

## **Part 1 General**

### **1.1 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.

### **1.2 DESIGN REQUIREMENTS**

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

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Final Report: submit report to the Cx Team.
  - .1 Include measurements, final settings and certified test results.
  - .2 Bear signature of commissioning technician and supervisor
  - .3 Report format to be approved by the Consultant and Department 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 the Consultant and Department 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.

#### **1.4 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.

#### **1.5 COMMISSIONING**

- .1 Do commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.
- .3 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .4 Load system with project software.
- .5 Perform tests as required.

#### **1.6 COMPLETION OF COMMISSIONING**

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

#### **1.7 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 Locations to be approved, readily accessible and readable.
- .4 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 Cx Plan.
- .3 Commission integrated systems using procedures prescribed by Cx Plan.

- .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 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 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 provide:
    - .1 1 technical personnel capable of re-calibrating field hardware and modifying software.
    - .2 Detailed daily schedule showing items to be tested and personnel available.
    - .3 Commissioning to commence during final startup testing.
    - .4 O&M personnel to assist in commissioning procedures as part of training.
    - .5 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
    - .6 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 7 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 7 consecutive 24 hour days.
  - .3 Tests to include:
    - .1 Demonstration of correct operation of monitored and controlled points.
    - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
  - .4 System will be accepted when:
    - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
    - .2 Requirements of Contract have been met.
  - .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
  - .6 Correct defects when they occur and before resuming tests.
- .5 Departmental Representative to 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**

**Part 1            General**

**1.1                DEFINITIONS**

- .1        CDL - Control Description Logic.
- .2        For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.2                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 training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipated date of beginning of training.
  - .1        List name of trainer, and type of visual and audio aids to be used.
  - .2        Show co-ordinated interface with other EMCS mechanical and electrical training programs.
  - .3        Departmental Representative may modify content of training program.
- .3        Submit reports within one week after completion of training program that training has been satisfactorily completed.

**1.3                QUALITY ASSURANCE**

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

**1.4                INSTRUCTIONS**

- .1        Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
- .2        Training to be project-specific.

**1.5                TRAINING MATERIALS**

- .1        Provide equipment, visual and audio aids, and materials for classroom training.
- .2        Supply manual for each trainee, describing in detail data included in each training program.
  - .1        Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

**1.6                TRAINING PROGRAM**

- .1        Four-hour program to begin before 30 day test period at time mutually agreeable to Contractor, Departmental Representative.
  - .1        Train O&M personnel in functional operations and procedures to be employed for system operation.
  - .2        Include overview of system architecture, communications, operation of computer and peripherals, report generation.

- .3 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
- .4 Equipment maintenance training: provide personnel with training in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **Part 1 General**

### **1.1 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.

### **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 CDL - Control Description Logic.
  - .9 CDS - Control Design Schematic.
  - .10 COSV - Change of State or Value.
  - .11 CPU - Central Processing Unit.
  - .12 DI - Digital Input.
  - .13 DO - Digital Output.
  - .14 DP - Differential Pressure.
  - .15 ECU - Equipment Control Unit.
  - .16 EMCS - Energy Monitoring and Control System.
  - .17 HVAC - Heating, Ventilation, Air Conditioning.
  - .18 IDE - Interface Device Equipment.
  - .19 I/O - Input/Output.
  - .20 LCU - Local Control Unit.
  - .21 MCU - Master Control Unit.

- .22 NC - Normally Closed.
- .23 NO - Normally Open.
- .24 OS - Operating System.
- .25 O&M - Operation and Maintenance.
- .26 OWS - Operator Work Station.
- .27 PID - Proportional, Integral and Derivative.
- .28 SP - Static Pressure.
- .29 TCU - Terminal Control Unit.
- .30 USB - Universal Serial Bus.
- .31 VAV - Variable Air Volume.

