

## **Part 1 General**

### **1.1 SUMMARY**

- .1 Related Requirements
  - .1 Section 25 05 01 EMCS: General Requirements.

### **1.2 DEFINITIONS**

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

### **1.3 DESIGN REQUIREMENTS**

- .1 Confirm with Departmental Representative that Design Criteria and Design Intents are still applicable.
- .2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

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

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Final Report: submit report to Departmental Representative.
  - .1 Include measurements, final settings and certified test results.
  - .2 Bear signature of commissioning technician and supervisor
  - .3 Report format to be approved by Departmental Representative before commissioning is started.
  - .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.
  - .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

### **1.5 CLOSEOUT SUBMITTALS**

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

### **1.6 COMMISSIONING**

- .1 Do commissioning
- .2 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative.
- .3 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to commissioning or each test. Indicate:
  - .1 Location and part of system to be tested or commissioned.

- .2 Testing/commissioning procedures, anticipated results.
- .3 Names of testing/commissioning personnel.
- .4 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.
- .5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .6 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.

## **Part 2 Products**

### **2.1 EQUIPMENT**

- .1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.
- .2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.
- .3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.
- .4 Locations to be approved, readily accessible and readable.
- .5 Application: to conform to normal industry standards.

## **Part 3 Execution**

### **3.1 PROCEDURES**

- .1 Commission each system using procedures prescribed by the Departmental Representative.
- .2 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

### **3.2 ADJUSTING**

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

### **3.3 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.

**END OF SECTION**



**Part 1            General**

**1.1            SUMMARY**

- .1    Related Requirements
  - .1            Section 25 05 01            EMCS General Requirements.

**1.2            DEFINITIONS**

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

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submittals in accordance with Section 01 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    Submit reports within one week after completion of training program that training has been satisfactorily completed.

**1.4            QUALITY ASSURANCE**

- .1    Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2    Departmental Representative reserves right to approve instructors.

**1.5            INSTRUCTIONS**

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

**1.6            TIME FOR TRAINING**

- .1    Time for training: 4 hours.

**1.7            TRAINING MATERIALS**

- .1    Provide equipment, visual and audio aids, and materials for classroom training.
- .2    Supply manual for each trainee, describing in detail data included in each training program.

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

## **1.8 MONITORING OF TRAINING**

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

### **Part 2 Products**

- .1 Not applicable.

### **Part 3 Execution**

- .1 Not applicable.

**END OF SECTION**

## **Part 1 General**

### **1.1 SUMMARY**

- .1 Related Requirements
  - .1 Section 23 05 49.01 Seismic Restraint Systems (SRS) - Type P2 Buildings
  - .2 Section 23 05 53 Mechanical Identification
  - .3 Section 23 05 93 Testing, Adjusting and Balancing for HVAC
  - .4 Section 25 01 11 EMCS Start-up, Verification and Commissioning
  - .5 Section 25 01 12 EMCS Training
  - .6 Section 25 05 02 EMCS Submittals and Review Process
  - .7 Section 25 05 54 EMCS Identification
  - .8 Section 25 30 01 EMCS Building Controllers Family of Controllers

### **1.2 REFERENCES**

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
  - .1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
  - .1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE 135-2012, BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA International).
  - .1 CAN/CSA-Z234.1-00(R2011), Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
  - .1 CEA-709.1-B-2014, Control Network Protocol Specification.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).

### **1.3 ACRONYMS AND ABBREVIATIONS**

- .1 Acronyms used in EMCS:
  - .1 AEL - Average Effectiveness Level.
  - .2 AI - Analog Input.
  - .3 AIT - Agreement on International Trade.
  - .4 AO - Analog Output.
  - .5 BACnet - Building Automation and Control Network.

