

Equipment ID	Equipment Type	Approx. Field Test Duration (Hours)	Contractor Commissioning Notes	Contractor Initials for completion Y or N
<b>MECHANICAL SYSTEM BALANCING / COMMISSIONING VERIFICATION</b>				
Air	Ducted air systems; see all relevant items below and as per mechanical equipment schedule	8	Includes all fans, air handling units (ERV's), and electric preheat coils	
Water	Piped hydronic systems; see all relevant items below and as per mechanical equipment schedule	8	Includes heating system and all associated pumps, domestic water heating system and recirculation pump, tanks/expansion vessels, finned tub radiation heating, domestic cold water supply piping and all plumbing fixtures	
<b>HEATING SYSTEM</b>				
B-1	Main Heating Boiler	2.25	c/w condenser neutralizer, zone controller, condensate hose & quick connect install manifold; connected to BAS to outdoor thermostat, such that boiler turns on when outdoor temperature drops to < 15C, and boiler deactivates (turns off) when outdoor temperature is great than or equal to 17C	
B-2	Main Heating Boiler	2.25	c/w condenser neutralizer, zone controller, condensate hose & quick connect install manifold; connected to BAS to outdoor thermostat, such that boiler turns on when outdoor temperature drops to < 15C, and boiler deactivates (turns off) when outdoor temperature is great than or equal to 17C	
BP-1	Primary Loop - mechanical room boiler water circulation pump	N/A	Factory mounted integral boiler pump, shall run continuously	
BP-2	Primary Loop - mechanical room boiler water circulation pump	N/A	Factory mounted integral boiler pump, shall run continuously	
P-1	Secondary Loop - mechanical room heating system circulation pump	N/A	Heating system water pump each at 100% capacity with one duty and one standby c/w VFD; energized by BAS based on outdoor air temperature signal to Boilers. Check for trapped air, especially where heating runs go down and up in the basement, and then install air vents where required	

	P-2	Secondary Loop - mechanical room heating system circulation pump	N/A	Heating system water pump each at 100% capacity with one duty and one standby c/w VFD; energized by BAS based on outdoor air temperature signal to Boilers. Check for trapped air, especially where heating runs go down and up in the basement, and then install air vents where required
	P-4	Mechanical room weeping tile sump	N/A	c/w simplex control package, steel lid, check valve, float bracket, lift chain package
	Boiler Zone Controller	Standalone DDC controller	3	Refer to B-1 and B-2 installation instructions
	ET-1	Heating water system expansion tank	0.5	c/w ASME certification label
	ET-2	Domestic hot water system expansion tank	0.5	c/w ASME certification label
	Type A	Finned tube radiation heating element c/w cover	0.5	c/w wall mounted thermostat
	Type B	Finned tube radiation heating element c/w cover	0.5	c/w wall mounted thermostat
	Type C	Finned tube radiation heating element c/w cover	0.5	c/w wall mounted thermostat
<b>DOMESTIC HOT WATER SYSTEM</b>				
	DHW-1	Domestic hot water heater	2	High efficiency gas fired water heater; Refer to manufacturer installation instructions
	P-3	Mechanical room domestic hot water recirculation pump	N/A	Inline, all bronze construction, c/w timer and aquastat. Refer to manufacturer installation instructions
	P-4	Mechanical room weeping tile system sump pump	N/A	c/w simplex control package, steel lid, check valve, float bracket, lift chain package. Refer to manufacturer installation instructions
<b>ELECTRIC PREHEAT COILS</b>				
	PHC-1	Suites ERV	0.25	c/w built-in control thermostat set at 10C supply air temperature, interlocked to motorized outside air intake damper c/w 24VAC actuator (located upstream of electric coil)
<b>EXHAUST FANS</b>				
	EF-1	Washroom exhaust fan	0.25	c/w wall switch - box
	EF-2	Mechanical Room exhaust fan	0.25	c/w wall switch - box
	RH-1	Range hood fan	0.25	c/w variable speed selection, controlled by local exhaust hood switch