### **1.3 DEFINITIONS**

- .1 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.
- .2 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 existing control schematics for system architecture.
- .2 Work consists of fully operational EMCS, including, but not limited to, following:
  - .1 Building Controllers.
  - .2 Control devices as listed in I/O point list.
  - .3 Field control devices.
  - .4 Software/Hardware complete with full documentation.
  - .5 Complete operating and maintenance manuals.
  - .6 Training of personnel.
  - .7 Acceptance tests, commissioning, full documentation.
  - .8 Wiring interface co-ordination of equipment supplied by others.
  - .9 Miscellaneous work as specified in EMCS sections and as indicated:
    - .1 Set-up trend logs for every DI, DO, AI, AO, and control loop.
- .3 Design Requirements:
  - .1 Design and provide conduit and wiring linking elements for the EMCS.
  - .2 Supply programmable controllers to meet project requirements and connect them to the existing EMCS.



- .3 Location of controllers as shown on the drawings and as reviewed by Departmental Representative prior to installation.
- .4 Provide Power to EMCS.
- .5 Metric references: in accordance with CAN/CSA Z234.1.
- .4 Language Operating Requirements:
  - .1 Provide English operator selectable access codes to match existing.
  - .2 Operating system executive: provide primary hardware-to-software interface to existing BMS System.
  - .3 System manager software: include operator access codes to match existing system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages.
  - .4 Include operator selectable access codes to:
    - .1 New input and output commands, field related changes and alarms as assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definitions).
    - .2 Graphic "display" functions, point commands to match existing BMS System.
    - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.
- .5 Scheduling Requirements
  - .1 The Contractor shall inspect the building prior to tender closure and include, in the submission to Departmental Representative, a work plan outlining scheduling, deliverables and allocation of resources pertaining to installation of EMCS. The work plan shall take into consideration the following:
    - .1 All work needs to be completed by the end of September.
  - .2 Final approval of access and working hours to be done by Owner during construction. Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
  - .3 Carry out the demolition required in a manner to cause as little inconvenience as possible to the users. Coordinate work with Owners.
  - .4 Monitor progress and keep detailed records of activities and results.

## **1.5 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit for review:
  - .1 Equipment list systems manufacturers at time of bid tender within 48 h within 10 days after award of contract.
  - .2 List existing field control devices to be re-used included in tender, 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 Permits and fees: in accordance with general conditions of contract.
- .5 Existing devices intended for re-use: submit test report.

## **1.6 QUALITY ASSURANCE**

- .1 Have local office within 50 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.

## **1.7 EXISTING - CONTROL COMPONENTS**

- .1 Include for the removal and/or relocation of all conduit, wire, fittings, etc. related to the EMCS system devices. Remove all conduit that is not being reused. Existing wiring may be reused if extension of wiring is not required; no splicing of existing wiring shall be utilized.
- .2 Re-use of existing field control devices, valves, dampers, sensors, etc is not permitted.
  - .1 Remove all existing control valves and replace with new electronic control valves and wiring. Allow for modifications to existing piping to accommodate replacement of new control valves.
  - .2 Remove all existing space thermostat and replace with new electronic thermostat. Allow for repairs and painting of walls for new thermostats.
  - .3 Repair pipe insulation back to new condition.
- .3 Be responsible for repair costs due to negligence or abuse of equipment.
- .4 Remove existing pneumatic controls. Allow for pneumatic tube removal. Place in approved storage for disposition as directed.

## **Part 2 Products**

### **2.1 ADAPTORS**

- .1 Provide adaptors between metric and imperial components.

**Part 3            Execution**

**3.1                MANUFACTURER'S RECOMMENDATIONS**

- .1            Installation: to manufacturer's recommendations.

**END OF SECTION**

**Part 1 General**

**1.1 DEFINITIONS**

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

**1.2 DESIGN REQUIREMENTS**

- .1 Preliminary Design Review: to contain following contractor and systems information.
  - .1 Location of office.
  - .2 Names of sub-contractors and site-specific key personnel.
  - .3 Sketch of site-specific system architecture.
  - .4 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
  - .5 Descriptive brochures.
  - .6 Response time for each type of command and report.
  - .7 Item-by-item statement of compliance.
  - .8 Proof of demonstrated ability of system to communicate utilizing existing BMS protocol.

