Part 1 General

1.1 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.

.2 Related Requirements

.1 Section 01 - Submittal Procedures.

.2 Section 01 - Closeout Submittals.

.3 Section 01 - General Commissioning Requirements.

.4 Section 01 - Commissioning Training.

.5 Section 25 - EMCS: General Requirements.

1.2 DEFINITIONS

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

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

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

.1 Outage of main power supply in excess of back-up power sources, provided that:

.1 Automatic initiation of back-up was accomplished.

.2 Automatic shut-down and re-start of components was as specified.

.2 Failure of communications link, provided that:

.1 Controller automatically and correctly operated in stand-alone mode.

.2 Failure was not due to failure of any specified EMCS equipment.

.3 Functional failure resulting from individual sensor inputs or output devices, provided that:

.1 System recorded said fault.

.2 Equipment defaulted to fail-safe mode.

.3 AEL of total of all input sensors and output devices is at least 99 % during test period.

1.3 DESIGN REQUIREMENTS

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

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

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Final Report: submit report to Departmental Representative.

.1 Include measurements, final settings and certified test results.

.2 Bear signature of commissioning technician and supervisor

.3 Report format to be reviewed 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 - Closeout Submittals.

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

1.5 CLOSEOUT SUBMITTALS

.1 Provide documentation, Operation and Maintenance (O&M) Manuals, and training of O&M personnel for review of Departmental Representative before interim acceptance in accordance with Section 01 Closeout Submittals.

1.6 COMMISSIONING

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

.2 Carry out commissioning under direction of Departmental Representative and in presence of a Departmental Representative.

.3 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to commissioning or each test. Indicate:

.1 Location and part of system to be tested or commissioned.

.2 Testing/commissioning procedures, anticipated results.

.3 Names of testing/commissioning personnel.

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

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

.6 Load system with project software.

.7 Perform tests as required.

1.7 COMPLETION OF COMMISSIONING

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

1.8 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

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

Part 2 Products

2.1 EQUIPMENT

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

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

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

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

.5 Application: to conform to normal industry standards.

Part 3 Execution

3.1 PROCEDURES

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

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

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

.4 Debug system software.

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

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

3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.

.1 General: consists of field tests of equipment just prior to installation.

.2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.

.3 Configure major components to be tested in same architecture as designed system. Include all required network and control components.

.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 metre at source.

.7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.

.8 Departmental Representative to mark instruments tracking within 0.5 % in both directions as "approved for installation".

.9 Transmitters above 0.5 % error will be rejected.

.10 DP switches to open and close within 2% of setpoint.

.2 Completion Testing.

.1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each A-to-D convertor.

.3 Test and calibrate each AI using calibrated digital instruments.

.4 Test each DI to ensure proper settings and switching contacts.

.5 Test each DO to ensure proper operation and lag time.

.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.

.7 Test operating software.

.8 Test application software and provide samples of logs and commands.

.9 Verify each CDL including energy optimization programs.

.10 Debug software.

.11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.

.12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on 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 the Departmental Representative and provide:

.1 2 technical personnel capable of re-calibrating field hardware and modifying software.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 Departmental Representative's acceptance signature to be on executive and applications programs.

.4 Commissioning to commence during final start-up testing.

.5 O&M personnel to assist in commissioning procedures as part of training.

.6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.

.7 Commission systems considered as life safety systems before affected parts of the facility are occupied.

.8 Operate systems as long as necessary to commission entire project.

.9 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.

.1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.

.1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.

.2 Test to last at least 30 consecutive 24 hour days.

.3 Tests to include:

.1 Demonstration of correct operation of monitored and controlled points.

.2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.

.4 System will be accepted when:

.1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.

.2 Requirements of Contract have been met.

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

.6 Correct defects when they occur and before resuming tests.

.5 Departmental Representative to review reported results.

3.3 ADJUSTING

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

3.4 DEMONSTRATION

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

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

.2 Related Requirements

.1 Section 01 - Submittal Procedures.

.2 Section 25 - EMCS: General Requirements.

1.2 DEFINITIONS

.1 CDL - Control Description Logic.

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to 30 days Departmental Representative 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 coordinated interface with other EMCS mechanical and electrical training programs.

.3 Submit reports within one week after completion of training program that training has been satisfactorily completed.

1.4 QUALITY ASSURANCE

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

.2 Departmental Representative reserves right to approve instructors.

1.5 INSTRUCTIONS

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

.2 Training to be project-specific.

1.6 TIME FOR TRAINING

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

1.7 TRAINING MATERIALS

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

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

.1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

1.8 TRAINING PROGRAM

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

.2 Phase 1: 2 day program to begin before 30 day test period at time mutually agreeable to Contractor, Departmental Representative, Commissioning Co-ordinator, and personnel in functional operations and procedures to be employed for system operation.

.1 Train O&M personnel in functional operations and procedures to be employed for system operation.

.1 Supplement with on-the-job training during 30 day test period.

.2 Review of shop drawings for building.

.1 Include overview of system architecture, communications, operation of computer and peripherals, report generation.

.2 Include detailed training on operator interface functions for control of mechanical systems, Control Description Logic’s (CDL) for each system, and elementary preventive maintenance.

.3 Include architecture for Direct Digital Controls (DDC) and BACnet protocol if applicable.

.3 Walk through of mechanical systems.

.1 Identification of Control Components.

.2 Detailed discussion of sequences of operation

.3 Review of DDC Network Diagram for the building(s).

.3 Phase 2: 5 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:

.1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.

.2 Equipment maintenance training: provide personnel with 2 days training within 5 day period in maintenance of EMCS equipment, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.

.3 Programmers: provide personnel with 2 days training within 5 day period in following subjects in approximate percentages of total course shown:

.1 Software and architecture: 10%
.2 Application programs: 15%
.3 Controller programming: 50%
.4 Trouble shooting and debugging: 10%
.5 Colour graphic generation: 15%
.6 Display and interpret summaries
.7 Command points
.8 Modify points and point groups
.9 Define trend logs
.10 Schedule and print reports

1.9 ADDITIONAL TRAINING

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

1.10 MONITORING OF TRAINING

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.

.2 Related Requirements

.1 The contractor is to ensure that all related work is co-ordinated among all specification sections, as well as between other Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.

.2 Section 01 – Submittal Procedures.

.3 Section 01 – Health and Safety Requirements.

.4 Section 01 – Construction/Demolition Waste Management and Disposal.

.5 Section 01 – General Commissioning Requirements.

.6 Section 09 - Interior Painting.

.7 Section 25 - EMCS: Start-up, Verification and Commissioning.

.8 Section 25 - EMCS: Training.

.9 Section 25 - EMCS: Submittals and Review Process.

.10 Section 25 - EMCS: Project Record Documents.

.11 Section 25 - EMCS: Identification.

.12 Section 25 - EMCS: Field Installation.

.13 Section 25 - EMCS: Warranty and Maintenance.

.14 Section 25 - EMCS: Local Area Network (LAN).

.15 Section 25 - EMCS: Operator Work Station (OWS).

.16 Section 25 - EMCS: Building Controllers

.17 Section 25 - EMCS: Field Control Devices.

.18 Section 25 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.2 REFERENCE STANDARDS

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

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

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

.1 ANSI/IEEE 260.1, 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, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA Group).

.1 CAN/CSA-Z234.1, Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA).

.1 CEA-709.1-B, 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, Light Grey Colour for Indoor Switch Gear.

.8 National Electrical Manufacturers Association (NEMA)

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

.1 Material Safety Data Sheets (MSDS).

.10 Transport Canada (TC).

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

1.3 ABBREVIATIONS AND ACRONYMS

.1 Acronyms used in EMCS:

.1 AEL - Average Effectiveness Level
.2 AI - Analog Input
.3 AO - Analog Output
.4 BACnet - Building Automation and Control Network.
.5 BC(s) - Building Controller(s).
.6 BECC - Building Environmental Control Centre.
.7 CAD - Computer Aided Design.
.8 CDL - Control Description Logic.
.9 CDS - Control Design Schematic.
.10 COSV - Change of State or Value.
.11 CPU - Central Processing Unit.
.12 DI - Digital Input.
.13 DO - Digital Output.
.14 DP - Differential Pressure.
.15 ECU - Equipment Control Unit.
.16 EMCS - Energy Monitoring and Control System.
.17 HVAC - Heating, Ventilation, Air Conditioning.
.18 IDE - Interface Device Equipment.
.19 I/O - Input/Output.
.20 ISA - Industry Standard Architecture.
.21 LAN - Local Area Network.
.22 LCU - Local Control Unit.
.23 MCU - Master Control Unit.
.24 NAFTA - North American Free Trade Agreement.
.25 NC - Normally Closed.
.26 NO - Normally Open.
.27 OS - Operating System.
.28 O& M - Operation and Maintenance.
.29 OWS - Operator Work Station.
.30 PC - Personal Computer.
.31 PCI - Peripheral Control Interface.
.32 PCMCIA - Personal Computer Micro-Card Interface Adapter.
.33 PID - Proportional, Integral and Derivative.
.34 RAM - Random Access Memory.
.35 SP - Static Pressure.
.36 ROM - Read Only Memory.
.37 TCU - Terminal Control Unit.
.38 USB - Universal Serial Bus.

.39 UPS - Uninterruptible Power Supply.

.40 VAV - Variable Air Volume.

.41 WAN – Wide Area Network

1.4 DEFINITIONS

.1 Point: may be logical or physical.

.1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.

.2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.

.2 Point Name: composed of two parts, point identifier and point expansion.

.1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.

.1 Area descriptor: building or part of building where point is located.

.2 System descriptor: system that point is located on.

.3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25 character field for each point identifier.

.2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.

.3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.

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

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

.1 AI (analog input).

.2 AO (analog output).

.3 DI (digital input).

.4 DO (digital output).

.5 Pulse inputs.

