltage variations of plus or minus 10%.
.5 Output linearity error: plus or minus 1.0% maximum of full scale output.
.6 Integral zero and span adjustment.
.7 Temperature effect: plus or minus 1.0% full scale/ 6 months.
.8 Long term output drift: not to exceed 0.25% of full scale output/ 6 months.

2.6 PRESSURE TRANSDUCER

.1 Requirements

.1 Combined sensor and transmitter measuring pressure:
.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 Temperature Effects: not to exceed plus or minus 1.5% full scale/ 50°C.
.6 Over-pressure input protection to at least twice rated input pressure.
.7 Output short circuit and open circuit protection.
.8 Accuracy: plus or minus 1% of Full Scale.

2.7 DIFFERENTIAL PRESSURE TRANSMITTERS

.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 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.8 STATIC PRESSURE SENSORS

.1 Requirements

.1 Multipoint element with self-averaging manifold.
.2 Maximum Pressure Loss: 160 Pa at 10 m/s; (air stream manifold).
.3 Accuracy: plus or minus 1% of actual duct static pressure.

2.9 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 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.10 VELOCITY PRESSURE SENSORS

.1 Requirements

.1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.
.2 Suitable for installation at fan inlet without flow straightener as required.
.3 Maximum Pressure Loss: 37 Pa at 1000 m/s.
.4 Accuracy: plus or minus 1% of actual duct velocity.

2.11 VELOCITY PRESSURE TRANSMITTERS

.1 Requirements

.1 Output Signal: 4 - 20 mA linear into 500 ohm maximum load.
.2 Calibrated Span: not to exceed 125% of duct velocity pressure at maximum flow.
.3 Accuracy: 0.4% of span.
.4 Repeatability: within 0.1 % of output.
.5 Linearity: within 0.5% of span.
.6 Deadband or Hysteresis: 0.1% of span.
.7 External exposed zero and span adjustment.
.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.12 LIQUID FLOW SENSORS

.1 Requirements
- .1 Pressure Rating: as specified in I/O summaries.
- .2 Temperature Rating: as specified in I/O summaries.
- .3 Repeatability: plus or minus 0.2%.
- .4 Accuracy and Linearity: plus or minus 1.0%.
- .5 Flow Rangability: at least 10:1.
- .6 Body material.
- .7 Ends:
  - .1 50mm and Under: screwed.
  - .2 50mm and Over: flanged.

2.13 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements

- .1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.
- .2 Adjustable setpoint and differential.
- .3 Switch: snap action type, rated at 120V, 15 amps AC or 24 V DC.
- .4 Switch Assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.
- .5 Accuracy: within 2% repetitive switching.
- .6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.
- .7 Switches on steam and high temperature hot water service: provide pigtail syphon.

2.14 TEMPERATURE SWITCHES

.1 Requirements

- .1 Operate automatically; reset automatically, except as follows:
  - .1 Low Temperature Detection: MANUAL RESET.
  - .2 High Temperature Detection: MANUAL RESET.
- .2 Adjustable setpoint and differential.
- .3 Accuracy: plus or minus 1°C.
- .4 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and EMCS connections.
- .5 Type as follows:
  - .1 Room: for wall mounting on standard electrical box with without protective guard as indicated.
  - .2 Duct and General Purpose: insertion length = 460 mm.
  - .3 Thermowell: stainless steel, with compression fitting for 19 mm thermowell; immersion length - 100 mm.
  - .4 Low temperature detection: continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 30 mm length.
  - .5 Strap-on: with helical screw stainless steel clamp.

2.15 SOLID STATE RELAYS

.1 General

.1 Relays to be socket or rail mounted.
.2 Relays to have LED Indicator
.3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
.4 Operating temperature range to be -20°C to 70°C.
.5 Relays to be CSA Certified.
.6 Input/output Isolation Voltage to be 4000 VAC at 25°C for 1 second maximum duration.
.7 Operational frequency range, 45 to 65 HZ.

.2 Input

.1 Control Voltage: 3 to 32 VDC.
.2 Drop Out Voltage: 1.2 VDC.
.3 Maximum input current to match AO (Analog Output) board.

.3 Output

.1 AC or DC Output Model to suit application.

2.16 CURRENT TRANSDUCERS

.1 Requirements

.1 Purpose: combined sensor/transducer, to 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 0-20 volts DC.
.2 Frequency insensitive from 10 - 80 hz.
.3 Accuracy to 0.5% full scale.
.4 Zero and span adjustments. Field adjustable range to suit motor applications.
.5 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.17 CURRENT SENSING RELAYS

.1 Requirements

.1 Suitable to detect belt loss or motor failure.
.2 Trip point adjustment, output status LED.
.3 Split core for easy mounting.
.4 Induced sensor power.
.5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.
.6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
.7 Adjustable latch level.
.8 Coordinate with Division 26, so current sensor relay’s required in motor starter come as a CSA certified assembly.

