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 Sections.

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 00 - Closeout Submittals.

.3 Section 01 91 13 - General Commissioning (Cx) Requirements.

.4 Section 01 79 00 - Demonstration and Training.

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

1.2 DEFINITIONS

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

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

.3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition.

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

1.3 DESIGN REQUIREMENTS

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

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

1.4 SUBMITTALS

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

.2 Final Report: submit report to Departmental Representative.
.1 Include measurements, final settings and certified test results.
.2 Bear signature of commissioning

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

1.5 CLOSEOUT SUBMITTALS

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

1.6 COMMISSIONING

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

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

.3 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to commissioning or each test. Indicate:
.1 Location and part of system to be tested or commissioned.
.2 Testing/commissioning procedures, anticipated results.
.3 Names of testing/commissioning personnel.

.4 Correct deficiencies, re-test in presence

of Departmental Representative until satisfactory performance is obtained.

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

.6 Load system with project software.

.7 Perform tests as required.

1.7 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 Commissioning Manager.

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

.4 Debug system software.

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

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

3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.

.1 General: consists of field tests of equipment just prior to installation.
.2 Testing may be on site or at

Contractor's premises as approved by Departmental Representative.

.3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.

.4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).

.5 Additional instruments to include:

.1 DP transmitters.

.6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source and to BECC.

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

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

.9 Transmitters above 0.5% error will be rejected.

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

.2 Completion Testing.

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

.2 Include following activities:

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

.2 Verify each A-to-D convertor.

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

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

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

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

.7 Test operating software.

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

.9 Verify each CDL including energy optimization programs.

.10 Debug software.

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

.12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Departmental Representative. This document will be used in final startup testing.

.3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and PWGSC Commissioning Manager and provide:

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

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

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

.4 Commissioning to commence during final startup testing.

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

.6 Commissioning to be supervised by qualified supervisory personnel

and Departmental Representative.

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

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

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

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

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

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

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

.3 Tests to include:

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

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

.4 System will be accepted when:

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

.2 Requirements of Contract have been met.

.5 In event of failure to attain

specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

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

.5 Commissioning Manager to verify reported results.

3.3 ADJUSTING

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

3.4 DEMONSTRATION

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

PART 1 - GENERAL

1.1 SUMMARY

.1 Related Requirements

.1 Section 25 01 11 – EMCS: START-UP, VERIFICATION AND COMMISSIONING.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
.1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.

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

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
.1 ASHRAE STD 135-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).
.1 CAN/CSA-Z234.1-89(R1995), Canadian Metric Practice Guide.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
.1 Material Safety Data Sheets (MSDS).

1.3 ACRONYMS AND ABBREVIATIONS

.1 Acronyms used in EMCS:

.1 AEL - Average Effectiveness Level.
.2 AI - Analog Input.

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

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 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 short forms 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 short form 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.

1.5 SYSTEM DESCRIPTION

.1 Refer to control schematics for system architecture.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
.1 Building Controllers.
.2 Control devices as listed in I/O point summary tables.
.3 OWS(s).
.4 Data communications equipment necessary to effect EMCS data transmission system.
.5 Field control devices.
.6 Software/Hardware complete with full documentation.
.7 Complete operating and maintenance manuals.
.8 Training of personnel.
.9 Acceptance tests, technical support during commissioning, full documentation.
.10 Wiring interface co-ordination of equipment supplied by others.
.11 Miscellaneous work as specified in these sections and as indicated.

.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 and French.

.3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English an] French.

.4 System manager software: include in English and French system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.

.5 Include, in English and French:

.1 Input and output commands and messages from operator-initiated functions, field related changes and alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

.2 Graphic "display" functions,

point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in French and English at specified OWS and to be able to operate one terminal in English and second in French. Point name expansions in both languages.
.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit for review:
.1 Equipment list and systems manufacturers at time of bid within 48 h.
.2 List existing field control devices to be re-used included in bid, along with unit price.

.3 Quality Control:
.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
.3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures. Label or listing of specified organization is acceptable evidence.
.4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and

that item conforms to their standard/code.