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

.1 Printouts: to ANSI/IEEE 260.1.

.2 Refer also to Section 25 - EMCS: Identification.

1.5 SYSTEM DESCRIPTION

.1 Refer to control schematics, sequences of operation and related Divisions of specifications 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 Operator Work Stations (OWSs).
- .4 Data communications equipment necessary to effect EMCS data transmission system.
- .5 Field control devices.
- .6 Software/Hardware complete with full documentation.
- .7 Complete operating and maintenance manuals.
- .8 Training of personnel.
- .9 Acceptance tests, technical support during commissioning, full documentation.
- .10 Wiring interface co-ordination of equipment supplied by others.
- .11 Miscellaneous work as specified in these sections and as indicated.

.3 Design Requirements:

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

.4 Language Operating Requirements:

- .1 Provide 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 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 one terminal in English and second in French. Point name expansions in both languages.

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

.5 The network design to be a fully distributed network, with each primary system having its own locally mounted dedicated controller. Any failure in the network shall **not** in any way affect the control of these primary systems. Connecting hardware points from one system to more than one controller is not acceptable. Any points associated with a system are to be connected to one dedicated controller. Each dedicated controller to have a locally mounted control and display device to allow the operator to view and adjust any point on the controller.

.6 All wiring associated with the EMCS communication network as well as all control wiring and conduit associated with the EMCS at 50 volts or less. Wire and conduit above 50 volts by Electrical Division.

.7 BACnet compliance: full compliance to the BACnet standard (ANSA/ASHRAE) 135, BACnet – A Data communication Protocol for Building Automation and Control Networks is mandatory. Down to the field device level, the EMCS system must meet BACnet standards for system architecture and administration, and use open communication protocols and user friendly programming and graphics. Install the EMCS installed to communicate at the supervisory layer to the WAN using the BACnet TCP/IP protocol implemented on Ethernet.

.8 The EMCS system for applicable facilities to be accessible by designated personnel via the WAN for monitoring and programming purposes. The EMCS contractor to provide all the required hardware, software, gateways, etc. needed to permit connection of the EMCS to the WAN. This shall include all hardware, software, programming, start-up and commissioning required. The contractor to supply and install all the required hardware and software on the WAN file server to allow for this remote operation monitoring and programming to take place. The contractor to supply and install all the required hardware and software on the operator workstation(s) located in the Owner’s facilities management department.

.9 In addition, a directly connected VPN Ethernet Firewall (managed switch) for access to the system shall be provided for troubleshooting/programming or occasional site status/monitoring by maintenance staff.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 25 - EMCS: Shop Drawings, Product Data and Review Process, 01 - Submittal Procedures.

.2 Co-ordinate submittal requirements and provide submittals required by Section 01 - Sustainable Requirements: Construction (if Section is applicable).

.3 Submit for review:

.1 Manufacturer and part numbers, equipment list, within 10 days after award of contract.

.2 List existing field control devices to be re-used (if applicable).

.4 Quality Control:

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

.1 BACnet devices to bear BACnet testing laboratories BTL mark and listed on BACnet manufacturer’s association web site.

.2 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 - EMCS: Shop Drawings, Product Data and Review Process.

.1 Product literature with Label or listing of specified organization is acceptable evidence.

.2 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.

.3 Permits and fees: in accordance with general conditions of contract.

.1 Provide copies of all completed Permits and inspections by the Authority Having Jurisdiction to the Departmental Representative for review and proof of completion.

.4 Existing devices intended for re-use (if applicable): submit test report.

1.7 QUALITY ASSURANCE

.1 Have local office within 50 km’s of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems.

.1 Be able to provide factory trained personnel on site within two (2) working days’ notice or provide instructions on maintenance and emergency service on system.

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

.3 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.

.4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

.5 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 - Health and Safety Requirements.

.6 Sustainable Requirements:

.1 Construction requirements: in accordance with Section 01 - Sustainable Requirements: Construction.

.2 Verification: contractor's verification in accordance with Section 01 - Sustainable Requirements: Contractor's Verification.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Owner's Representative with "Materials Delivery Schedule" within 2 weeks after award of contract.

.2 Waste Management and Disposal:

- .1 Separate waste materials for recycling and reuse in accordance with Section 01 - Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan.
- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with CEPA, Regional, Municipal, TDGA, and Provincial regulations.
- .7 Label location of salvaged material's storage areas and provide barriers and security devices.
- .8 Ensure emptied containers are sealed and stored safely.
- .9 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .10 Fold up metal and plastic banding, flatten and place in designated area for recycling.

1.9 EXISTING- CONTROL COMPONENTS

.1 Utilize existing control wiring and piping as indicated.

.2 Re-use field control devices that are usable in their original configuration provided that they conform to applicable codes, standards specifications.

- .1 Do not modify original design of existing devices without written permission from Departmental Representative.
- .2 Provide for new, properly designed device where re-usability of components is uncertain.

.3 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.

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

.4 Non-functioning items:

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

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

.6 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Departmental Representative.

- .1 Be responsible for items repaired or replaced by Departmental Representative.
- .2 Be responsible for repair costs due to negligence or abuse of equipment.
- .3 Responsibility for existing devices terminates upon final acceptance of EMCS or applicable portions of EMCS as approved by Departmental Representative.

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

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 - Sustainable Requirements: Construction.

2.2 EQUIPMENT

.1 Control Network Protocol / Data Communication Protocol: to CEA 709.1, ASHRAE STD 135.

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

2.3 ADAPTORS

.1 Provide adaptors between metric and imperial components.

2.4 ACCEPTABLE SYSTEMS, MANUFACTURERS

.1 Proposed system to have communication capability utilizing BACnet Protocol.

.2 Panel to be NEMA rated to suit environmental requirements.

.3 Panels to have hinged doors equipped with standard keyed-alike cabinet locks, keyed to same key.

.4 Wiring within panels to be contained within properly sized rigid PVC slotted wall wire duct. All wiring within the wire duct to be concealed with a non-slip cover.

.5 Terminations for the connection of power wiring, communication wiring and field mounted devices to be at properly identified terminal blocks mounted within the control panel.

.6 All control panels to be provided with an internally mounted 120 volt, 5A simplex convenience receptacle.

.7 All control panels to be identified with permanently mounted Lamecoid tags to identify the control panel and the systems served by the control panel. Submit schedule of labels with shop drawing submission.

.8 Provide low voltage transformers in panels or elsewhere as required.

.9 Provide adaptors between metric and imperial components.

Part 3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations and requirements.

3.2 PAINTING

.1 Painting: in accordance with EMAC/NEMA - Interior Painting, supplemented as follows:

.1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.

.3 Clean and prime exposed hangers, racks, fastenings, and other support components.

.4 Paint unfinished equipment installed indoors to EEMAC 2Y-1 / NEMA.

3.3 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 - Sustainable Requirements: Contractor's Verification, include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified Wood.

.8 Low-emitting materials.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

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

.2 Related Requirements:

.1 The contractor is to ensure that all related work is co-ordinated among all specification sections as well as between all Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.

.1 Section 01 - Submittal Procedures.

.2 Section 25 - EMCS: Start-up, Verification and Commissioning.

.3 Section 25 - EMCS: General Requirements.

1.2 DEFINITIONS

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

1.3 DESIGN REQUIREMENTS

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

.1 Location of local office.

.2 Description and location of installing and servicing technical staff.

.3 Location and qualifications of programming design and programming support staff.

.4 List of spare parts.

.5 Location of spare parts stock.

.6 Names of sub-contractors and site-specific key personnel.

.7 Sketch of site-specific system architecture.

.8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.

.9 Descriptive brochures.

.10 Sample CDL and graphics (systems schematics).

.11 Response time for each type of command and report.

.12 Item-by-item statement of compliance.

.13 Proof of demonstrated ability of system to communicate utilizing BACnet protocol.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit preliminary design document within 30 working days after tender closing for review by Departmental Representative.

.3 Shop Drawings shall be submitted electronically of design documents, shop drawings, product data and software.

.1 Electronic submittals shall be in PDF format and be a 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.

.2 Soft copy (if applicable) to be the latest version format of AutoCAD, or Microsoft Office file; structured using menu format for easy loading and retrieval on OWS.

.4 Submittals shall consist of:

.1 Data sheets of all products.

.2 Wiring and piping interconnection diagrams including panel and device power, and sources.

.3 List of materials of all proposed devices and equipment.

.4 Software documentation:

.5 Sequence of operation, in text form.

.6 Application programs.

.7 Point Schedules

.8 Controls schematics and system diagrams.

.9 Project installation schedule.

.10 Names of subtrades working for EMCS contractor.

.11 Mounting support details for components installed in airflow, waterflow and steam systems.

.5 Submit shop drawings in a package which contains the various schedules and drawings which completely describe the control system installed. At a minimum the shop drawing package to contain the following items described in all applicable divisions and specifications as well as follows:

.1 Network drawing showing the network connection of all network control units, programmable control units, terminal control units and operator workstations to indicate the location of each of these elements.

.2 Schematic control diagram for each system being controlled. Where there are typical systems a drawing to be provided for each system. This drawing to be on an ANSI B size sheet (11 x 17) and shall include a title block which includes as a minimum the drawing title, drawing number, project title, contractor’s name, contractor’s address, contractor’s phone and fax numbers, contractor’s project number and a section to provide a record for revision information.

.1 All drawings text and symbols shall be of reasonable size to allow an installer in poor lighting conditions to easily read its pages when the same drawing is printed on an ANSI A sheet (8.5 x 11).

.3 The schematic control diagram to include a bill of materials which provides a list of all part numbers and descriptions for the control components on the drawing list to include field equipment as well as panel mounted components.

.4 The schematic control diagram to include a complete wiring diagram for all electrical connections, including motor starters, heating coils, coiling coils etc.

