

## **1 General**

### **1.1 SUMMARY**

- .1 Section Includes.
  - .1 Methods and procedures for start-up, verification and commissioning, for modifications and additions to the existing building Energy Monitoring and Control System (EMCS) and includes:
  - .2 Start-up testing and verification of new systems and existing systems affected by the Work.
  - .3 Check out demonstration or proper operation of components.
  - .4 On-site operational tests.

### **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.

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### **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 01330 - 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 31 - Commissioning (Cx) Plan.
- .2 Carry out commissioning under direction of Departmental Representative and in presence of Engineer 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.

## **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.

## **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.

## **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 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.
    - .2 VAV supply duct SP transmitters.
    - .3 DP switches used for dirty filter indication and fan status.
  - .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source and to BECC.
  - .7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.
  - .8 Departmental Representative to mark instruments tracking within 0.5% in both directions as "approved for installation".
  - .9 Transmitters above 0.5% error will be rejected.
  - .10 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing.
  - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
  - .2 Include following activities:
    - .1 Test and calibrate field hardware including stand-alone capability of each controller.
    - .2 Verify each A-to-D convertor.
    - .3 Test and calibrate each AI using calibrated digital instruments.

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- .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 14day 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 14consecutive 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 and Engineer 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 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 79 00 - Demonstration and Training.

**END OF SECTION**

## **1 General**

### **1.1 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 Consumer Electronics Association (CEA).
  - .1 CEA-709.1-B-2002, Control Network Protocol Specification.
- .6 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
  - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .8 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

### **1.2 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 HMI – Human-Machine Interface.
- .19 HVAC - Heating, Ventilation, Air Conditioning.
- .20 IDE - Interface Device Equipment.
- .21 I/O - Input/Output.
- .22 ISA - Industry Standard Architecture.
- .23 LAN - Local Area Network.
- .24 LCU - Local Control Unit.
- .25 MCU - Master Control Unit.
- .26 NAFTA - North American Free Trade Agreement.
- .27 NC - Normally Closed.
- .28 NO - Normally Open.
- .29 OS - Operating System.
- .30 O M - Operation and Maintenance.
- .31 OWS - Operator Work Station.
- .32 PC - Personal Computer.
- .33 PCI - Peripheral Control Interface.
- .34 PCMCIA - Personal Computer Micro-Card Interface Adapter.
- .35 PID - Proportional, Integral and Derivative.
- .36 RAM - Random Access Memory.
- .37 SP - Static Pressure.
- .38 ROM - Read Only Memory.
- .39 TCU - Terminal Control Unit.
- .40 USB - Universal Serial Bus.
- .41 UPS - Uninterruptible Power Supply.
- .42 VAV - Variable Air Volume.

### 1.3 DEFINITIONS

- .1 Point: may be logical or physical.
  - .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
  - .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.
- .2 Point Name: composed of two parts, point identifier and point expansion.
  - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.
    - .1 Area descriptor: building or part of building where point is located.
    - .2 System descriptor: system that point is located on.
    - .3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25character 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 05 54- EMCS: Identification.

## **1.4 SYSTEM DESCRIPTION**

- .1 Refer to schematics for system architecture.
- .2 Utilize the existing building ECMS. All new equipment requiring automated control or controllers for new equipment are to be connected to the existing ECMS.
- .3 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.
- .4 Design Requirements:
  - .1 Provide and install instrumentation and materials as specified and as needed to achieve the design intent.
  - .2 Integrate new equipment, ancillary devices and instrumentation into the existing EMCS.
  - .3 Reconnect or replace and connect as required, all existing instrumentation.
  - .4 Retain the services of the existing EMCS provider for programming and updating of the Human-Machine Interface to incorporate changes to the existing controls system and new equipment added. Remove all HMI screens and control sequences made redundant.
  - .5 Design and provide conduit and wiring linking elements of system.
  - .6 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
  - .7 Location of controllers as reviewed by Departmental Representative prior to installation.
  - .8 Metric references: in accordance with CAN/CSA Z234.1.
  - .9 Update head end graphics to suit new installation.

## **1.5 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
- .2 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 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.
  - .4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that 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.
  - .8 Existing devices intended for re-use: submit test report.

## **1.6 QUALITY ASSURANCE**

- .1 Have local office 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 30 - Health and Safety Requirements.