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

## **1.4 DEFINITIONS**

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



- .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.
- .2 Point Name: composed of two parts, point identifier and point expansion.
  - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.
    - .1 Area descriptor: building or part of building where point is located.
    - .2 System descriptor: system that point is located on.
    - .3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25 character field for each point identifier.
  - .2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.
  - .3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
    - .1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.
- .3 Point Object Type: points fall into following object types:
  - .1 AI (analog input).
  - .2 AO (analog output).
  - .3 DI (digital input).
  - .4 DO (digital output).
  - .5 Pulse inputs.
- .4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
  - .1 Printouts: to ANSI/IEEE 260.1.
  - .2 Refer also to Section 25 05 54- EMCS: Identification.

## **1.5 SYSTEM DESCRIPTION**

- .1 Refer to control schematics for system architecture.
- .2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
  - .1 Building Controllers.
  - .2 Control devices as listed in I/O point summary tables.
  - .3 OWS(s).
  - .4 Data communications equipment necessary to effect EMCS data transmission system.
  - .5 Field control devices.
  - .6 Software/Hardware complete with full documentation.

- .7 Complete operating and maintenance manuals.
- .8 Training of personnel.
- .9 Acceptance tests, technical support during commissioning, full documentation.
- .10 Wiring interface co-ordination of equipment supplied by others.
- .11 Miscellaneous work as specified in these sections and as indicated.
- .3 Design Requirements:
  - .1 Design and provide conduit and wiring linking elements of system.
  - .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
  - .3 Location of controllers as reviewed by Departmental Representative prior to installation.
  - .4 Provide utility power to EMCS and emergency power to EMCS as indicated.
  - .5 Metric references: in accordance with CAN/CSA Z234.1.
- .4 Language Operating Requirements:
  - .1 Provide French operator selectable access codes.
  - .2 Use non-linguistic symbols for displays on graphic terminals. Other information to be in French.
  - .3 Operating system executive: provide primary hardware-to-software interface with associated documentation to be in French.
  - .4 System manager software: include in French system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
  - .5 Include, in French:
    - .1 Input and output commands and messages from operator-initiated functions, field related changes, alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definitions).
    - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in French at specified OWS and to be able to operate one terminal in English and second in French. Point name expansions in both languages.
    - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

## **1.6 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 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 Submittals and Review Process. Label or listing of specified organization is acceptable evidence.
- .4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that 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.

#### **1.7 QUALITY ASSURANCE**

- .1 Have local office within 100 km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems.
- .2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .3 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.
- .4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.
- .5 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

#### **1.8 EXISTING- CONTROL COMPONENTS**

- .1 Utilize existing control wiring and piping as indicated.
- .2 Re-use field control devices that are usable in their original configuration provided that they conform to applicable codes, standards specifications.
  - .1 Do not modify original design of existing devices without written permission from Departmental Representative.
  - .2 Provide for new, properly designed device where re-usability of components is uncertain.
- .3 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
- .4 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Departmental Representative.
  - .1 Be responsible for items repaired or replaced by Departmental Representative.
  - .2 Be responsible for repair costs due to negligence or abuse of equipment.

- .3 Responsibility for existing devices terminates upon final acceptance of EMCS as approved by Departmental Representative.
- .5 Remove existing controls not re-used or not required. Place in approved storage for disposition as requested.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Not applicable.

**Part 3 Execution**

**3.1 MANUFACTURER'S RECOMMENDATIONS**

- .1 Installation: to manufacturer's recommendations.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Related Requirements
  - .1 Section 25 05 01 - EMCS General Requirements.
  - .2 Section 25 01 11 - EMCS Start-up, Verification and Commissioning.

**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 Names of sub-contractors and site-specific key personnel.
  - .5 Sketch of site-specific system architecture.
  - .6 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
  - .7 Descriptive brochures.
  - .8 Sample CDL and graphics (systems schematics).
  - .9 Response time for each type of command and report.
  - .10 Item-by-item statement of compliance.
  - .11 Proof of demonstrated ability of system to communicate utilizing BACnet.

**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.
- .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.

**1.5 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 systems with point identifiers and textual description of system, 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.

**Part 2 Products**

- .1 Not applicable.

**Part 3 Execution**

- .1 Not applicable.