.5 The schematic control diagram to include a layout of the control panels for each system. This layout to show the mounting of all panel equipment, including transformers, power supplies, controllers, transducers, sensors, relays, contactors and any other panel mounted equipment.

.6 The contractor to include with the shop drawing submittal drawings, showing all wiring details for the connections of sensors, transducers, relays and contactors these details to show terminal numbers and be referenced to the appropriate schedules and drawings.

.7 The contractor to supply with the shop drawing package a complete point schedule to show every point connected to the system. This schedule to be in tabular format and provide the point identification, point type, wire tag, termination details reference, referenced drawings, device mounting location and device code numbers.

.8 The point schedule to provide at a minimum the following information on the software attributes of the point:

.1 Tag name – ex. EPT-1

.2 Point type – ex. AO-3

.3 System name – ex. A/C-1

.4 Object name – H-VLV.

.5 Expanded ID- Heating control valve

.6 Units of measurement - %.

.9 The point schedule to provide at a minimum the following information on the digital controller to which the point is connected:

.10 Controller type – ex. Unitary controller

.11 Controller address ex. 256.

.12 Cable destination – the termination at the controller, ex. AO-1.

.13 Terminal numbers – the termination at the controller.

.14 The point schedule to provide at minimum the following information on the control panel:

.1 Panel identification

.2 Panel location

.3 Reference drawing

.15 The point schedule to provide at a minimum the following information on any intermediate device which may be associated with the point:

.1 Type of wiring or tubing used

.2 Device part number

.3 Location of the device.

.4 Reference details.

.16 The point schedule to provide at a minimum the following information on any field device which may be associated with the point;

.1 Type of wiring or tubing used

.2 Device part number

.3 Location of the devices

.4 Reference details

.17 The contractor to supply with the shop drawing package a complete room schedule, to show the equipment associated with the room controls. Schedule to be in tabular format and provide the room number and location, terminal unit number, part numbers for the terminal unit controller, sensors and actuators. Included on this schedule terminal unit type, size, minimum flow and maximum flow.

.18 Sequence of operation for each system controlled. Sequence to be in complete conformance with the sequence of operations included with this specification. Any changes require the approval of the Owner's Representative in writing. Sequence to include all modes of operation including fail safe, emergency and fire modes.

.19 Valve schedule including design flow, CV, size, type, actuator, pressure drop and maximum shut off pressure differential for each control valve.

.20 Damper schedule including design air flow, size, type actuator and torque requirements for each control damper.

.21 Provide one permanent, not fading, as built copy of each control drawing, enclosed by an aluminium frame with glass cover, or sealed by plastic laminate in rigid metal bound frame. To be installed at each respective control panel location.

.22 Catalogue cut sheets of all equipment used. This includes, but is not limited to DDC panels, peripherals, sensors, actuators, dampers, control air system components, etc.

.23 Range and scale information for all transmitters and sensors. This sheet to clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.

.24 Hardware data sheets for all operator workstations, local access panels, and portable operator terminals.

.25 Software manuals for all applications programs to be provided as a part of the operator workstations, portable operator terminals, programming devices, and so forth.

1.5 PRELIMINARY SHOP DRAWING REVIEW

.1 Submit preliminary shop drawings within 30 working days of award of contract and include following:

- .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
- .2 Detailed system architecture showing all points associated with each controller including, signal levels, pressures where new EMCS ties into existing control equipment.
- .3 Spare point capacity of each controller by number and type.
- .4 Controller locations.
- .5 Auxiliary control cabinet locations.
- .6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
- .7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
- .8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.
- .9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.
- .10 Compressor schematic and sizing data.

1.6 DETAILED SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:

- .1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
- .2 Wiring diagrams.
- .3 Piping diagrams and hook-ups.
- .4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
- .5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
  - .1 Sensing element type and location.
  - .2 Transmitter type and range.
  - .3 Associated field wiring schematics, schedules and terminations.
  - .4 Pneumatic schematics and schedules.

.5 Complete Point Name Lists.

.6 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.

.7 Software and programming details associated with each point.

.8 Manufacturer's recommended installation instructions and procedures.

.9 Input and output signal levels or pressures where new system ties into existing control equipment.

.6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.

.7 Graphic system schematic displays of water air systems with point identifiers and textual description of system, and typical floor plans as specified.

.8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.

.9 Listing and example of specified reports.

.10 Listing of time of day schedules.

.11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.

.12 Type and size of memory with statement of spare memory capacity.

.13 Full description of software programs provided.

.14 Sample of "Operating Instructions Manual" to be used for training purposes.

.15 Outline of proposed start-up and verification procedures. Refer to Section 25 - EMCS: Start-up, Verification and Commissioning.

1.7 QUALITY ASSURANCE

.1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:

.1 Undertake functional review of preliminary design documents, resolve inconsistencies.

.2 Resolve conflicts between Contract Document requirements and actual items (e.g.: points list inconsistencies).

.3 Review interface requirements of materials supplied by others.

.4 Review "Sequence of Operations".

.2 Contractor's programmer to attend meeting.

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 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.

.2 Related Requirements

.1 Section 01 - Closeout Submittals.

.2 Section 25 - EMCS: Start-up, Verification and Commissioning.

.3 Section 25 - EMCS: General Requirements.

.4 Section 25 - EMCS: Submittals and Review Process.

1.2 DEFINITIONS

.1 BECC - Building Environmental Control Centre.

.2 OWS - Operator Work Station.

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit Operation and Maintenance Manual, As-built drawings, and Record Documents 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.

1.4 AS-BUILTS

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

.1 Changes to Contract Documents as well as addenda and contract extras.

.2 Changes to interface wiring.

.3 Routing of conduit, wiring and control air lines associated with EMCS installation.

.4 Locations of obscure devices to be indicated on drawings.

.5 Listing of alarm messages.

.6 Panel/circuit breaker number for sources of normal/emergency power.

.7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.

.8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 - EMCS: Start-up, Verification and Commissioning.

.9 Basic system design and full documentation on system configuration.

.2 Submit for final review by Departmental Representative.

.3 Provide before acceptance 4 Hard and 1 soft copy incorporating changes made during final review.

1.5 O&M MANUALS

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

.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 new and existing software modules to respond to changing system functional requirements without disrupting normal operation.

.4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device

.5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, and program execution.

.6 Software for each Controller and single section referencing Controller common parameters and functions.

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

.8 System configuration document:

.1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.

.2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 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.

.2 Related Requirements

.1 Section 01 - Submittal Procedures.

.2 Section 25 - EMCS: General Requirements.

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA Group).

.1 CSA C22.1, The Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTION

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

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 - Submittal Procedures and Section 25 – EMCS: Submittals and Review Process 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 (background), black core (lettering), square corners, lettering accurately aligned and engraved into core, mechanically attached with self-tapping screws.

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black lettering.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Instrument and Device Tags

.1 Identify by round Lamacoid tag (white background) attached by chain, or round aluminum tag attached by chain. Tag material, shape, size, and style shall be the same for the entire project. Provide a single hole in the top-centre of tag to allow #6 Chain to pass through.

.2 Sizes: 50 mm Round.

.3 Lettering: minimum 5 mm high type-written (black lettering for Lamacoid type).

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

.5 Chain: #6 Nickel Plated Brass Connector, #6 Stainless Steel Ball Chain sized to suit proper attachment to the equipment or instrument. Minimum chain length shall be 150 mm.

.2 Companion cabinet:

.1 Identify interior components using plastic enclosed cards with point name and point address.

.2 Provide exterior Lamacoid (sticky back) with white background and black lettering identifying the cabinet.

.3 Lettering: minimum 5 mm high type-written (black lettering).

.4 Sizes: 25mm x 50 mm.

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.

2.5 WIRING

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

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

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

2.6 PNEUMATIC TUBING

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

2.7 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

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

Part 3 Execution

3.1 NAMEPLATES AND LABELS

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

3.2 EXISTING PANELS

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 – Summary of Work.

.2 Section 01 – Execution Requirements.

.3 Section 07 – Fire-stopping.

.4 Section 21 – Common Work Results for Mechanical.

.5 Section 21 – Thermal Insulation of Piping.

.6 Section 22 – Drainage Waste and Vent Piping – Cast Iron and Copper.

.7 Section 23 – Installation of Pipework.

.8 Section 23 – Hangers and Supports for HVAC Piping and Equipment.

.9 Section 23 – Duct Insulation.

.10 Section 23 – Hydronic Systems: Steel.

.11 Section 23 – Copper Tubing and Fittings Refrigerant.

.12 Section 25 – EMCS: General Requirements.

.13 Section 26 – Common Work Results-Electrical.

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)

.1 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.

.2 ANSI C2, National Electrical Safety Code.

.3 ANSI/NFPA 70, National Electrical Code.

.2 CSA Group

.1 CSA C22.1,

.2 CAN/CSA-C22.3 No. 7, Underground Systems.

.3 CSA C22.2 No. 45.1, Electrical Rigid Metal Conduit.

.4 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.5 CSA C22.2 No. 83, Electrical Metallic Tubing.

.6 CAN/CSA-C22.3 No. 1, Overhead Systems.

1.3 SYSTEM DESCRIPTION

.1 Electrical:

.1 Provide power wiring from emergency power panels where emergency power is provided to EMCS field panels. If no emergency power provided, install UPS Device. 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.

.3 Communication wiring between EMCS field panels and OWS's including main control centre BECC.

.4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

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

.6 All control wiring 50 V and less for equipment supplied by Division 25 will be the responsibility of Division 25- Integrated Automation Contractor. Conduit and wire associated with this is the responsibility of Division 25.

.2 Pneumatic:

.1 Pneumatic tubing, valves and fittings for field control devices.

.3 Mechanical:

.1 Pipe taps required for EMCS equipment will be supplied and installed by Mechanical Division.

.2 Wells and control valves shall be supplied by EMCS Contractor and installed by Mechanical.