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**1.7 DELIVERY, STORAGE AND HANDLING**

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

**1.8 EXISTING- CONTROL COMPONENTS**

- .1 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.
- .2 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.
- .3 Non-functioning items:
  - .1 Provide with report specification sheets or written functional requirements to support findings.
  - .2 Departmental Representative will determine requirements for repair or replacement of existing items judged defective yet deemed necessary for EMCS.
- .4 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
- .5 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 applicable portions of EMCS as approved by Departmental Representative.
- .6 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.
- .7 Re-verify and recommission all existing points referred to on the EMCS i/o list on the drawings.

## **1.9 TRAINING**

- .1 Instructions:
  - .1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
  - .2 Provide instruction pertaining to all modifications to the existing EMCS systems.
  - .3 Training to be project-specific.
- .2 Plan for sufficient training time to adequately convey in full all aspects of the chilled water system control and boiler room ventilation control.
  - .1 Initial training to begin before 30 day test period at time mutually agreeable to Contractor, Departmental Representative, and PWGSC Commissioning Manager. Initial training is to be no less than 4 hours in duration.
  - .2 Train O M personnel in functional operations and procedures to be employed for system operation.
  - .3 Supplement with on-the-job training during 30 day test period.
  - .4 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
  - .5 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
- .3 Supply manual for each trainee, describing in detail data included in each training program.
  - .1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).
- .4 Additional Training
  - .1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.
- .5 Departmental Representative to monitor training program and may modify schedule and content.

## **1.10 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.

## **2 Products**

### **2.1 EQUIPMENT**

- .1 Control Network Protocol: to CEA 709.1 or ASHRAE STD 135.
- .2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

### **2.2 ADAPTORS**

- .1 Provide adaptors between metric and imperial components.

**3 Execution**

**3.1 MANUFACTURER'S RECOMMENDATIONS**

- .1 Installation: to manufacturer's recommendations.

**END OF SECTION**

## **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).

### **1.2 DEFINITIONS**

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

### **1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.
- .2 Submit preliminary design document within 5 working days after tender closing and before contract award, for review by Departmental Representative DCC Representative Consultant.
- .3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.

- .4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.
- .5 Soft copy to be in Autocad - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.
- .6 Submit As-built drawings and Operation and Maintenance Manual to Departmental Representative in English.
- .7 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
- .8 Binders to be 2/3 maximum full.
- .9 Provide index to full volume in each binder.
- .10 Identify contents of each manual on cover and spine.
- .11 Provide Table of Contents in each manual.
- .12 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

## **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 chiller controller supplied by chiller manufacturer, 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 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).
  - .7 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.

## **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 Complete Point Name Lists.
    - .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
    - .6 Software and programming details associated with each point.
    - .7 Manufacturer's recommended installation instructions and procedures.
    - .8 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 air and water 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 01 11 - 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.

## **1.1 AS-BUILTS**

- .1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:
  - .1 Changes to contract documents as well as addenda and contract extras.
  - .2 Changes to interface wiring.
  - .3 Routing of conduit, 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 01 11 - 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.

## 1.2 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 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.
  - .3 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
  - .4 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, program execution.
- .6 Software for each Controller and single section referencing Controller common parameters and functions.
- .7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.
- .8 System configuration document:
  - .1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.
  - .2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
- .9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

**2 Products**

Not Used.

**3 Execution**

Not Used.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

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

### **1.2 REFERENCES**

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

### **1.3 DEFINITIONS**

- .1 For acronyms and definitions refer to Section 25 05 01 - 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 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.
- .2 Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

## **2 Products**

### **2.1 NAMEPLATES FOR PANELS**

- .1 Identify by Plastic laminate, 3 mm thick, matt white finish, square corners, lettering accurately aligned and engraved into core.
- .2 Sizes: 25 x 67 mm minimum.
- .3 Lettering: minimum 7 mm high, black.
- .4 Inscriptions: machine engraved to identify function.

## **2.2 NAMEPLATES FOR FIELD DEVICES**

- .1 Identify by plastic encased cards attached by chain.
- .2 Sizes: 50 x 100 mm minimum.
- .3 Lettering: minimum 5 mm high produced from laser printer in black.
- .4 Data to include: point name and point address.
- .5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

## **2.3 NAMEPLATES FOR ROOM SENSORS**

- .1 Identify by stick-on labels using point identifier.
- .2 Location: as directed by Departmental Representative.
- .3 Letter size: to suit, clearly legible.