**1.3 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.
- .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.

**1.4 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.

- .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 to match existing.
  - .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 systems with point identifiers and textual description of system.
- .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.

## **1.5 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 DCC Representative Consultant retains right to revise sequence or subsequent CDL prior to software finalization without cost to Departmental Representative DCC Representative Consultant.

**Part 2            Products**

**2.1                NOT USED**

.1            Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 DEFINITIONS**

- .1 BECC - Building Environmental Control Centre.
- .2 OWS - Operator Work Station.
- .3 For additional acryonyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.
- .2 Submit Record Documents and Operation and Maintenance Manual to Departmental Representative in English.
- .3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
  - .1 Binders to be 2/3 maximum full.
  - .2 Provide index to full volume in each binder.
  - .3 Identify contents of each manual on cover and spine.
  - .4 Provide Table of Contents in each manual.
  - .5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

**1.3 RECORD DOCUMENTS**

- .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 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
  - .7 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.
  - .8 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.

**1.4 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.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**



## **Part 1 General**

### **1.1 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.

### **1.2 DEFINITIONS**

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

### **1.3 SYSTEM DESCRIPTION**

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

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

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.
- .2 Identification tags and list of proposed wording to match existing.

## **Part 2 Products**

### **2.1 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.

### **2.2 NAMEPLATES FOR ROOM SENSORS**

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

### **2.3 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.

**2.4 CONDUIT**

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

**Part 3 Execution**

**3.1 NAMEPLATES AND LABELS**

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

**3.2 EXISTING PANELS**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI/ASME B16.22-2013, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
  - .2 ANSI C2-1990, National Electrical Safety Code.
  - .3 ANSI/NFPA 70-1990, National Electrical Code.
- .2 CSA Group
  - .1 CSA C22.1-12,
  - .2 CSA C22.2 No. 45.1-07(R2012), Electrical Rigid Metal Conduit.
  - .3 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.

**1.2 SYSTEM DESCRIPTION**

- .1 Electrical:
  - .1 Provide power wiring power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
  - .2 Hard wiring between field control devices and EMCS field panels.
  - .3 Communication wiring between EMCS field panels and OWS's including main control centre BECC.
  - .4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
- .2 Mechanical:
  - .1 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by EMCS Contractor.
  - .2 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by EMCS Contractor. Costs to be carried by designated trade.
- .3 VAV Terminal Units.
  - .1 Air flow probe for vav boxes to be supplied and installed under Section 23 36 00 - Air Terminal Units, clause . Air flow dp sensor, actuator and associated vav controls to be supplied and installed by EMCS contractor. Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators to be the responsibility of EMCS contractor. Coordinate air flow adjustments with balancing trade.

### **1.3 PERSONNEL QUALIFICATIONS**

- .1 Qualified supervisory personnel to:
  - .1 Continuously direct and monitor all work.
  - .2 Attend site meetings.

### **1.4 EXISTING CONDITIONS**

- .1 Cutting and Patching: refer to Section 01 73 00 - Execution supplemented as specified herein.
- .2 Repair all surfaces damaged during execution of work.
- .3 Turn over to Departmental Representative existing materials removed from work not identified for re-use.

## **Part 2 Products**

### **2.1 PIPING**

- .1 Refrigeration.
- .2 Sleeves, escutcheons.
- .3 Hangers and supports.
- .4 Insulation.

### **2.2 WIRING**

- .1 As per requirements of CSA.
- .2 For 70V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.
- .3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.
- .4 Sizes:
  - .1 120V Power supply: to match or exceed breaker, size #12 minimum.
  - .2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
  - .3 Field wiring to digital device: 20 AWG stranded twisted pair.
  - .4 Analog input and output: shielded #20 minimum stranded twisted pair #18 minimum solid copper. Wiring must be continuous without joints.
  - .5 More than 4 conductors: #22 minimum solid copper.
- .5 Terminations:
  - .1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

## **2.3 CONDUIT**

- .1 As per requirements of CSA.
- .2 Electrical metallic tubing to CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 No. 56. Rigid steel threaded conduit to CSA C22.2 No. 45.1.
- .3 Junction and pull boxes: welded steel.
  - .1 Surface mounting cast FS: screw-on flat covers.
  - .2 Flush mounting: covers with 25 mm minimum extension all round.