2.18 CONTROL DAMPERS

.1 Construction

.1 Blades: 152 mm wide, 1219 mm long, maximum.
.2 Modular maximum size: 1219 mm wide x 1219 mm high.
.3 Three or more sections to be operated by jack shafts.

.2 Materials

.1 Frame: 2.03 mm minimum thickness extruded aluminum. For outdoor air and exhaust air applications, frames to be insulated.
.2 Blades: extruded aluminum. For outdoor air/exhaust air applications, blades to be internally insulated.
.3 Bearings: maintenance free, synthetic type of material.
.4 Linkage and shafts: aluminum, zinc and nickel plated steel.
.5 Seals: synthetic type, mechanically locked into blade edges.
.6 Frame Seals: synthetic type, mechanically locked into frame sides.

.3 Performance

.1 Minimum damper leakage meet or exceed AMCA Standard 500-D ratings:
.1 Size/Capacity: refer to damper schedule
.2 25 L/s/m^2 maximum allowable leakage against 1000 Pa static pressure for outdoor air and exhaust air applications.
.3 Temperature range: minus 40°C to plus 100°C.

.4 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.

.5 Jack Shafts

.1 25 mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.
.2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.
.3 Install using manufacturers installation guidelines.
.4 Use same manufacturer as damper sections.

2.19 ELECTRONIC CONTROL DAMPER ACTUATORS

.1 Requirements

.1 Direct mount proportional type as indicated.
.2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
.3 All dampers to have end – switch indication wired to EMCS for positive position indication regardless of whether the requirement for such is included in Sequence of operation.
.4 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
.5 Power requirements: 5 VA maximum at 24 V AC.
.6 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
.7 For VAV box applications floating control type actuators may be used.

.8 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

2.20 CONTROL VALVES

.1 Body - Globe Style, Characterized Ball

.1 Flow Characteristic: linear, equal percentage, quick opening.
.2 Flow Factor (KV) as Indicated on Control Valve Schedule: CV in imperial units.
.3 Normally open, Normally closed, as indicated.
.4 Two or three port, as indicated.
.5 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
.6 Packing easily replaceable.
.7 Stem, stainless steel.
.8 Plug and seat, stainless steel.
.9 Disc, replaceable, material to suit application.
.10 50 mm and under:
.1 Screwed National Pipe Thread (NPT) tapered female connections.
.2 Valves to ANSI Class 250, valves to bear ANSI mark.
.3 Rangeability 50: 1 minimum.
.11 63 mm and larger:
.1 Flanged connections.
.2 Valves to ANSI Class 150 or 250 as indicated, valves to bear ANSI mark.
.3 Rangeability 100: 1 minimum.

.2 Butterfly Valves 50 mm and Larger

.1 Body: for chilled water ANSI Class 150 cast iron lugged body and wafer body installed in locations as indicated. For steam and heating water ANSI Class 150 carbon steel lugged body and wafer body.
.2 End connections to suit flanges that are ANSI Class 150.
.3 Extended stem neck to provide adequate clearance for flanges and insulation.
.4 Pressure Limit: bubble tight sealing to 170 kilopascals.
.5 Disc/Vane: 316 stainless steel, aluminum bronze to ASTM B148.
.6 Seat: for service on chilled water PTFE (polytetrafluoroethylene), EPDM (ethylene propylene diene monomer). For service on steam and heating water PTFE, RTFE (reinforced PTFE).
.7 Stem: 316 stainless steel.

.8 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
.9 Flow characteristic linear.
.10 Maximum flow requirement as indicated on control valve schedule.
.11 Maximum pressure drop as indicated on control valve schedule: pressure drop not to exceed one half of inlet pressure.
.12 Normally open Normally closed, as indicated.
.13 Valves are to be provided complete with mounting plate for installation of actuators.

2.21 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements

.1 Construction: steel, cast iron, aluminum.
.2 Control Signal: 0-10V DC or 4-20 mA DC.

.3 Positioning Time - to Suit Application: 90 sec maximum.
.4 Fail to normal position as indicated.
.5 Scale or dial indication of actual control valve position.
.6 Minimum Shut-Off Pressure: Refer to maximum head on pump schedule and obtain shop drawings of all system pumps to determine shut off head. Select valves to close against pump shut off head.
.7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.
.8 Minimum shut-off pressure: refer to control valve schedule.

2.22 PANELS

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

.2 Multiple panels as required indicated 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.

2.23 WIRING

.1 In accordance with Division 26.

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

.3 Wiring must be continuous without joints.

.4 Sizes:

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

2.24 GAS SENSORS / DETECTORS

.1 Provide the following sensors/ detectors where indicated:

.1 CO – Carbon monoxide gas detection sensor.
.2 Cl - Chlorine gas detection sensor.
.3 R- Refrigeration gas detection sensor.
.4 NOX – Nitrous oxide gas detection sensor.