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

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

.7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.

1.7 QUALITY ASSURANCE

.1 Have local office within 100 km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,

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

.3 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 35 29.06 - Health and Safety Requirements.

1.8 DELIVERY, STORAGE AND HANDLING

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

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

1.9 PRODUCTS

.1 Materials and equipment shall be essentially the catalogued products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest standard design that complies with the specification requirements.

.2 Where two units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address and the model and serial number on a nameplate securely attached in a conspicuous place.

1.10 WIRING

.1 All wiring under this section shall be by this Contractor and shall include furnishing labour and miscellaneous material to make connections for all wiring related to the programmable controller.
.2 All wiring shall be concealed in cable tray or conduit.
.3 Low voltage wiring shall not be run in conduit containing high voltage wiring.
.4 Communication or shielded control wiring shall be installed away from high voltage wiring where possible.
.5 Provide all wiring in EMT conduit.
.6 Identify each wire and cable in a permanent manner with wire numbers referenced to EMCS hardware address.
.7 Network (communication) wiring shall be run separately from other wiring.
.8 Controls contractor to provide and install relays in motor starter's control circuit wiring as required, to allow EMCS control.
.9 Where there is a start/stop switch in place of a starter, the Contractor shall provide for manual

override capability. SACP LED modules with HOA switch are acceptable providing the manual starter label reads "Manual Override within SACP #". (Lamacoid Label Required).
.10 All heating circulation pumps shall be wired for fail-safe operation.
.12 Provide 120V, 15A power to each control panel from distribution panel and provide new locking circuit breakers. If emergency power exists, control panel shall be connected to the emergency power circuit.
.13 All networking and control device wiring to be continuous wire runs only, no splicing is permitted.

1.10 TESTING

.1 This work shall include pre-delivery testing of major subsystems, field-testing and adjustment of major subsystems and of the complete EMCS, and an on-site final operational acceptance test of the complete operational EMCS.

.1 The departmental representative shall be advised at least 14 days in advance of the dates of all tests and may attend at his discretion. If the departmental representative witnesses the test, such tests shall be subject to his approval prior to the release of equipment. If the departmental representative elects not to witness the test, performance certification shall be provided by the contractor. Acceptance of tests by the departmental representative shall not relieve the Contractor of responsibility for the complete system meeting the requirements of these specifications after installation.

.2 Site Tests: Site testing will consist of four phases: - Construction. - EMCS start-up. - Final testing. - Final inspection. Each of these phases is explained in detail below.

.1 Phase 1 (Construction, & Preliminary Commissioning)

.1 The Contractor shall properly install the proposed and approved system. All points shall be checked for continuity and proper connection. Calibrate all sensors. An all points list shall be forwarded to the departmental representative for review prior to start-up of the system for approval.

.2 Mechanical deficiencies which may inhibit

operation/control of the mechanical systems shall be brought to the attention of the departmental representative.

.2 Phase 2 (EMCS Start-Up)

.1 The departmental representative shall be present as each system is brought on line. The Contractor will be responsible for making this switch over, using his own forces.

.3 Phase 3 (Final Start-Up)

Note: Prior to departmental representative going to site for inspection, Contractor must submit Point Verification Report. Report must be completed to departmental representative's approval or Contractor will be required to re-do.

.1 The Contractor's field technician, and departmental representative be present during this phase.

.2 The Contractor shall notify the departmental representative at least 14 days in advance of the final start-up.

.3 The Contractor shall perform the following tests.

.1 A power failure for the building will be simulated and proper system operation and recovery observed.

.4 Verification of all input/output points with regards to proper operation. Departmental representative will randomly inspect 50% of each point type for input/output response. Any failure will result in termination of inspection and future 100% inspections will be at the Contractor's cost.

.5 All deficiencies shall be noted during this phase, and the Contractor shall correct these deficiencies within 7 days.

.6 The departmental representative will require testing, verification, of all point commissioning. The Contractor is to commit the necessary resources, manpower, and devices (ie. wireless radios) to allow departmental representative to complete commissioning.