## **2.4 WARNING SIGNS**

- .1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.
- .2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Departmental Representative's.

## **2.5 WIRING**

- .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
- .2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.
- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

## **2.6 CONDUIT**

- .1 Colour code EMCS conduit.
- .2 Pre-paint box covers and conduit fittings.
- .3 Coding: use fluorescent orange paint and confirm colour with Departmental Representative during "Preliminary Design Review".

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**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**

## **1 General**

### **1.1 RELATED SECTIONS**

- .1 Section 01 73 03 - Execution Requirements.
- .2 Section 23 33 15 - Dampers - Operating.
- .3 Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.
- .4 Section 25 05 01 - EMCS: General Requirements.
- .5 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
- .6 Section 25 05 54 - EMCS: Identification.
- .7 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.
- .8 Section 26 05 00 - Common Work Results for Electrical.
- .9 Section 26 27 26 - Wiring Devices.

### **1.2 REFERENCES**

- .1 American National Standards Institute (ANSI).
  - .1 ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.
- .2 American Society for Testing and Materials International, (ASTM).
  - .1 ASTM B148-97(03), Standard Specification for Aluminum-Bronze Sand Castings.
- .3 National Electrical Manufacturer's Association (NEMA).
  - .1 NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 Air Movement and Control Association, Inc. (AMCA).
  - .1 AMCA Standard 500-D-98, Laboratory Method of Testing Dampers For Rating.
- .5 Canadian Standards Association (CSA International).
  - .1 CSA-C22.1-02, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

### **1.3 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 25 05 02 - EMCS: Submittals and Review Process.
- .2 Manufacturer's Instructions:
  - .1 Submit manufacturer's installation instructions for specified equipment and devices.

## **1.5 EXISTING CONDITIONS**

- .1 Cutting and Patching: in accordance with Section 01 73 00 - Execution Requirementssupplemented 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.

## **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 (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 4enclosures.
- .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 Provide all relays, transformers, switches, and other ancillary devices required to power and operate all control devices.

## 2.2 TEMPERATURE SENSORS

- .1 General: to be resistance or thermocouple type to following requirements:
  - .1 Thermocouples: limit to temperature range of 200degrees C and over.
  - .2 RTD's: 100 or 1000 ohm at 0degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3integral 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: 20 mm (NPS 3/4), stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm as indicated.
- .2 Outdoor air temperature sensors:
  - .1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

## 2.3 TEMPERATURE TRANSMITTERS

- .1 Requirements:
  - .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 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/ 50degrees 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.

## **2.6 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.

## **2.7 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

## **2.8 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 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.
  - .2 Adjustable setpoint and differential.
  - .3 Accuracy: plus or minus 1degrees C.
  - .4 Snap action rating: 24V DC as required. Switch to be DPST for hardwire and EMCS connections.
  - .5 Type as follows:
    - .1 Room: for wall mounting on standard electrical box with without protective guard as indicated.
    - .2 Duct, general purpose: insertion length = 460 mm.
    - .3 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.
    - .4 Low temperature detection: continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 30 mm length.
    - .5 Strap-on: with helical screw stainless steel clamp.

## **2.10 ELECTROMECHANICAL RELAYS**

- .1 Requirements:
  - .1 Double voltage, DPDT, plug-in type with termination base.
  - .2 Coils: rated for 24V DC. Other voltage: provide transformer.
  - .3 Contacts: rated at 5 amps at 120 V AC.
  - .4 Relay to have visual status indication.

## **2.11 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.

## **2.12 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 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. Provide 600 V, 3-phase to 24 V AC power transformer.
  - .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
  - .6 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

## **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.
- .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.

## **2.15 REFRIGERANT GAS DETECTOR**

- .1 Requirements:
  - .1 Supply Voltage:24 VDC regulated 1.2A maximum.
  - .2 Signal Output:4-20 mA.
  - .3 Maximum Output Impedance mA:500Ω.
  - .4 Accuracy:±3% full scale.
  - .5 Repeatability:1% full scale.
  - .6 Measurement Range:0-1000 ppm standard (0-500 ppm to 0 to 3000 ppm).
  - .7 Sensing Technology: Dual infrared sensor.
  - .8 Calibration Interval: Every 6 months.
  - .9 Visual Indication: For testing and verification of 4-20 mA loop, calibration and operation.
  - .10 Response Time:10 seconds with full scale calibration gas @ 0.75 liters/ minimum flow rate.
  - .11 Gases Detected:R134a.
  - .12 Operating Humidity:0% to 99% RH non-condensing.
  - .13 Operating Temperature:-20° to 140°F (-28° to 60°C).
  - .14 Complete with audible alarm.