.2 Provide within the field termination schedules and/or control diagrams. Detection sensors shall meet, at a minimum, the following requirements:

.1 Setup to be fully microprocessor based via plug and play LCD.
.2 4-20 mA, 0-10 or 0-5V DC output compatible with BMS proportional to concentration of gas.

.3 Power supply to be 20-30V AC/DC @ 80mA maximum for 24V AC and 36 mA average @ 24V DC.
.4 No Maintenance or period sensor replacement needed. The sensor shall have a five (5) year calibration interval, utilizing the Automatic Calibration Logic Program (ACLP).
.5 Standard accuracy to be 3% of reading or 75 ppm, whichever is greater.
.6 Operating temperature of 0°C to 50°C (32°F to 122°F).

2.25 FLOW METERS (DOMESTIC WATER)

.1 Requirements:

.1 Pressure rating: 1.5mPa
.2 Temperature rating: -1 °C to 60°C.
.3 Repeatability: plus or minus 0.5%.
.4 Accuracy and linearity: plus or minus 1.5%.
.5 Flow rangability: at least 300:1".
.6 Pressure drop: 0 (electromagnetic meter).
.7 Body material: as required for medium.
.8 Ends: flanged
.9 Output Signal – 4-20 MA linear.

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

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

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

.6 Electrical

.1 Complete installation in accordance with Section 26 50 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. 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.

.7 Fan Powered Terminal Units

.1 Supply, install and adjust as required.

.1 Air probe, actuator and associated VAV controls.

.2 Tubing from air probe to DP sensor as well as installation and adjustment of air flow sensors and actuators.

.3 Co-ordinate air flow adjustments with balancing trade.

3.2 TEMPERATURE AND HUMIDITY SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

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

.3 Outdoor Installation

.1 Protect from solar radiation and wind effects by non-corroding shields.

.2 Install in NEMA 4 enclosures.

.4 Duct installations

.1 Do not mount in dead air space.

.2 Locate within sensor vibration and velocity limits.

.3 Securely mount extended surface sensor used to sense average temperature.

.4 Thermally isolate elements from brackets and supports to respond to air temperature only.

.5 Support sensor element separately from coils, filter racks.

.5 Averaging Duct Type Temperature Sensors:

.1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork.

.2 Each additional horizontal run to be no more than 300 mm from one above it.

.3 Continue until complete cross sectional area of ductwork is covered.

.4 Use multiple sensors where single sensor does not meet required coverage.

.5 Wire multiple sensors in series for low temperature protection applications.

.6 Wire multiple sensors separately for temperature measurement.

.7 Use software averaging algorithm to derive overall average for control purposes.

.6 Thermowells

.1 Install for Piping Installations:

.1 Locate well in elbow where pipe diameter is less than well insertion length.

.2 Thermowell to restrict flow by less than 30%.

.3 Use thermal conducting paste inside wells.

3.3 PANELS

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

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

.3 Identify wiring and conduit clearly.

3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

.1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows:

.1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

.2 Install pressure gauge on output of auxiliary cabinet pneumatic devices.

3.5 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance.

.2 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 REFERENCES

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results - Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.
.6 Section 25 90 01 – EMCS: Site Requirements, Application and System Sequence of Operation.

1.2 INTENT AND OVERVIEW

.1 M&V is a program undertaken by a building Departmental Representative in order to track a building's performance overtime.

.2 The actual and predicted building performance will be compared. Discrepancies will be studied and appropriate corrective actions will be recommended in order to enable the Departmental Representative to maximize the energy performance of the facility. Recommendations for corrective action by this division shall be reviewed by the Departmental Representative who will issue any instruction should they deem that the issue is a deficiency.

.3 This document and all referenced Appendices form part of Division 25 – Integrated Automation.

.4 The Energy Monitoring and Control System, hereafter referred to as the EMCS, collects data at various points, sampled at appropriate rates, as specified below.

.5 All sampled data is stored on the EMCS server.

.6 This data is to be available to the Departmental Representative for download and delivery through a virtual private network (VPN), remote desktop connection, file transfer protocol (FTP) or other previously and mutually agreed-upon electronic means.

PART 2 PRODUCTS

2.1 SCOPE

.1 This specification covers the provision for on-site data storage of building systems energy consumption and performance which will be required in order to properly execute the Measurement & Verification plan.

2.2 DELIVERABLES

.1 Provide the EMCS shop drawings for approval by the Departmental Representative.

.2 Provide a list of the points to be archived by the EMCS in the controls shop drawings.

.3 Provide a sample output data file a minimum of 1 month prior to building occupancy.

.4 Provide data files to the Departmental Representative in electronic format.

.5 Provide real time remote access to the EMCS operating systems (for both live data and archived data) to the Departmental Representative. Include any software necessary to achieve remote access.

2.3 SYSTEM SOFTWARE

.1 Provide a "Windows" based simplified user Interface for system operation.