.4 Phase 4 (Final Inspection) This phase shall consist of verifying to departmental representative that the deficiencies as outlined

in phase three have been rectified. If deficiencies are still found, the Contractor will have one week to correct them and costs for additional inspection shall be billed to the Contractor.

.3 Standards Compliance: Where materials or equipment are specified to conform to requirements of the standards of organizations such as the Canadian Standard's Association (CSA) that use a label or listing as method of indicating compliance, proof of such conformance shall be submitted and approved, indexed and cross-referenced with the Government specification. The label or listing of the specified organization will be acceptable evidence. In lieu of the label or listing, the Contractor shall submit a certificate from a testing organization adequately equipped and competent to perform such services, and approved by the Contracting Officer, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard or code.

1.11 TRAINING

.1 Scope of Training: The Contractor shall provide the services of competent instructors who will give full instruction to designated maintenance staff at their location. All training material shall be provided by the contractor. The course shall achieve the following objectives:

- .1 Train staff proficiently to operate system.
- .2 Train designated staff to change and modify system parameters (ie: points, logs, alarms, ID's).
- .3 Train designated staff to trouble shoot system hardware components.
- .4 Note: Contractor to provide to departmental representative full approved Operation & Maintenance Manuals prior to training. Manuals will be a training tool, used during training sessions.
- .5 Provide training to building staff to enable them to add system programming as required.

.2 Training shall be started no later than two weeks after completion of final testing and consist of one (1) full day training or two (2) half days, one after final testing and another 3-5 weeks later. A training day is described as eight hours of instruction regardless of

breaks.

.3 Operator training to include, but not be limited to:
.1 System Configuration/Architecture
.1 Stand alone control processing panels (SACP's), addressing.
.2 Overview of systems by the SACP's.

.4 Departmental representative may monitor the training program and will have the right to modify the schedule, content, as well as replace instructors deemed unqualified.

1.12 OPERATING MAINTENANCE & DESIGN MANUALS

.1 A description of each section is contained within the following paragraphs. Three copies of the manuals bound, to be provided. Manuals and specifications shall be furnished with full coverage of the following subjects in sections with index.
.1 Maintenance: documentation of all maintenance on all system components including inspection, periodic preventive maintenance, fault diagnosis and repair or replacement of defective units. This shall include calibration, maintenance and repair of all sensors and controls plus diagnosis and repair or replacement of all system hardware.
.2 System Configuration: The documentation shall show all control system connections to the SACP. Documentation shall explain all designations used with reference to the connections. The Contractor shall provide updates on any changes made to the original system design.
.3 System Drawings: Include all system as-built line drawings showing all interconnections of EMCS system hardware components and system layouts showing sensor locations, valves, heating control, etc. as per point list. Manuals are to include floor plan layouts for equipment.
Floor plans are to indicate location of all components, sensors, contactors, transducers, timers, etc.) in addition to all built-up systems, indicated in block form under EMCS control. Include routing of all network control wiring and major control wiring runs. Floor plan layouts are to be in AutoCAD format. Submit on 11x17 size for including in

manual. All items on floor plans are to be labelled as per project documents. Manuals shall include EMCS as-built control wiring schematics.

1.12 WARRANTY SERVICES

.1 The contractor shall provide all services, materials, and equipment necessary for the maintenance of the heating system EMCS controls for a period of one year, concurrent with the warranty period. This service shall include regular warranty service with a 12-hour response time, and emergency service with a 2-hour response time.

.2 The contractor shall provide two major inspections during the first year scheduled at 6-month interval.

.3 Records and logs of all maintenance tasks shall be kept and submitted to the contracting officer at the completion of the maintenance inspection.

.4 Provide printed graphs of trend logs that are one-week in duration and have hourly samples for all analog inputs connected to each panel.

.5 Software: provide implementation of all software updates for all EMCS application software.

.6 Update the printed and digital copies of any changes made to programs for any control sequence.

.7 Provide one open training day at both the first and second inspection, in addition to training specified elsewhere in this section.