## **2.16 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 without adding additional cabinets.
- .3 Panels to be lockable with same key.

## **2.17 WIRING**

- .1 In accordance with section 26 27 26 - Wiring Devices.
- .2 All wiring is to be installed in conduit.
- .3 Wiring must be continuous without joints.

### **3 Execution**

#### **3.1 INSTALLATION**

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, solenoid gas valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5 Electrical:
  - .1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical. Electrical drawings call for installation of empty conduit between mechanical components and EMCS control panel. Coordinate fully and provide additional conduit if required.
  - .2 Refer to electrical control schematics included as part of control design schematics on drawings and 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.
  - .3 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
  - .4 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.
  - .5 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 Outdoor installation:
  - .1 Protect from solar radiation and wind effects by non-corroding shields.
  - .2 Install in NEMA 4 enclosures.
- .4 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 ELECTRONIC CONTROL DAMPER ACTUATORS**

- .1 Install 24 V AC power wiring from exhaust to supply and exhaust dampers in conduit as specified in Division 26.

### **3.4 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.

### **3.5 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 IDENTIFICATION**

- .1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

### **3.7 TESTING AND COMMISSIONING**

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

**END OF SECTION**

## **1 General**

### **1.1 REFERENCES**

- .1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.
  - .1 MD13800-September 2000, Energy Management and Control Systems (EMCS) Design Manual. English:  
<ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>.

### **1.2 SEQUENCING**

- .1 Present sequencing of operations for systems, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.
  - .1 Chilled Water Pumps CWP-01 and CWP-02.
    - .1 Operation of the chilled water pumps is to remain un-altered from its current state. The existing sequence of control is as follows:
      - .1 The lead chilled water pump is started by the BCMS system whenever;
        - .1 The outdoor air temperature is above 15 °C, and
        - .2 Chilled water is required by air handling unit AHU-1 or AHU-2.
      - .2 When the chiller system is deactivated, the chilled water pumps will deactivate after a delay of 5 minutes.
      - .3 The lag pump is started upon a lead pump failure.
      - .4 Selection of the lead pump is automatically performed every two weeks by the BCMS system.
    - .2 Modular Chiller System
      - .1 The modular chiller system is to receive a permissive start signal from the BCMS in order to operate. The permissive start is given if the outdoor air temperature is above 15 C.
      - .2 The chiller system will then start whenever either circulation pump is running or the flow is proven via the existing flow switch (FS-1).
      - .3 When the air-handling units no longer require chilled water, the chiller system will be permitted to shut down after a time delay of 5 minutes.
      - .4 Loading and unloading of compressors is controlled by the chiller system master controller. Refer to section 23 64 26 for master controller description.

- .3 Mechanical Room Ventilation
  - .1 The mechanical room ventilation system consists of:
    - .1 Exhaust fan EF-21.
    - .2 Intake damper MD-21A.
    - .3 Outlet damper MD-21B.
  - .2 When the chiller system permissive start signal is present, the intake damper MD-21A is to open, outlet damper MD-21B is to modulate open to 20% (field adjustable) and exhaust fan EF-21 is to operate on low speed. Speed of the fan is to be regulated by variable frequency drive.
  - .3 When the gas detection system indicates elevated levels of refrigerant gas in the mechanical room, the an alarm is to be generated, the intake damper MD-21A and outlet damper MD-21B are to open fully and exhaust fan EF-21 is to operate on high speed. The ventilation system is to run on high speed for a minimum of 30 minutes or until the concentration of refrigerant gas in the room has fallen below the maximum allowable concentration.
  - .4 When the refrigerant leak alarm is present, the chillers and boilers are to be locked-out and the natural gas supply to the water heater is to be shut off by a natural gas solenoid.
  - .5 Once activated, the refrigerant leak alarm is to remain present until manually reset.
  - .6 The intake and outlet dampers are to be closed when the exhaust fan is not operating.

**2 Products**

Not Used.

**3 Execution**

Not Used.

**END OF SECTION**