.2 Software shall be provided, capable of accomplishing the following functions:

.1 Software shall store all data in comma separated variable (.CSV) file format. Meters and points are to be read every 15 minutes.

.2 The software shall allow the user to view instantaneous readings of voltage, current, energy, power, phase angle, present and peak demand for any electricity meter.

.3 Software shall have the ability to export data into Reporting Applications (e.g. Web, Excel and Notepad).

.4 Software shall store measurements for a period of no less than 15 months, measured from the data of occupancy. Data will be required and must be stored for the entire duration of the M&V period.

.5 Software shall include service menus for diagnostic monitoring of the metering equipment and through either a modem and telephone link or Internet access to permit remote diagnostics by the manufacturer's service technicians. Security access control shall permit remote diagnosis to be locked out.

PART 3 EXECUTION

3.1 PROJECT DURATION

.1 The M&V period is 15 months, measured from the data of occupancy. Data will be Required for the entire duration of the M&V period.

3.2 REQUIRED MONITORING POINTS

.1 The EMCS must be capable of storing all M&V monitoring points and meter data for a period of 15 months.

.2 All meter and monitored point data being stored shall follow the format outlined in 3.3.

3.3 OUTPUT FILE FORMAT & STORAGE

.1 Data shall be recorded every 15 minutes.

.2 Data shall be provided in comma separated value (.CSV) files.

.3 Each row in the output file shall represent a successive sample time.

.4 Include a time stamp for each line in the file.

.5 Separate each field by a single comma character.

.6 Each required monitoring point shall contain a unique and understandable identifier.

.7 Each required monitoring point shall be identified with a unique and understandable column.

.8 All recorded data is to be stored on the EMCS computer.

.9 Provide data files to the Departmental Representative in electronic format.

3.4 DATA STORAGE AND LOGGING REQUIREMENTS

.1 System shall be capable of storing data for a minimum of 250 EMCS points for a period of no less than 15 months.

3.5 NETWORK INTERFACE AND CONTROLLER

.1 The EMCS Tender price will include the necessary hardware, software and technical labour to connect the system to the Departmental Representative's enterprise network or Internet.

.2 The Departmental Representative shall provide a connection to the Internet to enable remote access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the Departmental Representative's Intranet to a corporate server providing access to an Internet Service Provider (ISP).

.3 The Departmental Representative will establish a Virtual Private Network (VPN), remote desktop, file transfer protocol (FTP) or other previously and mutually agreed-upon electronic means to allow the Departmental Representative to access the EMCS data remotely.

3.6 METERS

.1 Water Meters:

.1 Water meters shall be provided by Division 25.
.2 Water meters shall be revenue grade (1% accurate) but do not need to be sealed for the purposes of M&V.
.3 Meters must be equipped with visual readouts.

.4 Communications cable from meters to EMCS computer location shall be provided by Division 25.

.5 All water meters, including the main incoming service meters, shall be interconnected by a network connected to the EMCS computer.

.6 Provide interface equipment as required to connect the water meters to the EMCS computer.

3.7 ELECTRIC Meters

.1 All electric meters shall be provided by Division 26. EMCS Contractor shall provide connection to Division 26 Intellimetering system panels for meter data.

Appendix "A"

SAMPLE M&V OUTPUT FILE FOR B-1 & B-2

OUTPUT WHEN VIEWED IN EXCEL

Date/Time	*GLS (LT) Temp (˚C)*	*GLR (LT) Temp (˚C)*
8/29/2018 12:30	*27.65*	*44.71*
8/29/2018 12:45	*27.64*	*44.31*
8/29/2018 13:00	*27.55*	*44.41*
8/29/2018 13:15	*27.50*	*46.41*
8/29/2018 13:30	*27.53*	*44.71*
8/29/2018 13:45	*27.52*	*44.41*
8/29/2018 14:00	*27.51*	*44.31*

OUTPUT WHEN VIEWED IN NOTEPAD

Date / Time, GLS (LT) Temp(˚C), GLR (LT) Temp(˚C),
8/29/2018 12:30, 27.65, 44.71
8/29/2018 12:45, 27.64, 44.31
8/29/2018 13:00, 27.55, 44.41

END

PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Division 01 – General Requirements.
.2 Section 21 05 00 - Common Work Results for Fire Suppression.
.3 Section 22 05 00 - Common Work Results for Plumbing.
.4 Section 23 05 00 - Common Work Results - Mechanical.
.5 Section 25 05 01 – EMCS: General Requirements.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE):

.1 ASHRAE 90.1-01, Energy Code for Buildings Except Low-Rise Residential Buildings.

.2 Electrical Equipment Manufacturers' Advisory Council (EEMAC).

1.4 SECTION INCLUDES

.1 Electrical work to conform to Division 26 including the following:

.1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
.2 Control wiring and conduit shall be done by Division 25 to standards set out in Division 26.
.3 Division 26 shall leave designated breakers in power panels throughout the building where Division 25 will tie in and provide its own wiring distribution to Division 25 power requirements.