## **2.4 WIRING DEVICES, COVER PLATES**

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

## **2.5 STARTERS, CONTROL DEVICES**

- .1 Across-the-line magnetic starters:
  - .1 Enclosures: CSA Type 1, except where otherwise specified.
  - .2 Size, type and rating: to suit motors.
- .2 Starter diagrams:
  - .1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.
- .3 Auxiliary Control Devices:
  - .1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.
  - .2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.
  - .3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.
  - .4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.
- .4 Finish for starters:
  - .1 Exterior: in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .2 Interior: white.

**Part 3 Execution**

**3.1 INSTALLATION**

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

**3.2 PIPING**

- .1 Refrigeration.
- .2 Insulation.

**3.3 ELECTRICAL GENERAL**

- .1 Do complete installation in accordance with requirements of:
  - .1 Division 26, this specification.
  - .2 CSA 22.1 Canadian Electrical Code.
  - .3 ANSI/NFPA 70.
  - .4 ANSI C2.

**3.4 WIRING DEVICES, COVER PLATES**

- .1 Receptacles:
  - .1 Install vertically in gang type outlet box when more than one receptacle is required in one location.
  - .2 Cover plates:
    - .1 Install suitable common cover plate where wiring devices are grouped.
    - .2 Use flush type cover plates only on flush type outlet boxes.

**3.5 STARTERS, CONTROL DEVICES**

- .1 Install and make power and control connections as indicated.
- .2 Install correct over-current devices.
- .3 Identify each wire, terminal for external connections with permanent number marking identical to diagram.
- .4 Performance Verification:
  - .1 Operate switches and controls to verify functioning.
  - .2 Perform start and stop sequences of contactors and relays.
  - .3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

**3.6 IDENTIFICATION**

- .1 Refer to Section 25 05 54 - EMCS: Identification.

**END OF SECTION**

**Part 1 General**

**1.1 DEFINITIONS**

- .1 BC(s) - Building Controller(s).
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.
- .3 Submit detailed inspection reports to Departmental Representative.
- .4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:
  - .1 Point name and location.
  - .2 Device type and range.
  - .3 Measured value.
  - .4 System displayed value.
  - .5 Calibration detail
  - .6 Indication if adjustment required,
  - .7 Other action taken or recommended.
- .5 Submit network analysis report showing results with detailed recommendations to correct problems found.
- .6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.
  - .1 Maintain records and logs of each maintenance task on site.
  - .2 Organize cumulative records for each major component and for entire EMCS chronologically.
  - .3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.
- .7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

**1.3 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.

- .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.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution**

### **3.1 FIELD QUALITY CONTROL**

- .1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative as described in Submittal article.
- .2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.
- .3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
  - .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
  - .2 Check each field input/output device in accordance with CSA Z204.
  - .3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.
- .4 Minor inspections to include, but not limited to:
  - .1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.



- .2 Check equipment cooling fans as required.
- .3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
- .5 Major inspections to include, but not limited to:
  - .1 Minor inspection.
  - .2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.
  - .3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.
  - .4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
  - .5 Provide mechanical adjustments, and necessary maintenance on printers.
  - .6 Run system software diagnostics as required.
  - .7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
    - .1 Perform network analysis and provide report as described in Submittal article.
- .6 Rectify deficiencies revealed by maintenance inspections and environmental checks.
- .7 Continue system debugging and optimization.
- .8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
  - .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

**END OF SECTION**

**Part 1 General**

**1.1 DEFINITIONS**

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

**1.2 SYSTEM DESCRIPTION**

- .1 Data communication network architecture to match EMSI controls vendor latest communication network architecture.
  - .1 Provide reliable and secure connectivity of adequate performance between existing and new sections (segments) of network. The EMSI EMCS shall be a single integrated system between the Gatehouse and the rest of the facility.
  - .2 Allow for future expansion of network, with selection of networking technology and communication protocols.