**END OF SECTION**

## **Part 1            General**

### **1.1            SUMMARY**

- .1    Related Requirements
  - .1       Section 25 05 01 - EMCS: General Requirements.

### **1.2            REFERENCES**

- .1    Canadian Standards Association (CSA International).
  - .1       CSA C22.1-15, The Canadian Electrical Code, Part I (23rd 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 French.

### **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.

## **Part 2            Products**

### **2.1            NAMEPLATES FOR PANELS**

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

### **2.2            NAMEPLATES FOR FIELD DEVICES**

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

## **2.3 NAMEPLATES FOR ROOM SENSORS**

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

## **2.4 WARNING SIGNS**

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

## **2.5 WIRING**

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

## **2.6 PNEUMATIC TUBING**

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

## **2.7 CONDUIT**

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

## **Part 3 Execution**

### **3.1 NAMEPLATES AND LABELS**

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

### **3.2 EXISTING PANELS**

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

**END OF SECTION**



**Part 1 General**

**1.1 SUMMARY**

- .1 Related Requirements
  - .1 Section 25 05 01 EMCS: General Requirements.

**1.2 MAINTENANCE**

- .1 Provide manufacturers recommended maintenance procedures for insertion in Section 01 33 00 – Submittal Procedures.

**Part 2 Products**

**2.1 DESCRIPTION OF WORK**

- .1 Partial system (without integration to the central system) including, controllers, sensors, control devices, wiring, electrical connections, transmission cables, and all auxiliary equipment required for proper system operation. This section is also responsible for system verification, calibration and development.
- .2 Use equipment from manufacturer's regular production for this type of system and not custom designed or manufactured specifically for this project. Use thoroughly tested and approved equipment, designed to operate during a power failure.

**2.2 DESCRIPTION OF DIGITAL CONTROL SYSTEM**

- .1 Automated DDC-type control system including point servers, multiprotocol gateways and stand-alone digital controllers in areas specified on drawings.
- .2 Supply digital controllers with inputs/outputs, hardware, software, data transmission network, etc.
- .3 Supply control system with several digital controllers to ensure reliable, independent operation of local control loops and easy scalability.
- .4 Each digital controller to be independent and capable of controlling its activities without resorting to controllers or gateways connected to the data transmission network.
- .5 Provide customer with one (1) spare digital control in the event a controller breaks.

**2.3 DIGITAL CONTROLLERS**

- .1 Controllers that communicate with each other using one of the following communication networks:
  - .1 BACnet MSTP (RS-485)

- .2 Fully programmable controller capable of performing key measurement, control and monitoring functions. Install in the locations indicated on the drawings and have the input/output points required for the application and the desired spare points.
- .3 Communication speed to be such that the average query response time is 0.5 seconds, with a maximum of 3 seconds.

## **2.4 MOTORIZED ACTUATORS**

- .1 Provide and install all assembly accessories required, as per manufacturer's recommendations, for actuator coupling in motorized components.
- .2 Provide sufficient number of actuators to operate large motorized actuators.
- .3 Install all actuators outside ventilation ducts or terminal units, without exception.
- .4 Acceptable actuators are:
  - .1 Spring return actuator for electrical components, auxiliary switch incorporated on on-off actuator.
    - .1 On-off actuator: 24V or 120V
    - .2 Modulating actuator: proportional DC 0...10 V
- .5 Except for terminal elements, equip all damper actuators with a spring return.

## **2.5 CONTROL VALVES**

- .1 Supply all control valves.
- .2 Supply measurement valves and equipment for installation by plumbing contractor.
- .3 Valve size as indicated on drawings or calculated based on maximum permissible pressure loss, as indicated on drawings.

## **2.6 SENSORS AND TRANSMITTERS**

- .1 Duct sensors:
  - .1 To be 1,000 ohm platinum RTD or 20,000 ohm NTC thermistor.
    - .1 Measurement range based on application.
    - .2 Sensor accuracy:  $\pm 0.2$  °C or less.
  - .2 Averaging duct type sensors
    - .1 Sensitive over the entire operating range.
    - .2 Capillary tube length: 3,600 mm or 7,300 mm depending on duct size.
    - .3 Use "temperature sensors inside a malleable copper or aluminium tube."