1.5 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 – EMCS: Submittals and Review Process.

1.6 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for motors, drives and guards for incorporation into manual Section 01 77 00 –Closeout Procedures and Submittals and Section 25 05 02 – EMCS: Submittals and Review Process.

PART 2 PRODUCTS

2.1 GENERAL

.1 Provide variable speed drives as shown on the drawings and/or indicated in the equipment schedule. Variable speed drives are also referred to as variable speed controllers in the specifications and drawings.

.2 Provide on-site commissioning services of variable speed drives by factory trained technicians. Allow for a second visit of two days to instruct the operations staff in the operation and maintenance of the variable speed drives.

.3 Provide separate variable speed drives and controls for all pumps, supply fans, all return fans and exhaust fans as noted in the fan schedules.

.4 Where VSD's are called for in Packaged rooftop Air Handling Units, the EMCS Contractor shall supply them to the AHU factory for installation in the units.

.5 All variable speed drives noted in the contract documents as being supplied by Division 25 shall be supplied by the Section 25 05 01 - EMCS General Requirements contractor.

.6 Requirements for variable speed drives being supplied by this section (Section 25 73 15) are indicated on the mechanical equipment schedules.

2.2 VARIABLE SPEED DRIVES

.1 Each fan drive system shall consist of an adjustable frequency drive to control the speed of a standard squirrel cage induction motor.

.2 Adjustable Frequency Controllers

.1 The adjustable frequency controllers shall be of the pulse width modulated (PWM) type and shall have the following minimum specifications:

.1 CSA certified.

.2 Chassis mounted or MCC mounted.

.3 575 volt + 10%, 3 phase, 60 Hz input power supply and 0-575 volt, 3 phase, 0-60 Hz output. Line voltage tolerance of +/- 35% of 600V without tripping.

.4 Provide inherent short circuit protection for line to line and line to ground faults.
.5 Suitable for use with standard or high efficiency EEMAC Design B 575 volt motors.
.6 Minimum efficiency of 95% at maximum load and speed.
.7 Minimum line side power factor of 0.96 at all speeds.
.8 Provided with circuit breaker or disconnect switch with door mounted operating handle.
.9 Speed regulation of 1% or better without tachometer feedback.
.10 Maximum ambient temperature of 40°C.
.11 Maximum humidity of 90% non-condensing.
.12 Service factor rating: 1.0 continuous.
.13 Provide output motor contactor.
.14 True current limit adjustable between 50 and 100% of rated current. Current trip shall not be acceptable.
.15 Adjustable minimum speed 0 - 30%.
.16 Adjustable maximum speed 50 - 100%.
.17 Separately adjustable linear acceleration and deceleration of 6 to 60 seconds.
.18 Provide electronic protection for:
.1 Overload.
.2 Instantaneous over-current.
.3 Output short circuit.
.4 Output ground fault.
.5 Provide LED indication for above faults. Adjustable frequency controllers utilizing fuses to provide this protection shall not be acceptable.
.19 Provide line over and under voltage protection, phase loss protection and phase unbalance protection and provide LED indication if drive trips due to these faults.
.20 Provide automatic/manual signal follower modification.
.21 Provide line bypass mode utilizing a fused disconnect and two mechanically and electrically interlocked contactors and motor overloads. Bypass not required on pumping systems with full standby pumps.
.22 VSD shall be capable of starting into a running load (either direction).

.3 Door Mounted

.1 Provide the following:
.1 Manual-Off-Auto selector switch.
.2 Normal/bypass selector switch.
.3 Power On pilot light - White.
.4 VSD Run pilot light - Green.
.5 Bypass on pilot light - Red.
.6 Manual speed setting potentiometer.
.7 Speed indicator 0 - 100%.
.8 High temperature shut-down pilot light - Red
.9 Low temperature shut-down pilot light - Red

.4 Interlocks

.1 Provide the following:

.1 Terminals on the supply fan drives to interlock with the high temperature (firestat or smoke detector) protection contacts to shut down the drives on opening of the contacts.

.2 Terminals on the supply fan drives to interface with the low temperature (freezestat) protection contacts to shut down the drives on opening of the contacts.

.3 Dry contacts wired to terminals on the supply fan drives to allow interlocking the return fan drives to ensure that return fans run only if their respective supply fans are running.

.5 In addition, the following items shall be provided to allow interfacing with the building automatic controls (EMCS) being supplied under Section 25 05 01 - EMCS: General Requirements.

.1 Terminals to allow dry remote contacts to stop and start the fans.

.2 Dry status contact wired to terminals to indicate the drive is running.

.3 Terminals for the speed reference signal (4 - 20 mA).

.6 System Operation

.1 If the supply fan Hand-Off-Auto selector switch is in the "Hand" position the drive/motor shall start and the speed shall be controlled by the manual speed setting potentiometer. If the selector switch is in the "Auto" position the drive/motor shall start only when the dry remote contact from the EMCS is closed. The speed shall be controlled by the 4 - 20 mA signal.