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

.4 VAV Terminal Units.

.1 Air flow probe for VAV boxes to be supplied and installed under Mechanical Division. Air flow differential pressure sensor, actuator and associated VAV controls to be supplied and installed by EMCS contractor. Tubing from air probe to differential pressure sensor as well as installation and adjustment of air flow sensors and actuators to be the responsibility of EMCS contractor. Coordinate air flow adjustments with balancing trade.

.5 Structural:

.1 Special steelwork as required for installation of work.

1.4 PERSONNEL QUALIFICATIONS

.1 Qualified supervisory personnel to:

.1 Continuously direct and monitor all work.

.2 Attend site meetings.

1.5 EXISTING CONDITIONS

.1 Cutting and Patching: refer to Section 01 - Execution supplemented as specified herein.

.2 Repair all surfaces damaged during execution of work.

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

Part 2 Products

2.1 PIPING

.1 Domestic H&CWS: refer to Section 22 - Domestic Water Piping Copper and Section 22 – Domestic Water Piping Plastic.

.2 Sanitary, storm water: refer to Section 22 - Drainage Waste, Vent Piping – Cast Iron and Copper and Section 22 – Drainage, Waste and Vent Piping – Plastic.

.3 Hot water heating, chilled water: refer to Section 23 – Hydronic Systems: Steel and Section 23 Pressure Piping – Plastic.

.4 Condenser water: refer to Section 23 – Hydronic Systems: Steel.

.5 Refrigeration: refer to Section 23 - Refrigerant Piping.

.6 Sleeves, escutcheons: refer to Section 23 – Installation of Pipework.

.7 Hangers and supports: refer to Section 23 – Hangers and Supports for HVAC Piping and Equipment.

.8 Insulation: refer to Section 21 – Thermal Insulation for Piping and 23 – Thermal Insulation for Ducting.

2.2 SPECIAL SUPPORTS

.1 Structural grade steel, primed and painted after construction and before installation.

2.3 PIPING FOR PNEUMATIC CONTROL SYSTEMS

.1 Copper:

.1 Tubing: Type L Hard Drawn

.1 Fittings: wrought copper solder type to ANSI/ASME B16.22, and 95.5 antimonial tin solder. At instruments use compression fittings.

.2 At panels and junction boxes where there is a transition from plastic to copper use bulkhead fittings.

.2 Plastic:

.1 Flame retardant, black PVC with minimum burst strength 1.3 MPa at 23 degrees Celsius installed in conduit.

.2 Fittings: compression or barbed type as required.

2.4 WIRING

.1 As per requirements of Electrical Divisions.

.2 For 50V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.

.3 For wiring under 50 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.

.4 Sizes:

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

.2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 AWG minimum.

.3 Field wiring to digital device: #18 AWG, or 20 AWG stranded twisted pair.

.4 Analog input and output: shielded #18 AWG minimum solid copper minimum. Wiring must be continuous without joints. Shielding must be bonded on one end.

.5 More than 4 conductors: #18 AWG minimum solid copper.

.5 Terminations:

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

2.5 CONDUIT

.1 As per requirements of Electrical Division.

.2 Electrical metallic tubing to CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 No. 56. Rigid steel threaded conduit to CSA C22.2 No. 45.1.

.3 Junction and pull boxes: welded steel.

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

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

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

.5 Outlet boxes: 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 degree bends required for 25 mm and larger conduits.

.8 Fittings for thin wall conduit:

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

2.6 WIRING DEVICES, COVER PLATES

.1 Conform to CSA.

.2 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.

.1 In outdoor or wet/damp locations provide Weatherproof (WP) cover with while-in-use capabilities.

2.7 STARTERS, CONTROL DEVICES

.1 Shall have a panel plate on the front door of the enclosure with visible CSA or cUL markings.

.2 Across-the-line magnetic starters:

.1 Enclosures: CSA Type 4, except where otherwise specified.

.2 Size, type and rating: to suit motors.

.3 Starter diagrams:

.1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.

.4 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.

.5 Finish for starters:

.1 Exterior: in accordance with Section 26 - Common Work Results for Electrical.

.2 Interior: white.

2.8 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 PIPING

.1 Domestic H&CWS: refer to Section 22 – Domestic Water Piping Copper.

.2 Sanitary, storm water: refer to Section 22 - Drainage Waste and Vent Piping – Cast Iron and Copper.

.3 Hot water heating, chilled water: refer to Section 23 – Hydronic Systems: Steel.

.4 Condenser water: refer to Section 23 – Hydronic Systems: Steel.

.5 Refrigeration: refer to Section 23 - Copper Tubing and Fittings Refrigerant.

.6 Insulation: refer to Section 21 – Thermal Insulation for Piping and 23 – Thermal Insulation for Ducting.

3.3 MECHANICAL PIPING

.1 Install piping in accordance with Section 23 – Installation of Pipework.

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

.3 Ream ends of pipes before assembly.

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

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

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

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

.8 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 fire stopping by Section 07 - Fire Stopping. 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.

.9 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 hours 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.

.10 Introduce system pressure carefully into new piping.

3.4 SUPPORTS

.1 Install special supports as required and as indicated.

3.5 PNEUMATIC CONTROL SYSTEMS

.1 General:

.1 Install tubing in accessible concealed locations, straight, parallel and close to building structure with required grades for drainage and venting.

.2 Install drip legs and drains at low points.

.3 Tubing to be free from surface damage.

.4 Tubing NOT to pass through or touch unheated ducts or enclosures.

.5 Do not cover pneumatic tubing with insulation.

.6 Test tubing, check joints after connection to system.

.2 Copper tubing:

.1 Not to come into contact with dissimilar metal. Use non-metallic stand-offs on air handling systems.

.2 Install dielectric couplings where dissimilar metals are connected.

.3 Plastic tubing:

.1 Inaccessible locations: install plastic tubing in conduit.

.2 Inside panels: install in tube trays or racks, or clip individually to back of panel.

.3 Multiple tube bundles: install in tube trays, conduit or armoured flexible cable.

3.6 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:

.1 Electrical Divisions, 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 50 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 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.

3.7 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 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 indicated in cabinets to Electrical Division.

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

3.8 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.

3.9 WIRING DEVICES, 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.

3.10 STARTERS, CONTROL DEVICES

.1 Install and make control connections as indicated. Power connections above 50V by Electrical Division.

.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.

3.11 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.

3.12 TESTS

.1 General:

.1 Perform following tests in addition to tests specified Section 25 - 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.

3.13 IDENTIFICATION

.1 Refer to Section 25 - EMCS: Identification.

END OF SECTION

Part 1 General

1.1 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).

.2 Related Requirements

.1 Section 01 - Submittal Procedures.

.2 Section 01 - Closeout Submittals.

.3 Section 25 - EMCS: General Requirements.

.3 References.

.1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.

.2 Canadian Standards Association (CSA Group).

.1 CSA Z204, Guidelines for Managing Indoor Air Quality in Office Buildings.

1.2 DEFINITIONS

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

.2 OWS - Operator Work Station.

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

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

.3 Submit detailed inspection reports to Departmental Representative.

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

.1 Point name and location.

.2 Device type and range.

.3 Measured value.

.4 System displayed value.

.5 Calibration detail

.6 Indication if adjustment required,

.7 Other action taken or recommended.

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

.6 Records and logs: in accordance with Section 01 - Closeout Submittals.

.1 Maintain records and logs of each maintenance task on site.

.2 Organize cumulative records for each major component and for entire EMCS chronologically.

.3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.

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

1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD

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

.2 Emergency Service Calls:

.1 Initiate service calls when EMCS is not functioning correctly.

.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.

.3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.

.4 Service personnel to be 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.

1.5 SERVICE CONTRACTS

.1 Provide in-depth technical expertise and assistance to Departmental Representative and Commissioning Manager in preparation and implementation of service contracts and in-house preventive maintenance procedures. Service contracts duration is for the warranty period.

.2 Service Contracts to include:

.1 Annual verification of field points for operation and calibration.

.2 4 visits per year.

.3 2 responses to emergency calls during day, per year.

.4 2 responses to emergency calls during silent hours, per year.

.5 Silent hours defined as 1630 h – 0800 h and on weekends and statutory holidays.

.6 Complete inventory of installed system.

Part 2 Products

2.1 NOT USED

.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 CSA Z204 and Canada Labour Code - Part I.

.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 Operations Supervisor and/or 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.

.1 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 OF SECTION

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).

.2 Related Requirements

.1 Section 25 – EMCS: General Requirements.

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA Group).

.1 CSA T529, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).

.2 CSA T530, Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).

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

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

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

.1 TIA/EIA-568, 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, Commercial Building Standard for Telecommunications Pathways and Spaces.

.4 Treasury Board Information Technology Standard (TBITS).

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

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTION

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

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

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

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

.1 EMCS-LAN.

.2 Modems.

.3 Network interface cards.

.4 Network management hardware and software.

.5 Network components necessary for complete network.

1.5 DESIGN REQUIREMENTS

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

.1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.

.2 EMCS-LAN to: BACnet, Proprietary Protocol.

.3 Each EMCS-LAN to be capable of supporting at least 50 devices.

.4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.

.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.

.6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.

.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access.

.1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.

.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium.

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

.2 Related Sections:

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

.2 Section 25 - EMCS: Project Records Documents.

.3 Section 01 - Execution Requirements.

.4 Section 07 - Firestopping.

.5 Section 23 - Pneumatic Control System for HVAC.

.6 Section 23 - Dampers - Operating.

.7 Section 25 - EMCS: Start-Up, Verification and Commissioning.

.8 Section 25 - EMCS: General Requirements.

.9 Section 25 - EMCS: Shop Drawings, Product Data and Review Process.

.10 Section 25 - EMCS: Identification.

.11 Section 25 - EMCS: Site Requirements Applications and Systems Sequences of Operation.