**1.3 DESIGN REQUIREMENTS**

- .1 EMCS Local Area Network (EMCS-LAN).
  - .1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis.
  - .2 EMCS-LAN to: BACnet.
  - .3 Each EMCS-LAN to be capable of supporting at least 50 devices.
  - .4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
  - .5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.
  - .6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
  - .7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.
- .2 Dynamic Data Access.
  - .1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.
  - .2 Access to data to be based upon logical identification of building equipment.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 DEFINITIONS**

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

**1.2 DESCRIPTION**

- .1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided to support building systems and associated sequence(s) of operations as detailed in these specifications.
  - .1 Provide sufficient controllers to meet intents and requirements of this section.
  - .2 Controller quantity, and point contents to be approved by Consultant at time of preliminary design review.
- .2 Controllers: stand-alone intelligent Control Units.
  - .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
  - .2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.
  - .3 Capable of interfacing with operator interface device.
  - .4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
    - .1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

**1.3 DESIGN REQUIREMENTS**

- .1 To include:
  - .1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
  - .2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
  - .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
  - .4 Control of systems as described in sequence of operations.
  - .5 Execution of optimization routines.
- .2 Total spare capacity for MCUs and LCUs: at least 25% of each point type distributed throughout the MCUs and LCUs.
- .3 Field Termination and Interface Devices:
  - .1 To: CSA C22.2 No.205.
  - .2 Electronically interface sensors and control devices to processor unit.

- .3 Include, but not be limited to, following:
  - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
  - .2 Power supplies for operation of logics devices and associated field equipment.
  - .3 Lockable wall cabinet.
  - .4 Required communications equipment and wiring (if remote units).
  - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
  - .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
  - .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
- .4 AI interface equipment to:
  - .1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.
  - .2 Provide for following input signal types and ranges:
    - .1 4 - 20 mA;
    - .2 0 - 10 V DC;
    - .3 100/1000 ohm RTD input;
  - .3 Meet IEEE C37.90.1 surge withstand capability.
  - .4 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
- .5 AO interface equipment:
  - .1 Convert digital data from controller processor to acceptable analog output signals using 8bit digital-to-analog resolution.
  - .2 Provide for following output signal types and ranges:
    - .1 4 - 20 mA.
    - .2 0 - 10 V DC.
  - .3 Meet IEEE C37.90.1 surge withstand capability.
- .6 DI interface equipment:
  - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
  - .2 Meet IEEE C37.90.1 surge withstand capability.
  - .3 Accept pulsed inputs up to 2 kHz.
- .7 DO interface equipment:
  - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.
  - .2 Switch up to 5amps at 220 V AC using optional interface relay.
- .4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.

- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
  - .1 Provide for conduit entrance from top, bottom or sides of panel.
  - .2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
  - .3 Mounting details as approved by Departmental Representative for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

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

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
  - .1 Submit product data sheets for each product item proposed for this project.

#### **1.5 MAINTENANCE**

- .1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

### **Part 2 Products**

#### **2.1 MASTER CONTROL UNIT (MCU)**

- .1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines.
- .2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.
- .3 Central Processing Unit (CPU).
  - .1 Processor to consist of minimum 16 bit microprocessor capable of supporting software to meet specified requirements.
  - .2 CPU idle time to be more than 30 % when system configured to maximum input and output with worst case program use.
  - .3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
    - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
    - .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.

- .4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.

## **2.2 LOCAL CONTROL UNIT (LCU)**

- .1 Provide multiple control functions for typical built-up and package HVAC systems and hydronic systems.
- .2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.
- .3 Points integral to one Building System to be resident on only one controller.
- .4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:
  - .1 Include minimum 2 interface ports for connection of local computer terminal.
  - .2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.
  - .3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
  - .4 Include power supplies for operation of LCU and associated field equipment.
  - .5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
  - .6 Provide conveniently located screw type or spade lug terminals for field wiring.