.2 If the return fan Hand-Off-Auto selector switch is in the "Hand" position the drive/motor shall start and the speed shall be controlled by the manual speed setting potentiometer. If the selector switch is in the "Auto" position the drive/motor shall start only when the dry remote contact from the respective supply fan drive is closed. The speed shall be controlled by the 4 - 20 mA signal.

.3 In the event of a power outage the variable speed drive shall be restarted by the EMCS on resumption of power. The restart shall occur after an adjustable time delay of up to 3 minutes to allow a rotating fan to come to a stop. This time delay shall also occur at initial power up. The variable speed drive shall always be at zero speed and speed up to operating speed over an operator set time period but not less than sixty (60) seconds.

.4 In the event of a shut down of the variable speed drive due to a fault condition the drive shall be able to automatically restart. The number of times and time delay between re-start attempts shall be programmable after which the drive stays shut down until the fault is removed and the drive reset by turning the H-O-A selector switch to the "Off" position and back to either "Hand" or "Auto".

.5 When the normal - bypass selector switch is in the "Normal" position the drive/motor shall operate as a variable speed system. When the selector switch is in the "Bypass" position the fan motor shall start across the line and run as a fixed speed system. The bypass system shall incorporate two interlocked output contactors with thermal overload.

.7 The variable speed drive to be supplied with rectifiers and import line choke/reaction to reduce harmonics and protect from transients.

.8 Variable speed drives to be supplied complete with integral isolation transformers.

2.3 CONTROLS

.1 The VSD shall be complete with terminal of interface for connection to the EMCS. The connection shall include start/stop, static, alarm, speed failure.

.2 The VSD shall have open protocol and terminals for integration with the EMCS and for transfer data to the EMCS. The communication shall be BACnet or LON works.

PART 3 EXECUTION

3.1 INSTALLATION

.1 Install the variable speed drives in accordance with the manufacturers' recommendations.

.2 If manufacturer requires end-switch indication on load-site (motor) disconnects, supply and installation of same is to be included for by the EMCS contractor.

END

PART 1 GENERAL

1.1 SUMMARY

.1 Section includes:

.1 At minimum, Shop Drawings for EMCS to include a detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.

.1 Control Description Logic (CDL) for each system.

.2 Input/output Point Summary Tables for each system.

.3 System Diagrams consisting of the following; EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS), System flow diagram for each system with electrical ladder diagram for MCC starter interface.

1.2 RELATED SECTIONS

.1 Division 01 – General Requirements.

.2 Section 01 9 13 – General Commissioning Requirements.

.3 Section 21 05 00 - Common Work Results for Fire Suppression.

.4 Section 22 05 00 - Common Work Results for Plumbing.

.5 Section 23 05 00 - Common Work Results - Mechanical.

.6 Section 25 05 01 – EMCS: General Requirements.

1.3 SEQUENCING

.1 Present sequencing of operations for systems, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.

.2 Sequencing of operations for systems.

1.4 SUMMARY

.1 Section Includes

.1 At minimum, Shop Drawings for EMCS to include a detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules:

.1 Control Description Logic (CDL) for each system.

.2 Input/Output Point Summary Tables for each system.

.3 System Diagrams consisting of the following; EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS), system flow diagram for each system with electrical ladder diagram for MCC starter interface.

PART 2 PRODUCTS

2.1 GENERAL

.1 Standard Routines

.1 On a power interruption at the cabinet, the equipment controlled by the cabinet shall be turned off as if a signal to stop equipment had been given, unless the equipment is wired through normally closed contacts. On a return from power failure to one or more cabinets, the equipment shall restart or stop in an orderly fashion, with an adequate time delay between each motor system.

.2 Whenever operator command or equipment failure, the following events must occur unless specified otherwise in the sequence:

.1 Outside air, relief and exhaust dampers shall close.

.2 Control valves on water coils shall be controlled to allow some flow if the outside temperature is below 0˚C.

.3 Humidification systems shall be turned off.

.4 Interlocked equipment, such as refrigeration equipment, serving that unit only shall be shut off.

.5 Variable speed or inlet dampers shall be positioned to minimum value.

.6 Alarms shall be generated indicating the status of the equipment does not match the commanded state.

.3 Control sequences shall be executed if the corresponding equipment is operating, for example: if the operator was to place a supply fan in the hand position, and the fans were capable of operating as there are not external interlocks or safeties that would prevent it from operating, such as an end switch, the sequence shall execute as if the BMS system had initiated the start up.

.4 Structure programs and loop controls such that integral windup does not occur.

.2 Alarms, Alarm and Event Messages

.1 status; an alarm shall be generated to the alarm printer or main terminal.

.2 Whenever an input point or an output point is failed, over-ranged or not connected, the BMS shall disable the input point and place all outputs dependent on the disabled input to a safe state. An alarm shall be generated for each occurrence at the alarm printer or main terminal.