.8 Provide a separate price to the contract for an additional second year warranty to the ECMS controls installed under this contract.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 The EMCS shall be Native BACnet to the input/output level and shall provide 2-way master controller communication to the Operator's Workstation via Ethernet.

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

.3 Control system installed to be fail safe, ie. heating controls to normally open position.

2.2 ADAPTORS

.1 Provide adaptors between metric and imperial components.

PART 3 - EXECUTION

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

3.2 PAINTING

.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.

PART 1 - GENERAL

1.1 SUMMARY

.1 Related Sections:
.1 Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.
.2 Section 25 05 01 - EMCS: General Requirements.
.3 Section 25 90 02 - EMCS: Site Requirements Applications and Systems Sequences of Operation.
.4 Section 26 05 00 - Common Work Results for Electrical.
.5 Section 26 05 21 – Wires and Cables (1-1000V).

1.2 REFERENCES

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

.2 National Electrical Manufacturer's Association (NEMA).
.1 NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).

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

1.3 DEFINITIONS

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

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Pre-Installation Tests.
.1 Submit samples at random from equipment shipped, as requested by Departmental Representativ, for testing before installation. Replace devices not meeting specified performance and accuracy.

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

1.5 EXISTING CONDITIONS

.1 Repair surfaces damaged during execution of Work.

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

PART 2 - PRODUCTS

2.1 GENERAL

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

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, assembly.

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

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

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

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

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

.8 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 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

2.2 TEMPERATURE SENSORS

.1 General: To be resistance or thermocouple type to following requirements:

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

.2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.

.3 Sensing element: hermetically sealed.

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

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

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

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:

.1 Input circuit: to accept 3-lead, 100 or 1000 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 or 1000 ohm RTD sensor: not to exceed 25 mA.

.8 Integral zero and span adjustments.

.9 Temperature effects: not to exceed plus or minus 1.0% of full scale/ 50 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 PRESSURE TRANSDUCERS

.1 Requirements:

.1 Combined sensor and transmitter measuring pressure.
.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
.2 Output signal: 4 - 20 mA into 500 ohm maximum load.
.3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10%.
.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.
.5 Temperature effects: not to exceed plus or minus 1.5% full scale/ 50 degrees C.
.6 Over-pressure input protection to at least twice rated input pressure.
.7 Output short circuit and open circuit protection.
.8 Accuracy: plus or minus 1% of Full Scale.

2.5 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Requirements:

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
.2 Output signal: 4 - 20 mA into 500 ohm maximum load.
.3 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.
.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5% of full scale output over entire range.
.5 Integral zero and span adjustment.
.6 Temperature effects: not to exceed plus or minus 1.5% full scale/ 50 degrees C.
.7 Over-pressure input protection to at least twice rated input pressure.
.8 Output short circuit and open circuit protection.

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

2.7 LIQUID 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.

2.8 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements:

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

2.9 TEMPERATURE SWITCHES

.1 Requirements:

.1 Operate automatically. Reset automatically, except as follows:
.1 Low temperature detection: manual reset.
.2 High temperature detection: manual reset.
.2 Adjustable setpoint and differential.
.3 Accuracy: plus or minus 1 degrees C.
.4 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and

EMCS connections.
.5 Type as follows:
.1 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 10 mm.
.2 Strap-on: with helical screw stainless steel clamp.

2.10 SOLID STATE RELAYS

.1 General:

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

.2 Input:
.1 Control voltage, 3 to 32 VDC.
.2 Drop out voltage, 1.2 VDC.
.3 Maximum input current to match AO (Analog Output) board.

.3 Output.
.1 AC or DC Output Model to suit application.

2.11 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 MCC.

2.12 CURRENT SENSING RELAYS

.1 Requirements:

.1 Suitable to detect belt loss or motor failure.
.2 Trip point adjustment, output status LED.
.3 Split core for easy mounting.
.4 Induced sensor power.
.5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.
.6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
.7 Adjustable latch level.