## **2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)**

- .1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
- .2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.
- .3 VAV Terminal Controller.
  - .1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs.
  - .2 Controller to operate independent of network in case of communication failure.
  - .3 Controller to include damper actuator and terminations for input and output sensors and devices.

## **2.4 SOFTWARE**

- .1 General.
  - .1 Include as minimum: operating system executive, communications, application programs and systems sequence of operation - CDL's.

- .2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
  - .3 Include initial programming of Controllers, for entire system.
- .2 Program and data storage.
  - .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
  - .2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.
- .3 Programming languages.
  - .1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.
  - .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.
- .4 Pseudo or calculated points.
  - .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
  - .2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).
- .5 Control Description Logic (CDL):
  - .1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Departmental Representative must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.
  - .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
  - .3 Perform changes to CDL on-line.
  - .4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.
  - .5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.
  - .6 MCU to be able to perform following pre-tested control algorithms:
    - .1 Two position control.
    - .2 Proportional Integral and Derivative (PID) control.
  - .7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.



- .8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
- .9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.
- .6 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

## **2.5 LEVELS OF ADDRESS**

- .1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.
  - .1 Display analog values digitally to 1 place of decimals with negative sign as required.
  - .2 Update displayed analog values and status when new values received.
  - .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
  - .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

## **2.6 POINT NAME SUPPORT**

- .1 Controllers to support PWGSC point naming convention.

## **Part 3 Execution**

### **3.1 LOCATION**

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

### **3.2 INSTALLATION**

- .1 Install Controllers in secure locking enclosures as directed by Departmental Representative.
- .2 Provide necessary power from local 120V branch circuit panel for equipment.

- .3 Install tamper locks on breakers of circuit breaker panel.
- .4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

**END OF SECTION**

## **Part 1 General**

### **1.1 REFERENCES**

- .1 American National Standards Institute (ANSI).
  - .1 ANSI C12.7-1993(R1999), Requirements for Watthour Meter Sockets.
  - .2 ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.
- .2 American Society for Testing and Materials International, (ASTM).
  - .1 ASTM B148-97(03), Standard Specification for Aluminum-Bronze Sand Castings.
- .3 National Electrical Manufacturer's Association (NEMA).
  - .1 NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 Air Movement and Control Association, Inc. (AMCA).
  - .1 AMCA Standard 500-D-98, Laboratory Method of Testing Dampers For Rating.
- .5 Canadian Standards Association (CSA International).
  - .1 CSA-C22.1-02, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

### **1.2 DEFINITIONS**

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

### **1.3 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.

### **1.4 EXISTING CONDITIONS**

- .1 Cutting and Patching: in accordance with Section 01 73 00 - Execution Requirements supplemented as specified herein.
- .2 Repair surfaces damaged during execution of Work.
- .3 Turn over to Departmental Representative existing materials removed from Work not identified for re-use.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof 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 4 enclosures.
- .8 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.
- .9 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.
- .10 Room temperature sensors.
  - .1 Wall mounting, in slotted type covers having brushed aluminum finish, with guard.
  - .2 Element 10-50mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.
- .11 Duct temperature sensors:
  - .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm.
  - .2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.
- .12 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.

## **2.2 HUMIDITY SENSORS**

- .1 Room and Duct Requirements:
  - .1 Range: 5 - 90 % RH minimum.
  - .2 Operating temperature range: 0 - 60 degrees C.
  - .3 Absolute accuracy:
    - .1 Room sensors: plus or minus 2%.
  - .4 Room sensors: locate in air stream near RA grille.
  - .5 Duct mounted sensors: locate so that sensing element is in air flow in duct.
- .2 Outdoor Humidity Requirements:
  - .1 Range: 0 - 100 % RH minimum.

- .2 Operating temperature range: -40 - 50 degrees C.
- .3 Absolute accuracy: plus or minus 2%.
- .4 Temperature coefficient: plus or minus 0.03%RH/ degrees C over 0 to 50 degrees C.
- .5 Must be unaffected by condensation or 100% saturation.
- .6 No routine maintenance or calibration is required.

### **2.3 SOLENOID CONTROL AIR VALVES**

- .1 Coil: 120V AC, as indicated.
- .2 Capacity: to pass a minimum of 0.15 L/s air at 140 kPa differential.