	RD-1	Radon Gas fan (future rough-in only)		No action at this time
<b>AIR HANDLING UNITS</b>				
	ERV-1	Suites - energy recovery unit	0.5	c/w speed control switch installed in bath room. Refer to manufacturer installation instructions. The BAS system shall ensure ventilation is maintained based on pre-set timer
<b>FIRE SUPPRESSION SYSTEM</b>				
	FE-1	All-purpose fire extinguisher	0.25	Ensure installed as per manufacturer instructions, and that the fire extinguisher is fully charged
	FE-2	Electrical room, CO2 fire extinguisher	0.25	Ensure installed as per manufacturer instructions, and that the fire extinguisher is fully charged
	FE-3	All-purpose fire extinguisher under kitchen sink	0.25	Ensure installed as per manufacturer instructions, and that the fire extinguisher is fully charged
<b>GRILLES AND DIFFUSERS</b>				
	Types S, R, E, T, and L	Diffusers and grilles as per schedule	0.25	Ensure proper air flow from each grille and diffuser as per drawings
<b>PLUMBING FIXTURES</b>				
	Tag Numbers: WC, LAV, SK, TUB, NFHB, FD-1, HD-1	Refer to plumbing fixture schedule	0.25	Service test all plumbing fixtures; refer to plumbing code and manufacturer installation instructions
	Drinking water Backflow preventer	Water meter room, backflow preventer	0.25	Installed as per plumbing code

**Part 1 General**

**1.1 SUMMARY**

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

**1.2 DEFINITIONS**

- .1 AEL: ratio between total test periods less any system downtime accumulated within that period and test period.
- .2 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
  - .1 Outage of main power supply in excess of back-up power sources, provided that:
    - .1 Automatic initiation of back-up was accomplished.
    - .2 Automatic shut-down and re-start of components was as specified.
  - .2 Failure of communications link, provided that:
    - .1 Controller automatically and correctly operated in stand-alone mode.
    - .2 Failure was not due to failure of any specified EMCS equipment.
  - .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
    - .1 System recorded said fault.
    - .2 Equipment defaulted to fail-safe mode.
    - .3 AEL of total of all input sensors and output devices is at least 99 % during test period.

**1.3 DESIGN REQUIREMENTS**

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

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.6 COMMISSIONING**

- .1 Carry out commissioning in accordance with section 25 01 11.1 - Start-up Verification and Commissioning Checklists.
- .2 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.
- .3 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.
- .4 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .5 Load system with project software.
- .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 2months prior to tests.
- .4 Locations to be approved, readily accessible and readable.
- .5 Application: to conform to normal industry standards.

**Part 3 Execution**

**3.1 PROCEDURES**

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures prescribed by the Departmental Representative.
- .3 Commission integrated systems using procedures prescribed by Departmental Representative.
- .4 Debug system software.
- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

**3.2 FIELD QUALITY CONTROL**

- .1 Pre-Installation Testing.
  - .1 General: consists of field tests of equipment just prior to installation.
  - .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.
  - .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.

- .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
- .5 Additional instruments to include:
  - .1 DP transmitters.
  - .2 DP switches used for dirty filter indication and fan status.
- .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source and to BECC.
- .7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.
- .8 Departmental Representative 0.5 to mark instruments tracking within % in both directions as "approved for installation".
- .9 Transmitters above 0.5 % error will be rejected.
- .10 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing.
  - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
  - .2 Include following activities:
    - .1 Test and calibrate field hardware including stand-alone capability of each controller.
    - .2 Verify each A-to-D convertor.
    - .3 Test and calibrate each AI using calibrated digital instruments.
    - .4 Test each DI to ensure proper settings and switching contacts.
    - .5 Test each DO to ensure proper operation and lag time.
    - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
    - .7 Test operating software.
    - .8 Test application software and provide samples of logs and commands.
    - .9 Verify each CDL including energy optimization programs.
    - .10 Debug software.
    - .11 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 2 technical personnel capable of re-calibrating field hardware and modifying software.
  - .2 Detailed daily schedule showing items to be tested and personnel available.
  - .3 Departmental Representative's acceptance signature to be on executive and applications programs.
  - .4 Commissioning to commence during final startup testing.
  - .5 Operation and Maintenance personnel to assist in commissioning procedures as part of training.
  - .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
  - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
  - .8 Operate systems as long as necessary to commission entire project.
  - .9 Monitor progress and keep detailed records of activities and results.
- .4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
- .1 Prior to beginning of 30day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
    - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
  - .2 Test to last at least 30 consecutive 24 hour days.
  - .3 Tests to include:
    - .1 Demonstration of correct operation of monitored and controlled points.
    - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
  - .4 System will be accepted when:
    - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
    - .2 Requirements of Contract have been met.
  - .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
  - .6 Correct defects when they occur and before resuming tests.
- .5 Departmental Representative to 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                SUMMARY**

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

**1.2                DEFINITIONS**

- .1    CDL - Control Description Logic.

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

**1.7                TRAINING MATERIALS**

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

- .2 Supply manual for each trainee, describing in detail data included in each training program.
  - .1 Review contents of manual in detail to explain aspects of operation and maintenance.

**1.8 TRAINING PROGRAM**

- .1 To be completed over a two day period.
- .2 Two day program to begin before 5 day test period at time mutually agreeable to Contractor, and Departmental Representative.
  - .1 Train Operation and Maintenance personnel in functional operations and procedures to be employed for system operation.
  - .2 Supplement with on-the-job training during 5 day test period.
  - .3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
  - .4 Include detailed training on operator interface functions for control of mechanical systems, and elementary preventive maintenance.

**1.9 ADDITIONAL TRAINING**

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

**1.10 MONITORING OF TRAINING**

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

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1        General**

**1.1            SUMMARY**

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

**1.2            DESIGN REQUIREMENTS**

- .1        Preliminary Design Review: to contain following contractor and systems information.
  - .1        Location of local office.
  - .2        Description and location of installing and servicing technical staff.
  - .3        Location and qualifications of programming design and programming support staff.
  - .4        List of spare parts.
  - .5        Location of spare parts stock.
  - .6        Names of sub-contractors and site-specific key personnel.
  - .7        Sketch of site-specific system architecture.
  - .8        Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
  - .9        Descriptive brochures.
  - .10      Response time for each type of command and report.
  - .11      Item-by-item statement of compliance.

**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 PRELIMINARY SHOP DRAWING REVIEW**

- .1 Submit preliminary shop drawings within 15 working days of award of contract and include following:
  - .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

**1.5 DETAILED SHOP DRAWING REVIEW**

- .1 Submit detailed shop drawings within 30 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 Manufacturer's recommended installation instructions and procedures.
  - .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 Sample of "Operating Instructions Manual" to be used for training purposes.
  - .8 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

**1.6 QUALITY ASSURANCE**

- .1 Preliminary Design Review Meeting: Convene meeting within 20 working days of award of contract to:
  - .1 Undertake functional review of preliminary design documents, resolve inconsistencies.
  - .2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).

- .3 Review interface requirements of materials supplied by others.
- .4 Review "Sequence of Operations".
- .2 Contractor's programmer to attend meeting.
- .3 Departmental Representative retains right to revise sequence without cost to Departmental Representative.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1      General**

**1.1          SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for final control diagrams and operation and maintenance (O M) manual, for building Energy Monitoring and Control System (EMCS) Work.

**1.2          DEFINITIONS**

- .1 BECC - Building Environmental Control Centre.

**1.3          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 As-built drawings, 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.

**1.4          AS-BUILTS**

- .1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:
  - .1 Changes to contract documents as well as addenda and contract extras.
  - .2 Changes to interface wiring.
  - .3 Routing of conduit, wiring and control air lines associated with EMCS installation.
  - .4 Locations of obscure devices to be indicated on drawings.
  - .5 Listing of alarm messages.
  - .6 Panel/circuit breaker number for sources of normal/emergency power.
  - .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
  - .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

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- .9 Basic system design and full documentation on system configuration.
  - .2 Submit for final review by Departmental Representative.
  - .3 Provide before acceptance 4 Hard and 1 soft copy incorporating changes made during final review.
- 1.5 O & M MANUALS**
- .1 Custom design O M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
  - .2 Provide 2 complete sets of hard and soft copies prior to system or equipment tests
  - .3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.
  - .4 Functional description to include:
    - .1 Functional description of theory of operation.
    - .2 Design philosophy.
    - .3 Specific functions of design philosophy and system.
    - .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
    - .5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
    - .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.
  - .5 System operation to include:
    - .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
    - .2 Emergency, alarm and failure recovery.
    - .3 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.
  - .6 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.

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**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
- .2 American National Standards Institute (ANSI)
  - .1 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
  - .2 ANSI C2, National Electrical Safety Code.
  - .3 ANSI/NFPA 70, National Electrical Code.
- .3 CSA Group
  - .1 CSA C22.1,
  - .2 CAN/CSA-C22.3 No. 7, Underground Systems.
  - .3 CSA C22.2 No. 45.1, Electrical Rigid Metal Conduit.
  - .4 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .5 CSA C22.2 No. 83, Electrical Metallic Tubing.
  - .6 CAN/CSA-C22.3 No. 1-10, Overhead Systems.

**1.2 SYSTEM DESCRIPTION**

- .1 Electrical:
  - .1 Provide power wiring 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.
- .2 Mechanical:
  - .1 Pipe Taps Required for EMCS equipment will be supplied and installed by Division 23.
  - .2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by Division 23.
  - .3 Installation of dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs to be carried by designated trade.

**1.3 PERSONNEL QUALIFICATIONS**

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

**Part 2 Products**

**2.1 SPECIAL SUPPORTS**

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

**2.2 WIRING**

- .1 As per requirements of Division 26.
- .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 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 Division 26.
- .2 Electrical metallic tubing to CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 No. 56. Rigid steel threaded conduit to CSA C22.2 No. 45.1.
- .3 Junction and pull boxes: welded steel.
  - .1 Surface mounting cast FS: screw-on flat covers.
  - .2 Flush mounting: covers with 25 mm minimum extension all round.
- .4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.
- .5 Outlet boxes: 100 mm minimum, square.
- .6 Conduit boxes, fittings:
  - .1 Bushings and connectors: with nylon insulated throats.
  - .2 With push pennies to prevent entry of foreign materials.
- .7 Fittings for rigid conduit:
  - .1 Couplings and fittings: threaded type steel.
  - .2 Double locknuts and insulated bushings: use on sheet metal boxes.
  - .3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.
- .8 Fittings for thin wall conduit:
  - .1 Connectors and couplings: steel, set screw type.

## **2.4 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 to be selected by Departmental Representative.

## **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.

## **2.6 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT**

- .1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.
- .2 Exposed conduits or cables:
  - .1 50 mm diameter and smaller: one-hole steel straps.
  - .2 Larger than 50 mm diameter: two-hole steel straps.
- .3 Suspended support systems:
  - .1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
  - .2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

**Part 3 Execution**

**3.1 INSTALLATION**

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

**3.2 SUPPORTS**

- .1 Install special supports as required and as indicated.

**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.
- .2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.
- .3 Do underground installation to CAN/CSA-C22.3 No.7, except where otherwise specified.
- .4 Conform to manufacturer's recommendations for storage, handling and installation.
- .5 Check factory connections and joints. Tighten where necessary to ensure continuity.
- .6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.
- .7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
- .8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
- .9 Install conduits, and sleeves prior to pouring of concrete.
- .10 Holes through exterior wall and roofs: flash and make weatherproof.
- .11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
- .12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

**3.4 CONDUIT SYSTEM**

- .1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

- Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.
- .2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.
  - .3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Departmental Representative before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.
  - .4 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.
  - .5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.
  - .6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.
  - .7 Limit conduit length between pull boxes to less than 30 m.
  - .8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.
  - .9 Fastenings and supports for conduits, cables, and equipment:
    - .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
    - .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
    - .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.
  - .10 Install polypropylene fish cord in empty conduits for future use.
  - .11 Where conduits become blocked, remove and replace blocked sections.
  - .12 Pass conduits through structural members only after receipt of Departmental Representative's written approval.
  - .13 Conduits may be run in flanged portion of structural steel.
  - .14 Group conduits wherever possible on suspended or surface channels.
  - .15 Pull boxes:
    - .1 Install in inconspicuous but accessible locations.
    - .2 Support boxes independently of connecting conduits.
    - .3 Fill boxes with paper or foam to prevent entry of construction material.
    - .4 Provide correct size of openings. Reducing washers not permitted.
    - .5 Mark location of pull boxes on record drawings.
    - .6 Identify AC power junction boxes, by panel and circuit breaker.
  - .16 Install bonding conductor for 120 volt and above in conduit.

**3.5 WIRING**

- .1 Install multiple wiring in ducts simultaneously.
- .2 Do not pull spliced wiring inside conduits or ducts.
- .3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.
- .4 Tests: use only qualified personnel. Demonstrate that:
  - .1 Circuits are continuous, free from shorts, unspecified grounds.
  - .2 Resistance to ground of all circuits is greater than 50 Megohms.
- .5 Provide Departmental Representative with test results showing locations, circuits, results of tests.
- .6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.
- .7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.
- .8 Do not allow wiring to come into direct physical contact with compression screw.
- .9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

**3.6 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.

**3.7 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.

**3.8 GROUNDING**

- .1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.
- .2 Install separate grounding conductors in conduit within building.
- .3 Install ground wire in all PVC ducts and in tunnel conduit systems.
- .4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

**3.9 TESTS**

- .1 General:
  - .1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.
  - .2 Give 14 days written notice of intention to test.
  - .3 Conduct in presence of Departmental Representative and authority having jurisdiction.
  - .4 Conceal work only after tests satisfactorily completed.
  - .5 Report results of tests to Departmental Representative in writing.
  - .6 Preliminary tests:
    - .1 Conduct as directed to verify compliance with specified requirements.
    - .2 Make needed changes, adjustments, replacements.
    - .3 Insulation resistance tests:
      - .1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.
      - .2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Departmental Representative and authority having jurisdiction.

**3.10 IDENTIFICATION**

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

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS), also known as building mechanical systems (connected to any type of controls, including stand-alone controls).
- .2 References.
  - .1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
  - .2 Canadian Standards Association (CSA International).
    - .1 CSA Z204, Guidelines for Managing Indoor Air Quality in Office Buildings.

**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 as proof of system verification:
  - .1 Control Point name and location: ie. outdoor temperature controller and heating hot water supply temperature controller for boiler system, room thermostats, dampers or any other controlled piece of mechanical equipment.
  - .2 Measured value.
  - .3 System displayed value.
  - .4 Calibration detail
  - .5 Indication if adjustment required,
  - .6 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.
  - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
  - .3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
  - .4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.
  - .5 Perform Work continuously until EMCS restored to reliable operating condition.
- .3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.
- .4 Work requests: record each service call request, when received separately on approved form and include:
  - .1 Serial number identifying component involved.
  - .2 Location, date and time call received.
  - .3 Nature of trouble.
  - .4 Names of personnel assigned.
  - .5 Instructions of work to be done.
  - .6 Amount and nature of materials used.
  - .7 Time and date work started.
  - .8 Time and date of completion.
- .5 Provide system modifications in writing.
  - .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

### **1.4 SERVICE CONTRACTS**

- .1 Provide in-depth technical expertise and assistance to Departmental Representative and Commissioning Manager in preparation and implementation of service contracts and in-house preventive maintenance procedures.

- .2 Service Contracts to include:
  - .1 Annual verification of field points for operation and calibration.
  - .2 2 visits per year.
  - .3 Complete inventory of installed system.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 FIELD QUALITY CONTROL**

- .1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative as described in Submittal article.
- .2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.
- .3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
  - .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
  - .2 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 peripheral equipment, interface equipment and other panels.
  - .2 Review system performance with Operations Supervisor to discuss suggested or required changes.
- .5 Major inspections to include, but not limited to:
  - .1 Minor inspection.
  - .2 Check signal, voltage and system isolation of peripherals, interface and other panels.
  - .3 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
- .6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

- .7 Testing/verification of occupancy and seasonal-sensitive systems to take place during two (2) consecutive seasons, after facility has been accepted, taken over and fully occupied.
  - .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Control devices integral to the Building Energy Monitoring and Control System (EMCS): transmitters, sensors, controls, switches, transducers, valves, valve actuators, low voltage current transformers.
  - .2 Related Sections:
    - .1 Section 01 73 00 - Execution Requirements.
    - .2 Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.
    - .3 Section 25 01 11.1 - EMCS: Start-Up, Verification and Commissioning Checklists.
    - .4 Section 25 05 02 - EMCS: Submittals and Review Process.
    - .5 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.
    - .6 Section 26 05 00 - Common Work Results for Electrical.

**1.2 REFERENCES**

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

**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 Pre-Installation Tests.

- .1 Submit samples at random from equipment shipped, as requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.
- .3 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 heat resistant 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 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.
- .8 Range: including temperature, humidity, and pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

#### **2.2 TEMPERATURE SENSORS**

- .1 General: except for room sensors to be resistance or thermocouple type to following requirements:
  - .1 Thermocouples: limit to temperature range of 200 degrees C and over.

- .2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
  - .3 Sensing element: hermetically sealed.
  - .4 Stem and tip construction: copper or type 304 stainless steel.
  - .5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.
  - .6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm as indicated.
- .2 Room temperature sensors and display wall modules.
    - .1 Temperature sensing and display wall module.
      - .1 Sensor may be either RTD or thermistor type
      - .2 LCD display to show space temperature reading and temperature setpoint.
      - .3 Buttons for occupant selection of temperature setpoint (limited to +/-2°C. midpoint 22°C) and occupied/unoccupied mode.
    - .2 Room temperature sensors.
      - .1 Wall mounting, in slotted type covers having brushed aluminum brushed stainless steel finish, with guard as indicated.
      - .2 Element 10-50 mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.
  - .3 Outdoor air temperature sensors:
    - .1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

## **2.3 TEMPERATURE TRANSMITTERS**

- .1 Requirements:
  - .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.
  - .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees C per volt change.
  - .3 Output signal: 4 - 20 mA into 500 ohm maximum load.
  - .4 Input and output short circuit and open circuit protection.
  - .5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.
  - .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.
  - .7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25 mA.

- .8 Integral zero and span adjustments.
- .9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50 degrees C.
- .10 Long term output drift: not to exceed 0.25 % of full scale/ 6 months.
- .11 Transmitter ranges: select narrowest range to suit application from following:
  - .1 Minus 50 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.
  - .2 0 to 100 degrees C, plus or minus 0.5 degrees C.
  - .3 0 to 50 degrees C, plus or minus 0.25 degrees C.
  - .4 0 to 25 degrees C, plus or minus 0.1 degrees C.
  - .5 10 to 35 degrees C, plus or minus 0.25 degrees C.

## **2.4 CONTROL VALVES**

- .1 Body: characterized ball.
  - .1 Flow characteristic as indicated on control valve schedule: equal percentage.
  - .2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
  - .3 Normally open, as indicated.
  - .4 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
  - .5 Packing easily replaceable.
  - .6 Stem, stainless steel.
  - .7 Plug and seat, stainless steel.
  - .8 Disc, replaceable, material to suit application.
  - .9 NPS 2 and under:
    - .1 Screwed National Pipe Thread (NPT) tapered female connections.
    - .2 Valves to ANSI Class 250, valves to bear ANSI mark.
    - .3 Rangeability 50:1 minimum.

## **2.5 ELECTRONIC / ELECTRIC VALVE ACTUATORS**

- .1 Requirements:
  - .1 Construction: steel, cast iron, aluminum.
  - .2 Control signal: 0-10V DC or 4-20 mA DC.
  - .3 Positioning time: to suit application. 90 sec maximum.
  - .4 Fail to normal position as indicated.
  - .5 Scale or dial indication of actual control valve position.
  - .6 Size actuator to meet requirements and performance of control valve specifications.
  - .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.

**2.6 PANELS**

- .1 Wall mounted enamelled steel cabinets with hinged and key-locked front door.
- .2 Multiple panels to handle requirements with additional space to accommodate 25% additional capacity as required by Departmental Representative without adding additional cabinets.
- .3 Panels to be lockable with same key.

**2.7 WIRING**

- .1 In accordance with Section 26 27 10 - Modular Wiring System 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: 20AWG stranded twisted pair.
  - .2 Analog input and output: #20 minimum stranded twisted pair.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 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 Fire stopping: 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 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
  - .3 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.
- .4 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

### **3.2 TEMPERATURE SENSORS**

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
  - .1 Protect from solar radiation and wind effects by non-corroding shields.
  - .2 Install in NEMA 4 enclosures.
- .4 Thermowells: install for piping installations.
  - .1 Locate well in elbow where pipe diameter is less than well insertion length.
  - .2 Thermowell to restrict flow by less than 30%.
  - .3 Use thermal conducting paste inside wells.

### **3.3 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 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 SUMMARY**

- .1 Section Includes:
  - .1 At minimum detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.
  - .1 Control Description Logic (CDL) for each system.

**1.2 REFERENCES**

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

**1.3 SEQUENCE OF OPERATION**

- .1 Present sequencing of operations for systems, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.
  - .1 Building heating system.
  - .2 Domestic hot water system
- .2 Sequencing of operations for systems as follows:
  - .1 Building Heating System.
    - .1 The heating system consists of two (2) wall condensing boiler B-1 & B-2, integral boiler pumps BP-1 & BP-2, and heating pumps P-1 & P-2. P-1/P-2 are sized for 100% capacity each, one as standby.
    - .2 The boilers shall be set up on a lead lag basis. The boiler control system (by boiler manufacturer) shall control the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant.
    - .3 The heating water pumps shall be operated on a lead lag basis, and the speed shall be modulated to maintain a constant system differential pressure. Provide minimum run times to prevent short cycling.
    - .4 The setpoint of boilers shall be provided by integral individual boiler indicating loading of the boiler. Boiler loop supply temperature setpoint is to be reset based on outside air temperature according to the following schedule:

O/A Temp.	HWS
-20°C or less	82.2°C

10°C or higher	60°C
----------------	------

- .5 Heating system pressure sensors will monitor the heating supply and water system pressures. Provide alarms if the differential pressure increases above 235 kPa or decreases below 35 kPa. Provide alarms for boiler ignition failure, low heating water temperature and pump failure.
- .6 The EMCS shall modulate the bypass valve to maintain a constant differential pressure of 135kPa (adjustable) when the pump is running at minimum speed.
- .7 Disable heating alarms when outside air temperature is above the heating system shutdown set-point.
- .2 Radiation
  - .1 A space temperature sensor or space thermostat shall provide the signal to modulate the 2-way control valve to maintain the desired temperature.
- .3 Domestic hot water system
  - .1 Integral controls for domestic water heater maintain the water supply temperature setpoint. A water temperature sensor monitors the domestic supply water temperature, an alarm is generated if the temperature is above or below alarm limits.
  - .2 The timer and aquastat controls the re-circulation pump, the pump is shutdown during un-occupied schedules. An alarm is on pump failure.
- .4 HRV unit with electric reheat coil (typical)
  - .1 All HRVs and electric reheat coils consist of integral controls.
  - .2 Provide supply air temperature, operation status and alarm to EMCS system.
- .5 Weeping tile sump pump
  - .1 The sump pump package shall be complete with all operating controls with an associate control panel.
  - .2 A dry contact in the control panel shall provide a high level alarm condition to the EMCS.

**Part 2      Products**

**2.1          NOT USED**

- .1 Not Used.

**Jasper Staff Housing**

720 Patricia St. 5-Plex

Jasper, AB

**Part 3 Execution**

**3.1 NOT USED**

.1 Not Used.

**END OF SECTION**