2.13 CONTROL VALVES

.1 Body: globe style.
.1 Flow characteristic as indicated on control valve schedule: linear.
.2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
.3 Normally open, as indicated.
.4 Two port, as indicated.
.5 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
.6 Packing easily replaceable.
.7 Stem, stainless steel.
.8 Plug and seat, bronze.
.9 Disc, replaceable, material to suit application.
.10 NPS 2 and under:
  .1 Screwed National Pipe Thread (NPT) tapered female connections.
  .2 Valves to ANSI Class 250, valves to bear ANSI mark.
  .3 Rangeability 50: 1minimum.
.11 NPS 2½ and larger:
  .1 Flanged connections.
  .2 Valves to ANSI Class 150 or 250 as indicated, valves to bear ANSI mark.
  .3 Rangeability 100:1 minimum.

.2 Butterfly Valves NPS 2 and larger:
.1 Body: For heating water ANSI Class 150 carbon steel lugged body.
.2 End connections to suit flanges that are ANSI Class 150.
.3 Extended stem neck to provide adequate clearance for flanges and insulation.
.4 Pressure limit: bubble tight sealing to 170 kilopascals.
.5 Disc/vane: aluminum bronze to ASTM B 148.

.6 Seat: For service on heating water PTFE.
.7 Stem: 316 stainless steel.
.8 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
.9 Flow characteristic linear.
.10 Maximum flow requirement as indicated on control valve schedule.
.11 Maximum pressure drop as indicated on control valve schedule: pressure drop not to exceed one half of inlet pressure.
.12 Normally open, as indicated.
.13 Valves are to be provided complete with mounting plate for installation of actuators.

2.14 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements:

.1 Construction: steel, cast iron, aluminum.
.2 Control signal: 0-10V DC or 4-20 mA DC.
.3 Positioning time: to suit application. 90 sec maximum.
.4 Fail to normal position as indicated.
.5 Scale or dial indication of actual control valve position.
.6 Size actuator to meet requirements and performance of control valve specifications.

2.15 WATTHOUR METERS AND CURRENT TRANSFORMERS

.1 Requirements:
.1 Include three phases, test and terminal blocks for watthour meter connections and connections for monitoring of current. Provide two transformers for 600 V 3 wire systems for watthour meter use Accuracy: plus or minus 0.25% of full scale.
.2 Watthour meter 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.

2.16 OIL LEAK DETECTORS

.1 Requirements:

.1 Provide alarm on presence of oil in trench.
.2 Expendable cartridge sensor.
.3 Multi-zone compatible
.4 Volt free relay output for BMS connection.

.5 Unaffected by moisture in air.
.6 Battery backup.

2.17 PANELS

.1 Wall mounted enamelled steel cabinets with hinged and key-locked front door.

.2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as required by Departmental Representative adding additional cabinets.

.3 Panels to be lockable with same key.

2.18 WIRING

.1 In accordance with Section 26 05 21 – Wires and cables (0-1000V)

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

.3 Wiring must be continuous without joints.

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

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

.4 Fire stopping: Maintain fire rating integrity.

.5 Electrical:
.1 Complete installation in accordance with Section 6 05 00 - Common Work Results for Electrical.
.2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
.3 Refer to electrical control schematics included as part of control design schematics in Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation. 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.

3.2 TEMPERATURE 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 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.

3.3 PANELS

.1 Arrange for conduit and tubing entry from top,

bottom or either side.

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

.3 Identify wiring and conduit clearly.

3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

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

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

3.5 IDENTIFICATION

.1 Identify field devices in accordance with Section 23 05 53.01 - Mechanical Identification.

3.6 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

PART 1 - GENERAL

1.1 REFERENCES

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

.1 MD13800-September 2000 (latest edition), Energy Management and Control Systems (EMCS) Design Manual. English: ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf

1.3 CONTROL NARRATIVE SEQUENCE OF OPERATIONS

.1 Coil Tube Boiler System: The (2) new boilers will serve as the primary equipment for the facilities heating requirements as well as serving water heaters located throughout the building.