.3 Allow labour for the generation of two (2) alarm messages per major system.

.4 Provide room high and low alarms set for 18˚C and 25˚C, when in occupied mode, and 14˚C and 31˚C when in unoccupied mode.

.5 When more than one alarm device such as a printer or terminal is specified, provide the Departmental Representative with a point layout sheet so that alarms can be directed to a specific alarm device. The alarm layout sheet shall indicate the alarm limits and alarm messages. The Departmental Representative will then complete the column providing the requirements for the wording of the vent message and the operator terminals to which the event messages shall be output. This data shall be input into the system.

.3 Ventilation Systems:

.1 The following statements are common to all systems:

.1 When the Supply Fan is OFF:

.1 Outdoor air damper is CLOSED.

.2 Heating coil valve is controlled from the heating coil discharge air temperature.

.3 Cooling coil if OFF.
.4 Supply fan variable speed controllers are at a minimum position.

.2 When the Return Fan is OFF:
.1 Exhaust air damper is CLOSED.
.2 Return air damper is OPEN.
.3 Return fan variable speed drives are at minimum position.

.3 When the Supply Fan is OFF:
.1 Exhaust air damper is CLOSED.
.2 High limit stats located in exhaust fans shall shut down exhaust fan.
.3 Low limits located downstream of the heating coil shall shut down the supply fan and send an alarm signal on EMCS when the temperature drops to 5˚C.

2.2 HYDRONIC SYSTEMS

.1 Typical Hydronic Pump Control:

.1

.2 Hydronic Radiation:
.4 Baseboard Radiation Control
.1 When the room temperature falls below the setpoint, the motorized valve modulates open. when the room temperature rises above setpoint, the motorized valve modulates closed.

.3 Hydronic Unit Heater:
.1 Unit Heater and Cabinet Heaters:
.1 Reverse acting thermostat cycles heater to maintain setpoint.
.3 When heater fan is on the server modulates the heating valve to maintain setpoint.
.2 Force Flow and Unit Heaters
.1 Provide a line voltage thermostat to cycle the unit on to maintain set point. Heating control valve is not required.
.3 Force Flow Heater Control
.1 The force flow heater is cycled to maintain the set temperature of the thermostat.
.4 Horizontal Unit Heater Control
.1 The unit heater is cycled to maintain the set temperature of the thermostat.

.8 Heating Water Loop Temperature Control:

.1 Boiler Control:
.1 The EMCS shall enable the boilers and provide setpoint adjust.
.2 The EMCS shall monitor boiler alarms and provide an alarm at the operator’s workstation in the event of any alarm at the boiler control panel.

.2 Heating Water Control:
.1 Building heating is accomplished by circulating heating water with dual emergency
.2 Modulating pumps and condensing type heating water boilers. Return heating water temperature shall be as low as possible to maximize the efficiency of the boilers.

.3 A system enable point shall be used to start and stop the boilers and heating pumps. A pump lead point will determine the lead pump. The lead pump will be alternated after 500 hours of operation.

.4 If the lead pump fails, the secondary pump shall start in an emergency priority and operate until the lead pump returns to service. An alarm shall be generated and reported.

.5 The water temperature shall be controlled to the following schedule by the boiler control panel,

Outdoor Ambient	Supply Water Set Point
- 30ºC	75 ºC
18 ºC	49 ºC

.6 Provide a set point adjustment virtual point which will allow the operator to increase or decrease the water temperature by + 10 degrees.

.9 Domestic Hot Water Control:

.1 EMCS shall start/stop and monitor the status of the recirculation pumps.

.2 Pre-heat tanks: Waste heat from the primary heating loop shall be circulated through the pre-heat tanks to preheat the DCW supply to the central DHW heaters.

.3 Central Domestic Hot Water Heaters: The domestic hot temperature sensors shall modulate the heating hot water supply to the hot water heaters to maintain DHW setpoint.

.4 Provide alarm to BMS in event of heater failure.

.5 Provide temp sensor at each DHW tank.

.6 The domestic hot water recirculation pump (p-rec) normally runs continuously and can be started and stopped through the DDC system. the current sensor provides status indication. the temperature sensor provides the temperature of the potable domestic hot water.

.10 DHW Re-Circulation Pump:

.11 Condensate Pump:

2.3 VENTILATION AND AIR HANDLING SYSTEMS

.1 Flammable Storage Room Exhaust Fan (EF9-1):

.1 Continuous Operation Exhaust Fan Control

.1 An alarm shall be generated if an exhaust fan that is intended to operate continuously, is stopped including when the fan is commanded off via the EMCS.

.2 Temperature Controlled Exhaust Fan:

.1 Penthouse Mechanical Room Heating and Ventilation:

.1 Outdoor and exhaust air dampers and exhaust fan are controlled by space temperature sensor to maintain space temperature at 80°F.