### **2.4 CONTROL DAMPERS**

- .1 Construction: blades, 152 mm wide, 1219 mm long, maximum. Modular maximum size, 1219 mm wide x 1219 mm high. Three or more sections to be operated by jack shafts.
- .2 Materials:
  - .1 Frame: 2.03 mm minimum thickness extruded aluminum. For outdoor air and exhaust air applications, frames to be insulated.
  - .2 Blades: extruded aluminum. For outdoor air/exhaust air applications, blades to be internally insulated.
  - .3 Bearings: maintenance free, synthetic type of material.
  - .4 Linkage and shafts: aluminum, zinc and nickel plated steel.
  - .5 Seals: synthetic type, mechanically locked into blade edges.
    - .1 Frame seals: synthetic type, mechanically locked into frame sides.
- .3 Performance: minimum damper leakage meet or exceed AMCA Standard 500-D ratings.
  - .1 Size/Capacity: refer to damper schedule
  - .2 25 L/s/m<sup>2</sup> maximum allowable leakage against 1000 Pa static pressure for outdoor air and exhaust air applications.
  - .3 Temperature range: minus 40 degrees C to plus 100 degrees C.
- .4 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.
- .5 Jack shafts:
  - .1 25 mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.
  - .2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.
  - .3 Install using manufacturers installation guidelines.
  - .4 Use same manufacturer as damper sections.

## **2.5 ELECTRONIC CONTROL DAMPER ACTUATORS**

- .1 Requirements:
  - .1 Direct mount proportional type as indicated.
  - .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
  - .3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
  - .4 Power requirements: 5 VA maximum at 24 V AC.
  - .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
  - .6 For VAV box applications floating control type actuators may be used.
  - .7 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

## **2.6 ELECTRONIC / ELECTRIC VALVE ACTUATORS**

- .1 Requirements:
  - .1 Construction: steel, cast iron, aluminum.
  - .2 Control signal: 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.
  - .8 Minimum shut-off pressure: refer to control valve schedule.

## **2.7 PANELS**

- .1 Panels to be lockable with same key and match existing.

## **2.8 WIRING**

- .1 In accordance with Section 26 27 10 - Modular Wiring System and 26 27 26 - Wiring Devices.
- .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.
  - .2 Analog input and output: shielded #18 minimum solid copper.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1      Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2      Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3      Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .4      Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5      Firestopping: provide space for fire stopping in accordance with Section 07 84 00 - Firestopping. Maintain fire rating integrity.
- .6      Electrical:
  - .1          Complete installation in accordance with Section 26 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 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.
  - .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 AND HUMIDITY SENSORS**

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
  - .1 Protect from solar radiation and wind effects by non-corroding shields.
  - .2 Install in NEMA 4 enclosures.
- .4 Duct installations:
  - .1 Do not mount in dead air space.
  - .2 Locate within sensor vibration and velocity limits.
  - .3 Securely mount extended surface sensor used to sense average temperature.
  - .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
  - .5 Support sensor element separately from coils, filter racks.

### **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 MAGNEHELIC PRESSURE INDICATORS**

- .1 Install adjacent to fan system static pressure sensor and duct system velocity pressure sensor as reviewed by Departmental Representative.
- .2 Locations: as specified.

### **3.5 IDENTIFICATION**

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

### **3.6 AIR FLOW MEASURING STATIONS**

- .1 Protect air flow measuring assembly until cleaning of ducts is completed.

### **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**



**Part 1 General**

**1.1 DESIGN REQUIREMENTS**

- .1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.
- .2 Consult with the Departmental Representative during the shop drawing stage to finalize the control sequences for each system.