.12 Section 26 - Common Work Results for Electrical.

.13 Section 26 27 10 - Modular Wiring System.

.14 Section 26 27 26- Wiring Devices.

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI).

.1 ANSI C12.7, Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.

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

.1 ASTM B148, Standard Specification for Aluminum-Bronze Sand Castings.

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

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

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

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

.5 Canadian Standards Association (CSA Group).

.1 CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

1.3 DEFINITIONS

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

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Include:

.1 Information as specified for each device.

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

.3 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.

1.5 EXISTING CONDITIONS

.1 Cutting and Patching: in accordance with Section 01 - Execution Requirements supplemented as specified herein.

.2 Repair surfaces damaged during execution of Work.

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

Part 2 Products

2.1 GENERAL

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

.2 External trim materials to be corrosion resistant.

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

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

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

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

.7 Outdoor installations: use weatherproof construction in NEMA 3R 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, pressure, as indicated in I/O summary in Section 25 - EMCS: Site Requirements, Applications and System Sequences of Operation.

2.2 TEMPERATURE SENSORS

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

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

.2 RTD's: 100 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.

.3 Sensing element: hermetically sealed.

.4 Stem and tip construction: copper or type 304 stainless steel.

.5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.

.6 Immersion wells: 3/4" NPS, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm, or 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 for access to zone bus.

.4 Integral thermistor sensing element 10,000 ohm at 24 degrees C.

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

.6 Stability 0.02 degrees C drift per year.

.7 Separate mounting base for ease of installation.

.2 Room temperature sensors.

.1 Wall mounting, in slotted type covers having brushed aluminum 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 degrees C.

.3 Duct temperature sensors:

.1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm 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.

.4 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 4X enclosure.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:

.1 Input circuit: to accept 3-lead, 100 ohm at 0 degrees C, platinum resistance detector type sensors.

.2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees 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 RTD sensor: not to exceed 22.5 mA.

.8 Integral zero and span adjustments.

.9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50 degrees 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 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.

.2 0 to 100 degrees C, plus or minus 0.5 degrees C.

.3 0 to 50 degrees C, plus or minus 0.25 degrees C.

.4 0 to 25 degrees C, plus or minus 0.1 degrees C.

.5 10 to 35 degrees C, plus or minus 0.25 degrees C.

2.4 HUMIDITY SENSORS

.1 Room and Duct Requirements:

.1 Range: 5 - 95 % RH minimum.

.2 Operating temperature range: -40°C to 85°C.

.3 Absolute accuracy:

.1 Duct sensors: plus or minus 5 %.

.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 0.5% RH with defined curves.

.6 Room sensors: wall mounted as indicated.

.7 Duct mounted sensors: locate so that sensing element is between 1/3 and 2/3 distance across any duct dimension.

.8 Sensors to be unaffected by external transmitters such as walkie-talkies. Demonstrate to Owner’s Representative.

.9 Power supply: 18-35 Vdc, 18-32 Vac with temperature sensor.

2.5 HUMIDITY TRANSMITTERS

.1 Requirements:

.1 Input signal: from RH sensor.

.2 Output signal: 4 - 20 mA into 1000 ohm maximum load, 0-5 Vdc, 0-10 Vdc.

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

.4 Output variations: not to exceed 0.1 % of full span.

.5 Output linearity error: plus or minus 1.0% maximum of full scale output.

.6 Integral zero and span adjustment.

.7 Temperature range: 0-70ºC, -40ºC to 85ºC for outside air.

.8 Long term output drift: not to exceed 0.25 % of full scale output/ 6 months.

2.6 PRESSURE TRANSDUCERS

.1 Requirements:

.1 Range: as indicated in I/O summaries.

.1 Pressure sensing elements: bourdon tube, bellows or diaphragm type.

.2 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 - 20 mA, 0-5V, 0-10V.

.3 Output variations: $\pm$ 1 % 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 1% 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 Pressure ranges: see I/O Summaries.

.10 Accuracy: plus or minus 1 % of full scale.

.11 LCD Display.

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, 0-5V, 0-10V.

.3 Output variations: $\pm$ 1 % 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 1 % of full scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 °C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 The unit to have a NPT connections. The enclosure shall be an integral part of the unit.

.10 LCD Display.

2.8 STATIC PRESSURE SENSORS

.1 Requirements:

.1 Multipoint element with self-averaging manifold.

.1 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).

.2 Accuracy: plus or minus 1% of actual duct static pressure.

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 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20 mA in 400 ohms, 0-5V into 5K ohms minimum, 0-10 V into 10K ohms minimum.

.2 Output variations: $\pm$ 1% full scale for supply voltage variations of plus or minus 10%.

.3 Integral zero and span adjustment.

.4 Temperature effects: not to exceed plus or minus 3% full scale/ 50 °C.

.5 Output short circuit and open circuit protection.

.6 The unit to have a NPT ½ conduit connection. The enclosure shall be an integral part of the unit.

.7 Pressure ranges: see I/O Summaries.

.8 LCD Display.

2.11 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements:

.1 Range: as indicated in I/O summaries.

.1 Pressure sensing elements: bourdon tube, bellows or diaphragm type.

.2 Adjustable setpoint and differential.

.3 Switch: snap action type, rated at 120V, 15 amps AC or 24 V DC.

.4 Sensor 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 sensor pressure and accuracy ratings:

.1 Chilled and condenser water: 860 kPa.

.2 Hot water: 860 kPa.

.3 Low pressure steam, compressed air: 1050 kPa. Range: 0 to 200 kPa. Accuracy: plus or minus 3 kPa.

.4 Medium pressure steam, compressed air: 1050 kPa. Range: 0 to 700 kPa. Accuracy: plus or minus 7 kPa.

.5 High pressure steam: 2100 kPa. Range: 0 to 2100 kPa. Accuracy: plus or minus 14 kPa.

.6 High temperature water: 2700 kPa. Range: 0-2700 kPa. Accuracy: plus or minus 25 kPa.

.7 For fan operation: Range: 0 to 3000 Pa. Adjustable differential: 10 to 300 Pa.

.7 Provide sensors with isolation valve and snubber between sensor and pressure source on liquid service.

.8 Sensors on steam and high temperature hot water service: provide pigtail syphon.

2.12 DUCT SYSTEM 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 Maximum pressure loss: 37 Pa at 1000 m/s.

.3 Accuracy: plus or minus 1% of actual duct velocity.

2.13 FAN SYSTEM VELOCITY PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.

.2 Calibrated span: not to exceed 25 % 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 The unit to have a NPT ½ conduit connection. The enclosure shall be an integral part of the unit.

2.14 TURBINE FLOW METERS

.1 Requirements:

.1 Flow range: as specified in I/O summaries.

.2 Pressure rating: 1035 kPa (gauge) at 38 °C.

.3 Temperature rating: 5 to 260 °C.

.4 Repeatability: plus or minus 0.1 %.

.5 Accuracy and linearity: plus or minus 0.5 %.

.6 Flow rangability: at least 10:1.

.7 Output voltage: 30 to 300 mV peak-to-peak into 10 Kohm load.

.8 Body material: brass, bronze or cast iron.

.9 Ends:

.1 NPS 2 and under: screwed or flanged

.2 NPS 2 1/2 and over: flanged.

2.15 FREQUENCY-TO-DC TRANSMITTERS FOR TURBINE METERS

.1 Requirements:

.1 Input: greater than 5000 ohm.

.1 Range: greater than 100 mV less than 20 V peak-to-peak, 200 through 400 Hz.

.2 Span adjustment: fully adjustable.

.3 Zero adjustment: 0 to 10% of output.

.4 Output: 4 to 20 mA into 500 ohm load.

.5 Load effect: plus or minus 0.1 % of span zero to maximum load resistance.

.6 Linearity and repeatability: plus or minus 0.05 % of span.

.7 Power input: 24 V DC plus or minus 10 %.

.8 Input, output and power input transformer isolated.

.9 Enclosure: general purpose CSA 12.

2.16 LIQUID AND STEAM FLOW METERS

.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 Ends:

.1 NPS 2 and under: screwed.

.2 NPS 2.1/2 and over: flanged.

2.17 TEMPERATURE SWITCHES

.1 Requirements:

.1 Range: see I/O summaries.

.2 Temperature sensor: liquid, vapour or bimetallic type. Operate automatically. Reset automatically, except as follows:

.1 Freeze protection: manual reset. Optional if software does not auto restart.

.2 Fire detection: manual reset. Optional if software does not auto restart.

.3 Duct Heater: high limit manual reset in addition to automatic reset.

.3 Adjustable setpoint and differential.

.4 Accuracy: plus or minus 1 °C.

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

.6 Type as follows:

.1 Room: for wall mounting on standard electrical box with or without protective guard as indicated.

.2 Duct, general purpose: insertion length = 460 mm.

.3 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.

.4 Freeze detection: continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 300 mm length.

.5 Strap-on: with helical screw stainless steel clamp.

2.18 TANK LEVEL SWITCHES

.1 Requirements:

.1 Indicate high/low water level and to alarm.

.2 For mounting on top of tank.

.3 Maximum operating temperature: 120 °C.

.4 Mechanical switch or snap action contacts rated 15 amp at 120 V.

.5 Adjustable setpoint and differential.

2.19 SUMP LEVEL SWITCHES

.1 Requirements:

.1 Liquid level activated switch sealed in waterproof and shockproof enclosure.

.2 Complete with float, flexible cord, weight. Instrument casing to be suitable for immersion in measured liquid.

.3 N.O./N.C. Contacts rated at 15 amps at 120V AC. CSA approval for up to 250 volt 10 amps AC.

2.20 WIND VELOCITY TRANSMITTERS

.1 Requirements:

.1 3-cup anemometer and airfoil vane mounted on common vertical axis, designed for mast mounting.