Each boiler is provided with its own factory installed control panel and each boiler can be operated in a stand-alone mode. However, normal operation is for both boilers to interface with the EMCS system for operating output(0-10vdc)and lead/lag boiler control sequencing. The operators shall be able to change lead boilers, set point and sequence patterns via the operator workstation.

If the operating boiler is unable to maintain the HWS header temperature at the scheduled setpoint, an alarm will be sent to the operator’s workstation, and the oil boilers will be permitted to operate in sequence.

On a boiler trip or alarm condition, the lead/lag system shall automatically start the other boiler and alarm the trip condition.

Heating Mode Enable: Generate a call for heating from zone controllers if any of the zone valve positions is greater than 10% (adjustable) of full open until all are below 5% (adjustable.

Secondary Hot Water Pump Enable: When the BAS registers a call for central plant heating, enable the lead secondary hot water pump by a start-stop command from the BAS. Initially, start the pump at 10% speed. Proof the start of the pump after 15 seconds. If the pump fails to start enable the other secondary pump. Inhibit starting of the primary pumps and boiler if both pumps fail to prove running status or fail while running. When the commanded speed falls below 40%, disable the lag pump. When the commanded speed rises above 60%, enable the lag pump. If either pump fails to start, initiate an equipment specific critical alarm at the operators work station.

Primary Hot Water Pump Enable (Boiler Initiation): Open the lead boiler's isolation valves. If the valve opening fails to proof within 30-seconds, close the valve, enable the lag boiler, and send an equipment specific alarm to the operator workstation. If valve opening is successful, enable the primary hot water pump. If the flow is not proved within 30 seconds, disable the pump, close the valve and set the lag boiler as the lead boiler. If both valves fail to open, initiate boiler shutdown operation and send equipment specific alarms to the operator workstation. If both pumps fail to provide flow, initiate boiler shutdown operation and send equipment specific alarms to the operator workstation.

Boiler Enable: Upon proof of primary hot water flow, enable the selected boiler. Use a hard-wired flow switch as a back up to ensure that boiler only starts with hot water flow. Send an initial hot water temperature of 180° F to the boiler controller. After 60 seconds, prove boiler operation by means of a hard-wired current switch. Enable the lag boiler to start. If either or both boilers fail to prove or fail to proof when required to operate, initiate boiler shutdown and send equipment specific alarms to the operator workstation. During operation, use the boiler's internal safeties to initiate an equipment alarm at the operator workstation and disable the machine. If the boiler does not develop at least a 2°C temperature

difference after 15 minutes of being enabled initiate an equipment specific alarm at the operator workstation.

Boiler Staging: Modulate internal boilers controls between the boiler's two stages to meet the BAS water loop setpoint. If during boiler operation, the hot water temperature differential falls to 3°C (adjustable), initiate the lag boiler operation. Continue to run both boilers until the hot water temperature differential rises to 6°C. At this point, initiate the lag boiler shutdown sequence.

Boiler Shutdown: When all calls for central plant heating are cancelled or an internal alarm occurs, initiate boiler shutdown. Provide the BAS with redundant sensors for hot water flow, hot water temperature Hi Limit (more than 200° F). Disable operation of the affected boiler(s) if the limits are exceeded. If both boilers trip or fail to proof, initiate an equipment specific alarm at the operator workstation. Prevent the boiler from cycling on and off more often than once every 5 minutes (this may be redundant to the boiler's internal safeties). For each boiler, disable the boiler before shutting down the supply pump. After disabling the boiler, run the primary supply pump for 5 minutes. After 5 minutes, shut down the primary boiler pump and close the hot water isolation valves. If no other boiler is enabled, shut off the secondary water pumps.

1.4 Input/Output Point Summary Table

.1 Provide an input/output table that summarizes the Input/Output (I/O) points for the various systems as outlined within the EMCS specifications and control schematic drawings. 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 ADDITIONAL PROGRAMMING

.1 The EMCS contractor to make allowance during bidding process for 10hrs of additional programming as directed by the Departmental Representative to make any requested changes and adjustments to the EMCS programming.