.2 When the space temperature drops to 60°F, the unit heater will start.

.3 Typical Constant Volume Air Handling System (ERV9-1, ERV9-2):

.1 Units are 100% fresh air constant volume systems with energy recovery core or heat pipe and heating coil. Units are started automatically by the EMCS.

.2 When units are off:

.1 Fresh air inlet damper is closed and confirmed by end switch.
.2 Exhaust air damper is closed and confirmed by end switch.
.3 Return air damper is opened.
.4 Heating coil valve is cycled to closed position.
.5 Humidifier is off.
.6 Supply fan and return fan are signaled off by EMCS.

.3 When units are commanded on:

.1 Fresh air and exhaust air dampers are commended open and verified by end switch.
.2 Fans are commanded on once end switch has reported dampers open.
.3 Temperature controls are energized.

.4 Temperature Control:

.1 EMCS shall control supply air setpoint by modulating heat recovery wheel, heating coil and cooling coil in sequence. Supply air temperature may be reset in response to return air temperature measurement.

.5 Alarms:

.1 Provide manually resettable freeze stat at heating coil discharge to shut down supply fan (and fresh air and exhaust air dampers) on reaching cold air setpoint. Alarm shall be reported to EMCS.
.2 Provide interlock with fire alarm system to shut down units on activation of supply air smoke detectors.
.3 Provide differential pressure sensors at all filter banks to monitor pressure drop and indicate when filter change is required.

.1 AHU9-1, AHU9-2 and SW8-1

.1 When Units are off:

.1 Exhaust air dampers are closed.
.2 Outdoor air dampers are closed and confirmed by end switch.
.3 Mixed air damper is open.
.4 Cooling coil valve is cycled closed position.
.5 Heating coil valve is cycled to closed position.
.6 Supply fan and return fan VFD’s are signaled off by EMCS.

.2 When unit is commanded on:

.1 Exhaust air damper is opened.

.2 If the unit is in heating mode, the solar wall outdoor air damper shall open. If the unit is in cooling mode, the outdoor air damper shall open.

.1 The solar wall shall be permitted to operate from 1 October to 15 May. The schedule shall be operator adjustable.

.3 VFD is commanded on to ramp up supply and return fan speed.

.4 Temperature controls are energized.

.3 Temperature Control:

.1 Return air, exhaust air and fresh air dampers shall be modulated in sequence to maintain mixed air temperature at setpoint. Differential enthalpy controllers shall be used to control economizer mode.

.2 EMCS shall control supply air setpoint by modulating heating coil and cooling coil in sequence.

.4 Alarms

.1 Provide manually resettable freeze stat at heating coil discharge to shut down supply fan (and close isolation dampers) on reaching cold air setpoint. Alarm shall be reported to EMCS. Other units in safe operating mode may continue to run.

.2 Provide interlock with fire alarm system to shut down unit on activation of supply air smoke detectors.

.3 Provide differential pressure sensors at all filter banks to monitor pressure drop and indicate when filter change is required.

.4 Existing Solar Wall Fan Control:

.1 Fan to be monitored by EMCS and failure repeated as an alarm.

.2 The temperature of the solar wall shall be provided to the EMCS.

.5 Battery Charging Room Fan Control:

.1 Fan to be controlled by a wall switch.

.6 Engine Bay Ventilation Control:

.1 Fan to be controlled by the EMCS with a 0-3 hour user programmable push button override.

.2 The carbon monoxide and nitrogen dioxide sensors provide indication of the levels within the boathouse.

.3 If the levels rise above the acceptable limits, the two supply air dampers and the exhaust air dampers will go to the fully open position.

.4 The exhaust fan will continue to operate until the detected levels have dropped below acceptable levels.

.5 An audible and visual alarm will occur within the boathouse and the EMCS system if the carbon monoxide and nitrogen dioxide levels reach the high limits.

2.4 MISCELLANEOUS

.1 Carbon Monoxide Monitoring:

.1 Exhaust fans on each respective level shall be interlocked to its respective carbon monoxide detection system.

.2 On a riser to 50PPM, outside air and exhaust air dampers shall open.

.3 On a further rise to 75PPM, the engine bay exhaust fan on respective level shall energize.

.4 At 100PPM local alarm at the carbon monoxide controller alarm shall sound and provide indication at BMS.

.2 Variable Refrigerant Flow System:

.1 The VRF system shall provide primary heating to the space.

.2 When the VRF unit is unable to maintain the space temperature, the heater relay kit shall engage the control valve for the hot water baseboards.

.3 The system shall be provided with an adjustable time of day schedule.

.3 Energy Measurement Metering:

.1 Connect to Division 26 supplied meter.

.2 Provide report generating capability indicating the consumption to date and- the consumption over selected periods (e.g. monthly).

.4 Water Meter:

.1 The water meter provides the water consumption (cubic meters) measurement to the EMCS.

.5 Weather Station:

PART 3 EXECUTION

3.1 NOT USED

END