.2 Anemometer:

.1 Range: 0-160 km/h.

.2 Threshold: 3.0 km/h.

.3 Accuracy: +/- 2%.

.3 Airfoil vane

.1 Range: 0-360 degrees with infinite resolution potentiometer with no loss of reading at transition point.

.2 Starting threshold: 1.1 M/s.

.3 Accuracy: +/- 0.5%.

.4 Output signals: 4 to 20 Ma into 500 ohm load.

.5 Provide two output signals: velocity, direction.

.6 Mast: aluminum, size and height as indicated.

.1 Provide at least 3 stainless steel guys, turnbuckles, anchor bolts. Follow manufacturer's installation guidelines.

.2 Lightning protection as indicated on electrical drawings.

2.21 SOLAR SENSORS

.1 Monitor solar radiation as indicated.

.2 Pyranometer, black and white, producing proportional 0-50 mV signal. Include converter for 4-20mA signal.

2.22 CURRENT / PNEUMATIC (I/P) TRANSDUCERS

.1 Requirements:

.1 Input range: 4 to 20 mA.

.2 Output range: proportional 20-104 kPa 20-186 kPa as applicable.

.3 Housing: dustproof or panel mounted.

.4 Internal materials: suitable for continuous contact with industrial standard instrument air.

.5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2 % of full scale over entire range.

.6 Integral zero and span adjustment.

.7 Temperature effect: plus or minus 2.0 % of full scale/ 50 degrees C or less.

.8 Regulated supply pressure: 206 kPa maximum.

.9 Air consumption: 16.5 ml/s maximum.

.10 Integral gauge manifold c/w gauge (0-206 kPa).

2.23 SOLENOID CONTROL AIR VALVES

.1 Coil: 24VDC or 120V AC, as indicated.

.2 Capacity: to pass a minimum of 0.15 l/s air at 140 kPa differential.

2.24 AIR PRESSURE GAUGES

.1 Diameter: 38 mm minimum.

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

2.25 FAN SYSTEM STATIC PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20 mA in 400 ohms, 0-5V into 5K ohms minimum, 0-10 V into 10K ohms minimum.

.2 Output variations: $\pm$ 1% full scale for supply voltage variations of plus or minus 10%.

.3 Integral zero and span adjustment.

.4 Temperature effects: not to exceed plus or minus 3% full scale/ 50 °C.

.5 Output short circuit and open circuit protection.

.6 The unit to have a NPT ½ conduit connection. The enclosure shall be an integral part of the unit.

.7 Pressure ranges: see I/O Summaries.

.8 LCD Display.

2.26 ELECTRICAL RELAYS

.1 Requirements:

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

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

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

.4 Relay to have visual status indication

2.27 SOLID STATE RELAYS

.1 General:

.1 CSA approved.

.2 Suitable to the application as recommended by manufacturer.

.3 For input inductive noise use twisted-pair wires for electromagnetic noise and shielded cable for static noise.

.4 Relays to have LED Indicator

.5 Input and output Barrier Strips to accept 14 to 28 AWG wire.

.6 Operating temperature range to be -20 degrees C to 70 degrees C.

.7 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.

.8 Operational frequency range, 45 to 65 HZ.

.2 Input:

.1 Control voltage, 3 to 32 VDC.

.2 Drop out voltage, 1.2 VDC.

.3 Input capacitor/resistor circuit for pulse noise absorption.

.4 Maximum input current to match AO (Analog Output) board.

.3 Output.

.1 AC or DC Output Model to suit application.

.2 Voltage range: 75-265 VAC

.3 Output surge absorbing element for inductive on/off loads.

2.28 CURRENT TRANSDUCERS

.1 Requirements:

.2 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.

.3 Frequency insensitive from 10 - 80 Hz.

.4 Accuracy to 0.5% full scale.

.5 Zero and span adjustments. Field adjustable range to suit motor applications.

.6 Adjustable mounting bracket to allow for secure/safe mounting inside the MCC or starter enclosure.

2.29 CURRENT SENSING RELAYS

.1 Requirements:

.1 Complete with metering transformer ranged to match load, plug-in base and shorting shunt to protect current transformer when relay is removed from socket.

.2 Suitable to detect belt loss or motor failure.

.3 Trip point adjustment, output status LED.

.4 Split core for easy mounting.

.5 Induced sensor power.

.6 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC, and 10 amps at 240VAC. Output to be NO solid state.

.7 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.

.8 To have adjustable latch level, adjustable delay on latch and minimum differential of 10 % of latch setting between latch level and release level.

.9 To have adjustable latch level to allow detection of worst case selection. To be powered from control circuit of motor starter being metered. Relay and base to be mounted in adjacent auxiliary cabinet only if control circuit power to be brought into auxiliary cabinet. Adjustments to be acceptable from auxiliary cabinet.

2.30 CONTROL DAMPERS

.1 Construction: blades, 152 mm wide, 1219 mm long, maximum. Modular maximum size, 1219 mm wide x 2438 mm high. Multiple sections to have stiffening mullions and jack shafts.

.2 Materials

.1 Frame: 2.3 mm minimum thickness galvanized steel.

.2 Blades: galvanized steel with two sheets 0.5 mm thick or otherwise reinforced to ensure specified low leakage when fully closed.

.3 Bearings: oil impregnated sintered bronze. Provide thrust bearings for vertical blades.

.4 Linkage and shafts: zinc plated steel.

.5 Seals: replaceable neoprene or stainless steel spring on sides, top, bottom of frame, along all blade edges and blade ends.

.3 Performance:

.1 Capacity: refer to I/O Summaries.

.2 0.02 L/s.m 2 maximum allowable leakage against 1000 Pa static pressure.

.3 Temperature range: minus 50°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.

.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 manufacturer's installation guidelines.

.4 Use same manufacturer as damper sections.

2.31 PNEUMATIC CONTROL DAMPER ACTUATORS

.1 Requirements:

.1 Piston type with spring return for "fail-safe" in Normally Open or Normally Closed position, as indicated.

.2 Operator: size to control dampers against maximum pressure and dynamic opening/closing pressure, whichever is greater.

.3 Adjustable spring and stroke external stops to limit strokes in either direction.

.4 For modulating applications provide with full relay type positioner with interconnecting linkage for mechanical feedback. Adjust to operate between range of 20-90 kPa unless otherwise indicated in control sequence of operation or input/output summary sheet.

.5 Positioners not required on single damper sections with less than 1 m^2face area.

.6 Multiple section dampers over 1200 mm long: to be driven from both ends.

2.32 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 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.

.4 Power requirements: 5 VA maximum at 24 V AC.

.5 Operating range: 4-20 mA. 0-10 V DC, 2-10 V DC.

.6 For VAV box applications floating control type actuators may be used.

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

2.33 CONTROL VALVES

.1 Requirements:

.1 NPS 2 and under: bronze with screwed ends.

.2 NPS 2 1/2 and over: cast iron with flanged ends.

.3 Trim: type 316 stainless steel.

.4 Leakage: 0.5 % of rated flow maximum.

.5 Two or three port as indicated. Normally Open or Normally Closed, as indicated.

.6 Flow characteristics: linear or equal percentage as indicated.

.7 Rangeability: 50:1 minimum.

.8 Performance: Capacity refer to I/O Summaries and Valve Schedule.

2.34 PNEUMATIC VALVE ACTUATORS

.1 Requirements:

.1 Construction: steel, cast iron, aluminum.

.2 Diaphragm: moulded Buna-N rubber, nylon reinforced.

.3 Spring return to normal position.

.4 Spring range adjustment and position indicator.

.5 Provide pilot positioners on modulating control valves over 50 mm and where indicated on drawings. Positioners to operate between 20 to 90 kPa unless otherwise noted or required by sequence.

.6 Minimum shut-off pressure: refer to control valve schedule.

2.35 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements:

.1 Construction: steel, cast iron, aluminum.

.2 Control voltage: 0-5, 0-10, 2-10V DC, or 4-20 mA.

.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 Size actuator to meet requirements and performance of control valve specifications.

.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.

.9 Spring return to normal position as indicated.

2.36 WATTHOUR METERS AND CURRENT TRANSFORMERS

.1 Requirements:

.1 Include three phases, test and terminal blocks for watthour meter connections and connections to FID for monitoring of current. Provide three potentiometer transformers for 600 V 4 wire systems for watthour meter use. Accuracy: plus or minus 0.25 % of full scale. For chiller applications: To have instantaneous indicator with analog or digital display.

.2 Watthour metre sockets: to ANSI C12.7.

.3 Potential and current transformers: to ANSI/IEEE C57.13.

.4 Potential transformers: provide two primary fuses.

.5 Demand meters: configure to measure demand at 15 minute intervals.

2.37 SURFACE WATER DETECTORS

.1 Requirements:

.1 Provide alarm on presence of water on floor.

.2 Expendable cartridge sensor.

.3 Internal waterproof switch.

.4 One set of dry contacts 2 amps at 24 V.

.5 Unaffected by moisture in air.

.6 Self-powered.

2.38 PANELS

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

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

.3 Panels to be lockable with same key.

2.39 CONTROL AIR COMPRESSOR STATIONS

.1 Requirements: provide 2 high pressure, base mounted, each complete with belts, guards, intake muffler, replaceable cartridge intake cleaner, starter, pressure switches, alternator.

.2 Capacity: size to maintain air pressure; meet control air requirements on 25% maximum running time.

.3 Receiver: size to suit running time. Complete with electronic automatic drain with strainer, pressure relief valve, pressure gauge ASME code rated for 1400 kPa.

.4 Vibration isolation: 5% transmissibility.

.5 Refrigerated air drier:

.1 2 continuous operating type, complete with refrigerant evaporator, mechanical condensate separator, installed with 2 isolating valves. Designed for 1400 kPa maximum operating pressure.