- .4 Sensor accuracy:  $\pm 0.2$  °C or less.
- .3 Room temperature sensors
  - .1 Type 1: Open spaces:
    - .1 Room temperature sensor, no setpoint adjustment.
  - .2 Type 2: Closed offices:
    - .1 Room thermostat with setpoint adjustment.

## **2.7 CONTROL PANEL**

- .1 Where no specifications are provided on the drawing, supply the components defined hereunder.
- .2 Mount digital controllers in control panels, located as shown on drawings or coordinated with Departmental Representative.
- .3 Connect the physical points of a system in a single panel.
- .4 Characteristics of automatic control panels:
  - .1 Freestanding NEMA 12 enclosure with 100 mm base.
  - .2 Equipped with mounting plate.
  - .3 Connect all control wires from outside the panel to the terminal block mounted on DIN rails. Place wiring in chutes large enough to accommodate future cables. Identify each wire and terminal block with an identification device designed for this purpose. Handwritten identification will not be accepted.

## **2.8 WIRE NUMBERING**

- .1 Pre-numbered plastic rings.

## **Part 3 Execution**

### **3.1 GENERAL CONDITIONS**

- .1 Have experienced technicians regularly used by the manufacturer install and adjust the controls. Ensure control devices are easily accessible for repair and calibration. Install all control devices in NEMA 12 cabinets.
- .2 Install all capillary tubes correctly and ensure support all along their length.
- .3 Use copper hooks to solidly anchor pedestals and capillary tubes inside ventilation ducts. An access door in the duct will be provided for in another section to facilitate inspection.

- .4 Ensure any control device installed on a thermally insulated ventilation duct is equipped with an appropriate metallic support. The position of the thermostats or room sensors shown on the drawings is approximate and provided for reference only.
- .5 Ensure the thermostat or room sensor is not affected by sunlight or any other source of heat, cold or air current.
- .6 Provide, connect and install the power transformers in accordance with the requirements of electrical division 26 05 00.

### **3.2 ELECTRICAL CONNECTIONS**

- .1 Provide and install panels, controls and other devices. Provide and install ducts, cables and boxes required to connect all devices applicable to contractor's specialty.
- .2 Laws and regulations:
  - .1 All temporary and permanent installations described on the drawings and in these specifications must conform to the requirements of the Canadian Electrical Code and the Bureau des examinateurs électriciens.
- .3 Ducts, wires:
  - .1 All conductors to be installed in conduits:
    - .1 In exposed locations and in the mechanical and electrical rooms;
    - .2 In gypsum ceilings and other inaccessible ceilings;
    - .3 In suspended ceilings with return air plenums, stranded shielded plenum FT-6 cables may be installed without a duct if properly fastened to the structure or in the cable troughs provided for communication purposes.
  - .2 Conduit diameter to be at least 20 mm.
  - .3 Conduits must be concealed wherever possible and installed parallel to building lines.
  - .4 Use flexible conduits for transition between control elements and EMT conduits. Flexible conduits not to exceed 500 mm.
  - .5 In classified locations, conduits and related hardware to conform to application concerned.

### **3.3 COMMISSIONING**

- .1 Commission the system. Test all points connected to a digital controller. Calibrate thermostats and controllers and check operation of each tested actuator. Submit results of following tests in a report after commissioning.
- .2 Physical point testing report:
  - .1 Inputs:
    - .1 No-response check

- .2 Readings test
- .2 Outputs:
  - .1 Check failsafe mode
  - .2 Start/Stop check
  - .3 Three-point check of output range, if applicable (0%, 50%, 100%)
- .3 Sequence of operations testing report:
  - .1 Test all sequences programmed in a controller for each control loop.
  - .2 Complete, annotate, date and sign all required reports. Include jobsite comments in reports.

**END OF SECTION**