**1.2 SEQUENCING**

- .1 Sequencing of operations for systems as follows:
  - .1 F-1 Air System
    - .1 Existing air system is a single duct, constant volume air system. The system consists of an outside air damper, return air damper, filter section, glycol heating coil, supply fan, and a wet cell humidifier. Two new DX cooling coils are added to the system main branches.
    - .2 System Start/Stop
      - .1 The EMCS shall operate the air system continuously. A weekly schedule shall be provided which is to be initially set for 24 hour operation.
      - .2 Upon system start-up, the supply fan shall be energized. After a 30 second time delay, the mixed air dampers shall be energized and opened to their minimum position.
      - .3 The initial minimum damper position shall be 15%.
    - .3 Freeze Stats
      - .1 A freezestat with a sensing element supported downstream of the supply fan shall cause the system to shut down upon sensing air temperature of 4°C or lower. The supply fan shall stop, and outdoor air damper shall close. The freeze stat must be reset manually.
      - .2 The EMCS shall monitor the freezestat. When it trips, the EMCS shall modulate the heating coil valve to maintain plenum temperature at 10°C.
    - .4 Temperature Control
      - .1 The mixed air dampers and heating coil valve shall be modulated in sequence to maintain a supply air temperature setpoint initially set to 16°C (operator adjustable from 10°C to 25°C).
      - .2 When the outside air temperature is above the return air temperature, the mixed air dampers shall be reverted to minimum position.
      - .3 When the economizer cannot meet cooling demand, mechanical cooling shall be enabled and controlled according to return air temperature.
      - .4 There shall be no overlap between heating and cooling modes.

.5 Humidity Control

- .1 The humidifier shall be cycled to maintain humidity set point as sensed by return duct humidity sensor. The humidity set point is reset in accordance with an operator adjustable outdoor temperature reset schedule initially set as follows:

O/A Temp	% R.H
-35°C	15
0°C	30

- .2 The humidifier is only allowed to run when the air system is on and the mechanical cooling is off.
- .3 A humidity transmitter located in the discharge duct shall limit the discharge humidity to 80% (adjustable).
- .4 The controls contractor shall supply, install and commission all interlock wiring required for the proper operation of the humidifier.

.6 Equipment Failure

- .1 Provide alarm points for fan failure, low and high supply temperature condition, and high pressure drop across the filter.

.2 Radiant Panel

- .1 A room sensor via the EMCS shall modulate a normally open heating radiant panel control valve to maintain room temperature setpoint initially set to 21°C.
- .2 The EMCS shall monitor the space temperature and provide high and low alarms.

.3 Typical of F-4 to 8

- .1 Exhaust fans shall operate continuously once they are enabled by the individual wall mounted switches.
- .2 The EMCS shall monitor status of each exhaust fan.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**1. General**

- .1 A point is a specific software address which is resident in the EMCS controller and which is identified with a particular field sensor, instrument or sensor.
- .2 The point schedule contains a list and description of the points to be connected. The Contractor shall examine the point list and ensure that all points required to make control sequences work are included in the point schedules.
- .3 The relationships between the points, systems and building are described in the control sequences, Section 25 90 01.01.
- .4 Control loops shall not be closed across communication networks.
- .5 All physical I/O points for each mechanical system must be terminated within a single controller. Exceptions will only be permitted for points that are not used for alarming, shutdowns or control loops.
- .6 Consult with the Engineer during the shop drawing stage to finalize the physical terminal address of each point within the EMCS controller.
- .7 Point mnemonics shall follow an existing naming convention.
- .8 Every alarm annunciation, log and report whether displaying to the workstation screen or printing shall also include a concise English description of the point that also identifies the building, system and point.

**2. Products**

Not Applicable

**3. Execution**

SYSTEM: F-1 AIR SYSTEM 1							
	DIGITAL			ANALOG			REMARKS
POINT DESCRIPTION	OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Supply Fan							
Status					X	X	
Start/Stop	X						
Outside Air Damper				X			
Return Air Damper				X			
3-way Htg Valve				X			
Dx Clg	2						
Humidifier Enable	X						
Outside Air Temperature					X		
Mixed Air Temperature					X		
Supply Air Temperature					X	X	
Freezestat		X				X	
Return Air Humidity					X	X	
Supply Air Humidity					X	X	
Filter Pd					X	X	
Dx Clg Coil Discharge Temp					2		

[illegible]

END OF SECTION