.2 Capacity: sized for full capacity of compressors, to reduce dewpoint to minus 10 degrees C when dehydrating at 700 kPa. Maximum pressure drop 19 kPa at rated capacity.

.3 Provide 2 filter and PRV assemblies, with isolating valves and filter element, having 99% efficiency in removal of 0.5 micron diameter solid particles and oil aerosols and with indication of degree of saturation. Piping: ensure one dryer is always in circuit and active.

2.40 ELECTRONIC VAV TERMINAL CONTROL BOX

.1 Terminal box sized to deliver air quantities as per mechanical VAV Box Schedule.

.2 Box complete with factory installed averaging air velocity sensor.

.1 Provide removable air flow sensor with minimum 4 point sensing with +/- 5% accuracy at 10 deg C to 35 deg C and 40 to 1000 l/s.

.3 Box to include direct damper shaft mounted actuator, of the non-stall, full linear with position feedback type. Actuator to de-energize when at desired position.

.4 Box to be complete with power transformer and control wiring to damper actuator and termination terminals for room sensors and other specified sensors and auxiliary devices.

.5 Box to include VAV Controller as described in Section 25 - EMCS: Building Controllers with appropriate mounting plate and protective cover.

2.41 ELECTRONIC AIR FLOW MEASUREMENT STATIONS AND TRANSMITTERS

.1 Each station to contain an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. The velocity sensing elements to be of the thermal, temperature compensated thermistor type, with linearizing means. The sensing elements to be distributed across the duct cross section in the quantity and pattern set forth for measurements and instruments of ASHRAE and SMACNA for the traversing of ducted air flows. The resistance to air flow through the airflow measurement station not to exceed 20 Pa gauge at an airflow of 10 m/s. Station construction suitable for operation at airflows of up to 25 m/s over a temperature range of 5 to 50 degrees C, and accuracy plus or minus 3 percent over a range of 0.625 to 12.5 m/s scaled to air volume.

.2 Transmitters to produce a linear, temperature compensated 4-20 mAdc output corresponding to the required velocity pressure measurement. The transmitter to be a 2-wire, loop powered device with local indication where indicated. The output error of the transmitter not to exceed 0.5 percent of the calibrated measurement.

2.42 FUEL TANK LEVEL SENSOR

.1 Provide suitable electronic, cUL approved oil tank level sensor to measure product and water level in oil tank specified in Section 33 – Aboveground Fuel Storage Tanks. Components in oil tank to be of stainless steel construction, electrical enclosures CSA rated. Float type probes to be provided with riser to suit oil tank c/w suitable tapping adaptor and S.S. guide tube with foot.

.2 Sensor to communicate with EMCS system for oil and water level in tank.

2.43 WIRING

.1 In accordance with Section 26 - Wiring Devices, 26 - Modular Wiring System.

.2 For wiring under 50 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: #18 AWG stranded twisted pair.

.2 Analog input and output: shielded #18 minimum stranded twisted pair.

Part 3 Execution

3.1 INSTALLATION

.1 Install field control devices, conduit and wire in accordance with manufacturers recommended methods, procedures and instructions. Wiring and conduit above 50 volts by electrical Division. Coordinate requirements with Electrical Contractor.

.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 12 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 in accordance with Section 07 - Firestopping. Maintain fire rating integrity.

.6 Electrical:

.1 Complete installation in accordance with Section 26 - 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 on drawings per Section 25 - EMCS: Site Requirements Applications and Systems Sequences of Operation. 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 Pneumatic: provide Pneumatic tubing, valves and fittings for field control devices in accordance with Section 23 - Pneumatic Control System for HVAC.

.8 Mechanical: supply and install in accordance with Section 23 - Pneumatic Control System for HVAC.

.1 Pipe Taps.

.2 Wells and Control Valves.

.3 Air flow stations, dampers, and other devices.

.9 VAV Terminal Units: supply, install and adjust as required.

.1 Air probe, actuator and associated vav controls.

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

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

3.2 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 4X enclosures.

.4 Duct installations:

- .1 Do not mount in dead air space.
- .2 Locate within sensor vibration and velocity limits.
- .3 Securely mount extended surface sensor used to sense average temperature.
- .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
- .5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors.

- .1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
- .2 Sensor length to be not less than 1000 mm per square metre of duct cross-sectional area.
  - .1 Use multiple sensors where single sensor does not meet minimum length ratio.
- .3 Wire multiple sensors in series for freeze protection applications.
- .4 Wire multiple sensors separately for temperature measurement.
- .5 Use either software averaging algorithm to derive overall average for control purposes or separate inputs, based on site requirements.

.6 Thermowells: install for piping installations.

- .1 Locate well in elbow where pipe diameter is less than well insertion length.
- .2 Thermowell to restrict flow by less than 30%.
- .3 Use thermal conducting paste inside wells.
- .4 Where pipe diameter is less than well insertion length, locate well in elbow.

3.3 PANELS

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

.2 Use modular multiple panels if necessary to handle all requirements, with space for additional 20% PCU or FID if applicable without adding additional panels. Space to accommodate maximum capacity of associated controller (ECU, LCU, MCU, PCU, TCU).

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

.4 Identify wiring and conduit clearly.

3.4 MAGNEHELIC PRESSURE INDICATORS

.1 Install adjacent to fan system static pressure sensor and duct system velocity pressure sensor as reviewed by Departmental Representative.

.2 Locations to be as indicated or specified.

3.5 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.

3.6 I/P TRANSDUCERS

.1 Install air pressure gauge on outlet.

3.7 AIR PRESSURE GAUGES

.1 Install pressure gauges on pneumatic devices, I/P, pilot positioners, motor operators, switches, relays, valves, damper operators, valve actuators.

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

3.8 PNEUMATIC VALVE ACTUATORS

.1 Install full relay type positioner having interlocking linkage for mechanical feedback of actual valve position on all modulating valves except radiation and unit heaters.

3.9 TANK LEVEL SWITCHES

.1 Mount in top of tank in threaded coupling.

3.10 LIQUID LEVEL SWITCHES

.1 Suspend float in sump from flexible cord and with weight mounted not more than 50 mm above switch.

3.11 IDENTIFICATION

.1 Identify field devices properly.

.2 Identify field devices in accordance with Section 25 - EMCS: Identification.

3.12 AIR FLOW MEASURING STATIONS

.1 Cap manifold until cleaning of ducts is completed.

3.13 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance. Submit report detailing tests performed, results obtained to Department Representative for approval. Provide testing equipment and manpower necessary for this verification.

.2 Calibrate and test field devices for accuracy and performance in accordance with Section 25 - EMCS: Start-up, Verification and Commissioning.

.3 Refer to Section 25 - EMCS: Warranty and Maintenance.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 At minimum 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 REFERENCE STANDARDS

.1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.

.1 MD13800, Energy Management and Control Systems (EMCS) Design Manual.

1.3 DESIGN DOCUMENTATION

.1 Design documentation for each system to include, as a minimum:

.1 Narrative type of Sequence of Operation.

.2 Control Description Logic (CDL).

.3 Input/Output Summary Schedules.

.4 Schematics.

1.4 SEQUENCING

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

1.5 EMCS Language Design Criteria

.1 Language: refer to Section 25 EMCS: General Requirements.

.2 Levels of EMCS Language

.1 Level 1: alarm and operational messages to convey alarm conditions or operational messages.

.2 Level 2: full names of equipment and control points. The various systems, their equipment and components and all control points are named in accordance with this section.

.3 Level 3: system, equipment, component and control point descriptors: unique, alphanumeric identifiers derived from full names of corresponding system component and control point.

.4 Level 4: commands: represent various computer functions and routines.

.1 Operational commands - relate to building operations and building system controls.

.2 Computer system commands - relate to computer maintenance, upgrading or development software used to improve and maintain the application software for the building site.

.5 Level 5: machine language. Languages specific to each manufacturer's product, used internally to perform its functions and routines.

.3 Additional Equipment, Components and/or Control Points. Where additional equipment, components and/or control points are required on specific projects, the following procedures shall be adopted:

.1 Full names of the equipment, component and control points shall be not more than 40 characters, including numerals.

.2 SYSTEM descriptors shall be not more than 10 alphanumeric characters. INPUT and OUTPUT descriptors shall be not more than 10 alphanumeric characters. The letters shall be based upon the English/French language full name, and should, where possible, be the first letter of each word of the full name.

.4 The descriptor shall be unique.

.5 Descriptors and expansions: table lists standardized system identifiers and point identifiers.

.1 Table:

Identifiers and Expansions

English Identifier (10 characters max)	English Expansion (40 characters max)
OAD	Outside air damper
OAT	Outside air temperature
OAH	Outside air humidity
OAV	Outside air volume
RAD	Return air damper
RAT	Return air temperature
RAH	Return air humidity
RASP	Return air static pressure

MAD	** Mixed air dampers **
MAT	Mixed air temperature
MAPSP	Mixed air plenum static pressure

** MAD shall be used for applications where outside air and return air dampers are controlled from one (1) only output signal.

EAD	Exhaust air damper
PFPD	Pre-filter pressure drop
PFALM	Pre-filter pressure drop alarm
FFPD	Final filter pressure drop
FFALM	Final filter pressure drop alarm
HCVLV	Heating coil valve
HCVLVC	Heating coil valve control
HCVLVS	Heating coil valve status
BPD	Heating coil face and bypass damper
HCFA	Heating coil freeze alarm
CCVLV	Cooling coil valve
CCVLVC	Cooling coil valve control
CCVLVS	Cooling coil valve status
SVLV	Steam valve
SVLVC	Steam valve control
SVLVS	Steam valve status
SF#-C	Supply fan # control
SF#-S	Supply fan # status
SF#-VSD	Supply fan # VSD control
SF#-VSDF	Supply fan # VSD fault
SAV	Supply air volume
SAVC	Supply air volume control
SAT	Supply air temperature
SAH	Supply air humidity
SAVP	Supply air velocity pressure
SASP	Supply air static pressure
RF#-C	Return fan #control
RF#-S	Return fan # status
RF#-VSD	Return fan # VSD control
RF#-VSDF	Return fan # VSD fault
RAV	Return air volume

RAVC	Return air volume control
RAT	Return air temperature
RAH	Return air humidity
RAVP	Return air velocity pressure
RASP	Return air static pressure
EF#-C	Exhaust fan # control
EF#-S	Exhaust fan s# status
EXAT	exhaust air temperature
EXAV	exhaust air volume
Chiller #1:	
CH1F	flow rate
CH1LWT	leaving chilled water temperature
CH1LWP	Leaving chilled water pressure
CH1EWT	Entering chilled water temperature
CH1EWP	Entering chilled water pressure
CD1EWT	Entering condenser water temperature
CD1EWP	Entering condenser water pressure
CD1LWT	Leaving condenser water temperature
CD1LWP	Leaving condenser water pressure
CHP1F	Chilled water pump #1 flow rate
CHP1DP	Chilled water pump #1 discharge pressure
CHP1S	Chilled water pump #1 status
CP3C	Circulating pump #3 control
CP3F	Circulating pump #3 flow rate
CP3DP	Circulating pump #3 discharge pressure
CP3S	Circulating pump #3 status
HTA	High temperature alarm
LTA	Low temperature alarm
HTCO	High temperature cutout
LTCO	Low temperature cutout
HLA	High level alarm
LLA	Low level alarm
HLCO	High level cutout
LLCO	Low level cutout
HWF	Heating water flow rate
HWST	Heating water supply temperature
HWRT	Heating water return temperature
STP	Steam pressure
STF	Steam flow rate
RM-T	Room temperature

RM-H	Room humidity
RM-SP	Room static pressure (add reference point)

Examples of specific space conditions:

RM-TNPER 2	Space temperature, North Perimeter, 2nd floor
RM-SPSPER I9	Space static pressure, South Perimeter, 19th floor
RM-HEINT 9	Space humidity, East Interior, 9th floor

AFS	Air Flow Switch
AFM	Air Flow Monitor

F	Flow
P	Pressure
ST	Supply temperature
RT	Return temperature

FA	Fire alarm
FTA	Fire trouble alarm

CW	Chilled water system
CD	Condenser Water System
HWH	Hot water heating system
RADN	Radiation system

CDR	Condensate return system
HPS	Steam - High pressure system
LPS	Steam - Low pressure system

DCW	Domestic cold water system
DHW	Domestic hot water system
DHWR	Domestic hot water system Recirculation

SANP	Sanitary sewage - pumped system
STMP	Storm water - pumped system

SPRD	Sprinkler - Dry pipe system
SPRW	Sprinkler - Wet pipe system
FSTP	Fire standpipe & hose system
VBA	Volume Box Control Assembly

1.6 I/O Summary Schedules

.1 General:

.1 The EMCS contractor shall provide a complete I/O summary schedule similar to the one listed below, listing and describing all I/O's in detail. Contractor's standard schedule may be used provided all relevant information is provided.

.2 PCU no: identifies the PCU to which all points in the I/O Summary Schedule are wired.

.3 Building/Area: unique label given to each building forming part of a multi-building facility.

.4 Area/System Label: unique label given to each area of the building or to each system.

.1 Column 1: Point no: I/O Summary Schedule reference number.

.2 Column 2: Point label: unique label for each point in the system. Point labels may be repeated for other buildings or systems.

.3 Column 3: Description: describes the point label in expanded terms.

.4 Column 4: Type: (e.g. AI, AO, DI, DO).

.5 Column 5: Eng. Units: Describes the engineering units used (e.g. for AI, AO: C, kPa, Amp Volt. For DI, DO: OFF, ON).

.6 Column 6: Access level: Defines the level of access for varying complexity of functions. Usually associated with password feature. Usually assigned value between 0 (lowest) and 4 (highest).

.7 Column 7: Sensor type: describes in 2 or 3words.

.8 Column 8: Assoc. Point: Identifies/ describes points for purposes of alarm suppression, software interlocks.

.9 Column 9: Type: defines the type of alarm (e.g. CR = CRITICAL, CA = CAUTIONARY, M = MAINTENANCE).

.10 Column 10: DI/DO, NO/NC: defines the NORMAL condition of alarm. (NC = NORMALLY CLOSED. NO = NORMALLY OPEN).

.11 Column 11: Limits: Defines alarm levels (e.g. L2 = Low alarm, Level2. H1 = High alarm, Level1).

.12 Column 12: Alarm Mess: Defines alarm message number. This number is related to pre-composed message detailing the problem and describing the required action.

.13 Column 13: Maint Mess: defines maintenance message number. This number as related to pre-composed message detailing the problem and describing the required action.

.14 Column 14: Set Point: Defines the design set-point of the control loop.

.15 Column 15: Dead band: defines the range above or below the set-point at which no change in output signal is to occur.

.16 Column 16: Dev alarm limit: defines the limit on deviation of the measured value from the set-point (sometimes also referred to as the "error limit").

.17 Column 17: NC/NO: defines NORMAL condition when de-energized. NC - NORMALLY CLOSED. NO = NORMALLY OPEN. DA/RA:

defines the form of action. DA = direct acting. RA = REVERSE ACTING.

.18 Column 18: Contacts: NO/NC: defines NORMAL condition when de-energized. NC = NORMALLY CLOSED. NO = NORMALLY OPEN.

.19 Column 19: Delay Succ starts: defines the time limits (usually in seconds). To prevent overheating of motors or equipment from frequent re-starting.

.20 Column 20: Heavy motor delay: defines the time (usually up to 60seconds). To prevent heavy electrical load from simultaneous starting of large consumption equipment.

.21 Column 21: auto-reset: A = AUTOMATIC. M=MANUAL.

.22 Column 22: Programs:

.1 Examples of Applications Programs include: Night set-back; optimum start/stop; demand limiting (load shedding).

.2 Optimization routines (e.g. chiller optimization, supply air temperature optimization, enthalpy control) should be described as part of CDL's.

.3 Parameters for all application programs should be provided separately as part of the design documentation (e.g. the Systems Operation Manual).

.4 Note requirements for computer totalization, recording, print-out of accumulated value of a point over a period of time. If totalization depends upon a number of analog points, include for pseudo energy points.

.5 Run time totals: for calculation of operation of digital points.

.6 Optimum start/stop: Example: HVAC unit to start before scheduled occupancy, based upon HVAC unit capacity, heat loss, interior and exterior environmental conditions, etc.

.1 Schedule:

INPUT/OUTPUT			SCHEDULE PCU NO.					(see 1.3.2)		
PROJECT NO.			BLDG/AREA				NAME	(see 1.3.3)		
PROJECT NAME			AREA/SYSTEM				NAME	(see 1.3.3)		
POINT IDENTIFICATION								ALARMS		
1	2	3	4	5	6	7	8	9	10	11
Point. No	Point Label	Descrip	Type	Eng. Unit	Access Level	Sensor type	Assoc Point	Type (M,CR)	DI/D0 NO/NC	Limits

MESSAGES								DI/DO		
12	13	14	15	16	17	18	19	20	21	22
Alarm Limit	Maint	Set-Point MO/MA	Dead band start	Dev. alarm delay	NO/NC DA/RA	Cont's NO/NC	Delay succ.	Heavy Motor	Auto reset	Prog

1.7 CONTROL NARRATIVE SEQUENCE OF OPERATIONS

.1 Outside Air Units

.1 For AHUs which are 100% fresh air heat recovery units, basic unit control logic is the same as other units. However, these units shall employ a "cold corner" defrost control on the plate exchanger for freeze protection. A multi blade damper and modulating 24 V damper actuator are used to deflect cold air away from the cold corner based on the cold corner leaving air temperature. These units are also equipped with heat exchanger bypass dampers. These dampers to be controlled based on the heat exchanger leaving air temperature to prevent over-recovery. When the temperature leaving the heat exchanger on the supply air side exceeds its setpoint (initially set at 13°C), the bypass damper shall be modulated open.

.2 These systems are interconnected by bypass ducts c/w a normally closed damper. Should one of the units be taken out of service, the bypass damper shall open to allow the operating unit to handle air from the "off" units duct system. The airflow monitors and motorized dampers in the supply and return ducts shall be utilized to proportion the available air.

.3 Should one of the units be taken out of service, the corresponding interlocked return fan shall be shutdown (and vice versa). These units, which are operating in parallel, shall be provided with the necessary logic to ensure that each unit delivers 50% of the airflow despite minor variations in system pressures at each unit.

.2 Room Temperature Control

.1 <u>Unit Heater/Cabinet Heater Control Sequence</u>

.1 On a call for heat as sensed by the room temperature controller, the heater control valve shall open and the fan shall start.

.2 Fan speed shall be manually adjustable from within cabinet enclosure (where applicable).

.2 <u>Miscellaneous Equipment Alarm/Status Points</u>

.1 The following equipment shall be monitored by the EMCS: (Refer also to I/O list)

.1 High pressure steam header (pressure status/alarm)

.2 Low pressure steam header (pressure status/alarm)

1.8 Input/Output Point Summary Table

.1 The input/output table summarizes the Input/Output (I/O) points for the various systems as outlined within the EMCS specifications and control schematic drawings. However, the tables are not all inclusive as they do not list the typical room temperature sensors; reheat coil valves, radiator valves, unit heater/force flow valves, terminal unit control assemblies, infloor heating manifold loop valves, etc. The number and location of these devices can be found on the floor plans and/or listed in relevant schedules. All points and field devices required to accomplish the specified sequence of operation shall be provided. Any discrepancies in I/O counts between the points list, specs and drawings shall be reported to the Owner's Representative.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION