

## **Part 1        General**

### **1.1            SUMMARY**

- .1        The terms DDC and EMCS are used interchangeably in Division 25 and throughout the specifications document.
- .2        The scope of controls work for this project includes the following:
  - .1        Decommissioning of existing local boiler control panels for Boilers 1 and 2. All controls wiring connected to existing sensors and actuators shall be reused where possible and necessary. Retain, in place and well labelled, all such wiring when the existing control panels are decommissioned and removed.
  - .2        Decommissioning of existing control panel located in control room. Retain, in place and well labelled, all controls wiring connected to existing sensors and actuators selected for reuse and reconnection in new controls cabinet.
  - .3        Supply and installation of new local control panels for Boilers 1 and 2.
  - .4        Supply and installation of new master boiler control panel in the control room.
  - .5        Supply and installation of new controls network to monitor and control the following:
    - .1        Boilers 1 Local Control Panel (via new Master Boiler Control Panel)
    - .2        Boilers 2 Local Control Panel (via new Master Boiler Control Panel)
    - .3        Boilers 3 Local Control Panel (via new Master Boiler Control Panel)
    - .4        Master Boiler Control Panel
    - .5        Boiler 1 Drum Level Controller (new)
    - .6        Boiler 2 Drum Level Controller (new)
    - .7        Boiler 3 Drum Level Controller (existing)
    - .8        Boilers 1 Economizer Temperature Controller (new)
    - .9        Boilers 2 Economizer Temperature Controller (new)
    - .10        Deaerator Level Controller 1 (existing)
    - .11        Deaerator Level Controller 1 (existing)
    - .12        Boiler 1 Steam Flow
    - .13        Boiler 2 Steam Flow
    - .14        Boiler 3 Steam Flow
    - .15        Steam Flow to Farm (“3 inch”)
    - .16        Steam Flor to Farm (“4 inch”)
    - .17        City Water PressureRefer to drawings for schematic of control network.
  - .6        Supply and installation of new controls cabinet in controls room to contain equipment and cabling. Utilize existing sensors and controllers as shown on drawings. Reuse all controls wiring connected to existing sensors and actuators were possible and necessary.

- .7 Supply and installation of all new cabling for controls network shall be the responsibility of the electrical contractor. The controls contractor shall be responsible for all wiring connections within control panels and enclosures at all sensors and actuators.
- .8 Supply and installation of all conduits shall be the responsibility of the electrical contractor.
- .9 Supply and installation of two new Operator Work Stations (OWS) in the control room, connected to the new control network. Controls contractor shall provide programming and graphics on OWS to monitor and control all items listed above.
- .10 Provide commissioning for all new and modified systems, including:
  - .1 Local boiler control panels (combustion management systems);
  - .2 Master boiler control panel;
  - .3 Ancillary controllers and sensors;
  - .4 Boiler control network;
  - .5 Operator Work Stations;
  - .6 Boilers 1, 2 and 3.
- .11 Submission of as-built line/block diagrams of the entire boiler control network, showing all connected sensor, actuators, and controllers.

Note: Demolition and construction work shall be staged to minimize boiler downtime. Refer to required staging in Section 01 11 00 – Summary of Work, article 1.6 Work Sequence.

- .3 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.
- .4 Related Requirements
  - .1 Section 23 09 33 - Electric and Electronic Control System for HVAC.

## **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 DESIGN REQUIREMENTS**

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

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

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

- .1 Submittals in accordance with Section 01330 - Submittal Procedures.
- .2 Final Report: submit report to Departmental Representative.
  - .1 Include measurements, final settings and certified test results.
  - .2 Bear signature of commissioning technician and supervisor
  - .3 Report format to be approved by Departmental Representative before commissioning is started.
  - .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.
  - .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

#### **1.5 CLOSEOUT SUBMITTALS**

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

#### **1.6 COMMISSIONING**

- .1 Do commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Carry out commissioning under review 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 Update operator work station graphics.
- .7 Perform tests as required.

#### **1.7 COMPLETION OF COMMISSIONING**

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

## **1.8 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION**

- .1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

## **Part 2 Products**

### **2.1 EQUIPMENT**

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

## **Part 3 Execution**

### **3.1 PROCEDURES**

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures prescribed by the manufacturer and commissioning plan.
- .3 Commission integrated systems using procedures prescribed by the manufacturer and commissioning plan.
- .4 Debug system software and programming.
- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .6 Test operation under normal and emergency power conditions.

### **3.2 FIELD QUALITY CONTROL**

- .1 Completion Testing.
  - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
  - .2 Include following activities:
    - .1 Test and calibrate field hardware including stand-alone capability of each controller.
    - .2 Verify each A-to-D convertor.
    - .3 Test and calibrate each AI using calibrated digital instruments.

- .4 Test each DI to ensure proper settings and switching contacts.
  - .5 Test each DO to ensure proper operation and lag time.
  - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
  - .7 Test operating software.
  - .8 Test application software and provide samples of logs and commands.
  - .9 Verify each CDL including energy optimization programs.
  - .10 Debug software.
  - .11 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space for commissioning technician and Departmental Representative to sign off. 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 review by Departmental Representative and provide:
- .1 1 technical personnel capable of re-calibrating field hardware and modifying software.
  - .2 Detailed daily schedule showing items to be tested and personnel available.
  - .3 Departmental Representative's acceptance signature to be on executive and applications programs.
  - .4 Commissioning to commence during final startup testing.
  - .5 O&M personnel to assist in commissioning procedures as part of training.
  - .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
  - .7 Operate systems as long as necessary to commission entire project.
  - .8 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 14 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
    - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
  - .2 Test to last at least 14 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 performance requirements.
  - .2 Requirements of Contract have been met.
  - .5 Correct defects when they occur and before resuming tests.
- .5 Departmental Representative to review and approve reported results. Final acceptance by Departmental Representative.

### **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.
  - .2    Related Requirements
    - .1        Section 01 79 00 - Demonstration and Training.

**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 14 days prior to anticipated date of beginning of training.
  - .1        List name of trainer, and type of reference materials to be used.
- .3    Submit reports within one week after completion of training, verifying that training has been satisfactorily completed.

**1.4                QUALITY ASSURANCE**

- .1    Provide competent instructors thoroughly familiar with aspects of EMCS and heating systems installed in facilities.

**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    Training shall consist of two 4 hour training sessions.

**1.7                TRAINING MATERIALS**

- .1    Provide reference materials for training. This shall include the O&M manual, as well as any supplementary documentation that will be useful for training.

- .2 Supply an O&M manual for each trainee.
- .3 Review contents of O&M manual in detail to explain aspects of operation and maintenance, design intent, and system functionality.

**1.8 TRAINING PROGRAM**

- .1 Training shall consist of one 4 hour training session.

**1.9 MONITORING OF TRAINING**

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

**Part 2 Products**

**2.1 NOT USED**

**Part 3 Execution**

**3.1 NOT USED**

**END OF SECTION**

## **Part 1        General**

### **1.1        SUMMARY**

- .1 Section Includes:
  - .1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.
- .2 Related Requirements
  - .1 Section 25 01 11 – EMCS: Start-up, Verification and Commissioning.  
Refer to this section for an overview of Division 25 work.

### **1.2        REFERENCE STANDARDS**

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

### **1.3        ABBREVIATIONS AND ACRONYMS**

- .1 Acronyms used in EMCS:
  - .1 AI - Analog Input
  - .2 AO - Analog Output
  - .3 BC(s) - Building Controller(s).
  - .4 CDL - Control Description Logic.
  - .5 CDS - Control Design Schematic.
  - .6 CPU - Central Processing Unit.
  - .7 DI - Digital Input.
  - .8 DO - Digital Output.
  - .9 EMCS - Energy Monitoring and Control System.
  - .10 HVAC - Heating, Ventilation, Air Conditioning.
  - .11 I/O - Input/Output.
  - .12 O&M - Operation and Maintenance.
  - .13 OWS - Operator Work Station.
  - .14 PID - Proportional, Integral and Derivative.

- .15 RAM - Random Access Memory.
- .16 USB - Universal Serial Bus.
- .17 UPS - Uninterruptible Power Supply.

## 1.4 DEFINITIONS

- .1 Point: may be logical or physical.
  - .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
  - .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve 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 Section 25 01 11 – EMCS: Start-up, Verification and Commissioning for a summary of Division 25 work.
- .2 Refer to Boiler Control Schematics on drawings for control network architecture.
- .3 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, the following:
  - .1 Controllers.
  - .2 Control devices as listed in I/O point summary tables.
  - .3 OWS(s).
  - .4 Data communications equipment necessary to effect EMCS data transmission system.
  - .5 Field control devices.
  - .6 Software/Hardware complete with full documentation.
  - .7 Complete operating and maintenance manuals.
  - .8 Training of personnel.
  - .9 Acceptance tests, technical support during commissioning, full documentation.
  - .10 Wiring interface co-ordination of equipment supplied by others.
  - .11 Miscellaneous work as specified in these sections and as indicated.
- .4 Design Requirements:
  - .1 Supply programmable controllers and equipment to meet project requirements.
  - .2 Design and provide wiring linking elements of system. Location of controllers shall be as shown on drawings.
  - .3 Electrical contractor shall be responsible for conduit installation.
  - .4 Connect boiler controller to battery backup power as indicated. Electrical contractor shall provide and install battery backup device.
  - .5 Metric references: in accordance with CAN/CSA Z234.1.
- .5 Language Operating Requirements:
  - .1 Provide English operator selectable access codes.
  - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
  - .3 System manager software: include in English 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.
  - .4 Include, in English:
    - .1 Alarms and input and output commands and messages from operator-initiated functions as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

- .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS.
- .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 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process and Section 01 33 00 - Submittal Procedures.
- .2 Quality Control:
  - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
  - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
  - .3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.
  - .4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
  - .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
  - .6 Permits and fees: in accordance with general conditions of contract.
  - .7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.
  - .8 Existing devices intended for re-use: submit test report.

## **1.7 QUALITY ASSURANCE**

- .1 Have local office within 200 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 - Health and Safety Requirements.

## **1.8 DELIVERY, STORAGE AND HANDLING**

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.  
Waste Management and Disposal in accordance with Section 01 74 19 -  
Construction/Demolition Waste Management and Disposal.

## **1.9 EXISTING- CONTROL COMPONENTS**

- .1 Utilize existing control wiring and sensors unless indicated otherwise.
- .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 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.
  - .1 Furnish test report within 40 days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair by Departmental Representative.
  - .2 Failure to produce test report will constitute acceptance of existing devices by contractor.
- .4 Non-functioning items:
  - .1 Provide with report specification sheets or written functional requirements to support findings.
  - .2 Departmental Representative will repair or replace existing items judged defective yet deemed necessary for EMCS.
- .5 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
- .6 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 applicable portions of EMCS as approved by Departmental Representative upon final acceptance of EMCS.
- .7 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

**Part 2            Products**

**2.1                EQUIPMENT**

- .1            Control Network Protocol shall be Modbus RTU.
- .2            Complete list of equipment and materials to be used on project including manufacturer's name, model number and details of materials, and submit for approval.

**2.2                ADAPTORS**

- .1            Provide adaptors between metric and imperial components.

**Part 3            Execution**

**3.1                MANUFACTURER'S RECOMMENDATIONS**

- .1            Installation: to manufacturer's recommendations.

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

**1.2                DEFINITIONS**

- .1    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 and coordinate with requirements in this Section.
- .2    Shop Drawings to initially consist of one copy of shop drawings and product data in PDF format.
- .3    Approved Shop Drawings to be included in O&M manuals.

**1.4                PRELIMINARY SHOP DRAWING REVIEW**

- .1    Submit preliminary shop drawings within 30 working days of award of contract and include following:
  - .1        Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
  - .2        Detailed system architecture showing all points associated with each controller including where new EMCS ties into existing control equipment.
  - .3        Complete Point Name Lists.
  - .4        Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
  - .5        Spare point capacity of each controller by number and type.
  - .6        Controller locations.
  - .7        Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
  - .8        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.

- .9 Graphic system schematic displays of hydronic systems with point identifiers and textual description of system, and typical floor plans.
- .10 Sample of "Operating Instructions Manual" to be used for training purposes.
- .11 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

**1.5 QUALITY ASSURANCE**

- .1 Contractor shall submit shop drawings to Departmental Representative for review and approval.

**Part 2 Products**

**2.1 NOT USED**

**Part 3 Execution**

**3.1 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        OWS - Operator Work Station.
- .2        For additional acryonyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

### **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 Record Drawings and an 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 and wiring associated with EMCS installation.
  - .4        Locations of obscure devices to be indicated on drawings.
  - .5        Listing of alarm messages.
  - .6        Panel/circuit breaker number for sources of normal/emergency power.
  - .7        Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.

- .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- .9 Basic system design and full documentation on system configuration.
- .10 Marked-up set of construction drawings, indicating all deviations from design as shown and specified.
- .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 for implementation in automatic mode.
- .5 System operation to include:
  - .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
  - .2 Operation of computer peripherals, input and output formats.
  - .3 Emergency, alarm and failure recovery.
  - .4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.
- .6 OWS instruction and operations manuals shall be updated to cover the modified and expanded scope of the DDC controls network.

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

**Part 2 Products**

**2.1 NOT USED**

**Part 3 Execution**

**3.1 NOT USED**

**END OF SECTION**

## **Part 1           General**

### **1.1               SUMMARY**

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

### **1.2               REFERENCE STANDARDS**

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

### **1.3               DEFINITIONS**

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

### **1.4               SYSTEM DESCRIPTION**

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

### **1.5               ACTION AND INFORMATIONAL SUBMITTALS**

- .1   Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.
- .2   Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

## **Part 2           Products**

### **2.1               NAMEPLATES FOR PANELS**

- .1   Identify by Plastic laminate, 3 mm thick 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 NOT USED.

### **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.

### **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
- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

### **2.6 CONDUIT**

- .1 Colour code EMCS conduit.
- .2 Pre-paint box covers and conduit fittings.

## **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                REFERENCE STANDARDS**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI/ASME B16.22-2013, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
  - .2 ANSI C2-1990, National Electrical Safety Code.
  - .3 ANSI/NFPA 70-1990, National Electrical Code.
- .2 CSA Group
  - .1 CSA C22.1-12,
  - .2 CAN/CSA-C22.3 No. 7-10, Underground Systems.
  - .3 CSA C22.2 No. 45.1-07 (R2012), Electrical Rigid Metal Conduit.
  - .4 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .5 CSA C22.2 No. 83-M1985 (R2013), Electrical Metallic Tubing.
  - .6 CAN/CSA-C22.3 No. 1-10, Overhead Systems.

### **1.2                SYSTEM DESCRIPTION**

- .1 Electrical:
  - .1 Provide power wiring from existing emergency power panels to EMCS field panels as shown. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
  - .2 Hard wiring between field control devices and EMCS field panels.
  - .3 Communication wiring between EMCS field panels and OWS's including building controller.
  - .4 Trace existing control wiring installation for boiler controls and provide updated wiring schematics including additions and/or deletions to control circuits for approval by Departmental Representative prior to closeout.
- .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 and installed my mechanical contractor and integrated into EMCS by controls contractor.

### **1.3                PERSONNEL QUALIFICATIONS**

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

## **1.4 EXISTING CONDITIONS**

- .1 Cutting and Patching: refer to Section 01 73 00 - Execution Requirements supplemented as specified herein.
- .2 Repair all surfaces damaged during execution of work.
- .3 Turn over to Departmental Representative existing materials removed from work not identified for re-use in accordance with Section 02 42 00 - Removal and Salvage of Construction Materials

## **Part 2 Products**

### **2.1 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 Sizes:
  - .1 120V Power supply: to match or exceed breaker, size #12 minimum.
  - .2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
  - .3 Field wiring to digital device: #18 AWG stranded twisted pair.
  - .4 Analog input and output: shielded #18 minimum stranded twisted pair. Wiring must be continuous without joints.
  - .5 More than 4 conductors: #22 minimum solid copper.
- .5 Terminations:
  - .1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

### **2.2 CONDUIT**

- .1 As per requirements of Division 26.
- .2 Where indicated on drawings, electrical metallic tubing to CSA C22.2 No. 83.
  - .1 Junction and pull boxes: welded steel.
  - .2 Surface mounting cast FS: screw-on flat covers.
  - .3 Flush mounting: covers with 25 mm minimum extension all round.
- .3 Elsewhere, install control cables in flexible CSA instrumentation conduit, ACIC type, rated to 105C. Secure flexible conduits in aluminum raceways. Protect all cables from radiant heat produced by the boilers.

- .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.

### **2.3 WIRING DEVICES, COVER PLATES**

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

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

- .1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.
  - .1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.
- .2 Exposed conduits or cables:
  - .1 50 mm diameter and smaller: one-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 and components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Supply and installation of conduit and power supply wiring is the responsibility of the electrical contractor. Supply and installation of controls wiring is the responsibility of the controls contractor.

### **3.2 SUPPORTS**

- .1 All closures and conduit shall be surface mounted to walls were possible. The ceiling surface contains asbestos and cannot be disturbed. New conduit routed across the ceilings shall be supported by existing hangers or wall mounted supports.

### **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 Conform to manufacturer's recommendations for storage, handling and installation.
- .4 Check factory connections and joints. Tighten where necessary to ensure continuity.
- .5 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.
- .6 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
- .7 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
- .8 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

### **3.4 CONDUIT SYSTEM**

- .1 Communication wiring shall be installed in conduit. Provide complete conduit system to link boiler controllers to building controllers. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Refer to drawings for specified conduit route and size.
- .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.
- .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 terminal blocks or strips indicated in cabinets in accordance with Division 26.
- .17 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 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.
- .6 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.
- .7 Do not allow wiring to come into direct physical contact with compression screw.
- .8 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 GROUNDING**

- .1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.
- .2 Install separate grounding conductors in conduit within building.

### **3.8 TESTS**

- .1 General:
  - .1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.
  - .2 Give 7 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.

### **3.9 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).

**1.2                DEFINITIONS**

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

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

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

- .7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "record drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

#### **1.4 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.

**Part 2            Products**

**2.1                NOT USED**

**Part 3            Execution**

**3.1                FIELD QUALITY CONTROL**

.1                Warranty in accordance with Section 01 78 00 – Closeout Submittals.

**END OF SECTION**

## **Part 1           General**

### **1.1               SUMMARY**

#### **.1                Section Includes:**

- .1                Requirements for the two new Operator Work Station (OWS) located in the Saskatchewan Penitentiary Power House Control Room.**

### **1.2               DEFINITIONS**

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

### **1.3               OWS SYSTEM DESCRIPTION**

Each OWS shall provide operators with the ability to monitor and control the boilers and all ancillary controllers and devices connected to the new control network. OWSs shall not perform any control logic. The OWSs will only monitor devices on the network and push changes to operational set points to the controllers/devices when requested by the operator.

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

- .1                Make submittals in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.**

### **1.5               MAINTENANCE**

- .1                Provide maintenance in accordance with Section 25 05 03 - EMCS: Project Record Documents.**
- .2                Provide an O&M manual for the OWS and OWS software.**

## **Part 2           Products**

### **2.1               OWS 1 and OWS 2**

- .1                Each OWS shall provide operators with the ability to monitor and control the following devices, and all sub-parameters, using a graphical user interface:**
  - .1                Master Boiler Control Panel**
    - .1                Boiler 1**
    - .2                Boiler 2**
    - .3                Boiler 3**
  - .2                Drum Level Controllers**
  - .3                Economizer Temperature Controllers**
  - .4                Deaerator Level Controllers**
  - .5                Pump Controller**
- .2                In addition to the above, each OWS shall provide operators with the ability to monitor the following parameters using a graphical user interface:**

- 
- .1 Boiler 1 Steam Flow
  - .2 Boiler 2 Steam Flow
  - .3 Boiler 3 Steam Flow
  - .4 100mm Steam Flow to Farm
  - .5 75mm Steam Flow to Farm
  - .6 City Water Pressure
- .3 Each OWS shall allow operators to generate a printable 'Daily Operations Summary Report' to documenting the following parameters at intervals (03:00, 07:00, 11:00, 15:00, 19:00, 23:00 hours):
- .1 Feedwater Temperature
  - .2 Feedwater Pressure
  - .3 Instrument Air Pressure
  - .4 Hot Well Pressure
  - .5 Deaerator Pressure
  - .6 City Water Pressure
  - .7 Steam Header Pressure
  - .8 Total Gas Flow
  - .9 For Each Boiler 1, 2 and 3
    - .1 Economizer Temperature
    - .2 Boiler Pressure
    - .3 Drum Level
    - .4 Steam Flow
    - .5 Gas Flow
    - .6 Boiler Load
    - .7 Burner Start Time
    - .8 Burner Finish Time
    - .9 Burner Total Run Hours
- .4 The 'Daily Operations Summary Report' shall also document the following parameters at midnight (00:00 hours):
- .1 Minimum Daily Outdoor Temperature
  - .2 Maximum Daily Outdoor Temperature
  - .3 Total Make-Up Water Consumption
  - .4 Total '3 inch Steam Flow to Farm'
  - .5 Total '4 inch Steam Flow to Farm'
  - .6 Total Boiler Steam Flow
  - .7 Total Gas Consumption
  - .8 Total Oil Consumption
- .5 Provide sample 'Daily Operations Summary Report' for review by Departmental Representative. Departmental Representative reserves the request changes to report format and content.

## **2.2            **HARDWARE****

- .1     PC, minimum 500 GB hard drive and 8 GB RAM
- .2     Comes with 610 mm LCD screen, wired keyboard and wired mouse
- .3     OWS shall not be connected to internet.

## **2.3            **SOFTWARE****

- .1     Customized software that graphically displays boiler and ancillary controller/device operating parameters.
- .2     Shall show equipment locations on floorplan of power house.
- .3     Shall show systems schematically (boilers, economizers, deaerators, etc.)
- .4     Shall generate audible and visual notification on OWS when an errors or alarm is experienced on any device connected the network, including the following alarms:
  - .1     Boiler Trip
  - .2     High Steam Pressure
  - .3     Low Steam Pressure
  - .4     High Drum Level
  - .5     Low Drum Level
  - .6     High Water Trip
  - .7     High Oil Pressure
  - .8     Low Oil Pressure
  - .9     High Furnace Pressure
  - .10    Low Feedwater Pressure
  - .11    Deaerator High Level
  - .12    Deaerator Low Level
  - .13    Low Hot Well Pump Pressure

## **2.4            **PRINTER****

- .1     Provide a colour laser printer with each OWS.
- .2     Handles letter size paper.
- .3     Provide one spare set of ink cartiges.

## **2.5            **BATTERY BACKUP****

- .1     Provide a UPS for each OWS. Refer to Section 26 33 53 for details.

## **Part 3        **Execution****

### **3.1            **INSTALLATION REQUIREMENTS****

- .1     Install OWSs as shown on drawings. OWSs will be installed on reinstalled desks.

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

- .1    Section Includes:
  - .1        Specifications for boiler control network controllers.
- .2    Related Requirements
  - .1        Section 25 10 02 – EMCS: Operator Work Station (OWS).

**1.2                REFERENCE STANDARDS**

- .1    Canadian Standards Association (CSA International).
  - .1        C22.2 No.205-M1983 (R2009), Signal Equipment.
- .2    Institute of Electrical and Electronics Engineers (IEEE).
  - .1        IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

**1.3                DEFINITIONS**

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

**1.4                DESIGN REQUIREMENTS**

- .1    To include:
  - .1        Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
  - .2        Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
  - .3        Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
  - .4        Control of systems as described in sequence of operations.
- .2    Field Termination and Interface Devices:
  - .1        To: CSA C22.2 No.205.
  - .2        Electronically interface sensors and control devices to processor unit.
  - .3        Include, but not be limited to, following:
    - .1            Programmed firmware or logic circuits to meet functional and technical requirements.
    - .2            Power supplies for operation of logics devices and associated field equipment.
    - .3            Lockable wall cabinets.
    - .4            Required communications equipment and wiring.

- 
- .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
  - .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
  - .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
  - .4 AI interface equipment to:
    - .1 Convert analog signals to digital format with 10 bit analog-to-digital resolution, where appropriate.
    - .2 Provide for following input signal types and ranges, where appropriate:
      - .1 4 - 20 mA;
      - .2 0 - 10 V DC;
      - .3 100/1000 ohm RTD input;
    - .3 Meet IEEE C37.90.1 surge withstand capability.
    - .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
    - .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
  - .5 AO interface equipment:
    - .1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.
    - .2 Provide for following output signal types and ranges, where appropriate:
      - .1 4 - 20 mA.
      - .2 0 - 10 V DC.
    - .3 Meet IEEE C37.90.1 surge withstand capability.
  - .6 DI interface equipment:
    - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
    - .2 Meet IEEE C37.90.1 surge withstand capability.
    - .3 Accept pulsed inputs up to 2 kHz.
  - .7 DO interface equipment:
    - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24V AC.
  - .3 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.
  - .4 Controllers: mount in wall mounted cabinet with hinged, keyed-alike locked door.
    - .1 Provide for conduit entrance from top, bottom or sides of panel.
  - .5 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
  - .6 Provide surge and low voltage protection for interconnecting wiring connections.

## **1.5 ACTION AND INFORMATIONAL SUBMITTALS**

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

## **1.6 MAINTENANCE**

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

## **Part 2 Products**

- 2.1 Siemens controls equipment has been specified in order to ensure system compatibility with new and existing Weishaupt burner controls, which use Siemens combustion management controllers.

### **.1 Master Boiler Controller**

- .1 Siemens Combustion Controls TS-MS Master Panel (Siemens PLC)
- .2 Controls 3 Siemens LMV linkageless control systems (boiler combustion management systems) and performs boiler lead/lag sequencing and boiler modulation.
- .3 Communicates with local boiler control panels using Modbus RTU via RS485
- .4 Communicates with control network through Modbus Master Controller using Modbus RTU via RS485
- .5 610 x 610 x 254 mm enclosure, NEMA 12
- .6 305 mm touch screen
- .7 Gas and oil fuel flow is monitored by the local boiler control panel and logged by the master boiler controller.
- .8 The Master Panel shall have the following operation:
  - .1 Operation of the Master Panel boiler lead/lag system shall be selectable for sequential or unison modulation
  - .2 Individual boiler firing rates, pressure, and temperature shall be monitored
  - .3 Based upon the lead boiler firing rate, the first lag boiler shall be placed online Additional lag sequenced boilers shall be placed online based upon total output from all operating boilers
  - .4 As total boiler output drops to a pre-determined setpoint, lag boilers will be taken offline and placed in standby, based upon programmed lag boiler sequencing
  - .5 Sequence of boiler operation shall be selectable via the touch screen
  - .6 Configurable boiler rotation shall be based on up to 999 hours

- .7 A centralized display of LMV parameters and RWF parameters of every boiler shall be available via the touch screen
- .8 Centralized alarm status for all boilers shall be available via the touch screen
- .9 The Master Panel lead/lag system shall be capable of navigating through the local boiler touch screens to view and monitor all aspects of boiler operation, such as flame signal, system status, and parallel positioning information, as well as all temperature and pressure parameters
- .10 Alarms shall be integrated with external connections and shall provide fault and lockout indication of individual boilers and equipment
- .11 The Master Panel lead/lag system shall perform a low fire hold based upon the temperature sensor installed on each boiler
- .12 The Master Panel lead/lag system shall modulate to maintain a preset adjustable pressure or temperature setpoint
- .13 The Master Panel lead/lag system shall be capable of performing a hot standby routine to cycle connected boilers ON and OFF
- .9 Monitoring of all LMV5 system parameters at each boiler shall include, but not be limited to:
  - .1 Boiler related alarm messaging and logging in plain text English
  - .2 Steam or temperature actual value
  - .3 Steam or temperature setpoint
  - .4 Flame signal strength
  - .5 Firing rate
  - .6 Actuator position
  - .7 VFD speed
  - .8 VFD power consumption
  - .9 O2 concentration
  - .10 Stack and ambient temperatures
  - .11 Burner status and alarm status
  - .12 Drum level control, via connected RWF55
  - .13 Gas and Oil fuel flows
- .10 Adjustment of operation and burner/boiler parameters shall include:
  - .1 Boiler pressure/temperature setpoint
  - .2 Master Panel pressure/temperature setpoint
  - .3 Boiler automatic/manual operation, set firing rate in manual
  - .4 Sequence of rotation in multi-boiler lead/lag configuration
  - .5 Timing of lead boiler rotation
  - .6 Drum level setpoint

- .11 Failure of any component within the Master Panel will not result in a loss of boiler operation. Operation will revert to local PID control, located in the RWF55/LMV5, utilizing a pre-programmed local setpoint.

## **.2 Modbus Master Controller**

- .1 Siemens SIMATIC S7-1200 PLC controller (or equivalent) with Modbus RTU Communications Card
- .2 The Modbus Master Controller shall not perform any logic or control operations, but will rather serve as a central hub for the boiler control network. This controller shall connect the following controllers:
  - .1 Master Boiler Control Panel (x1 New)
  - .2 Drum Level Controllers (x2 New, x1 Existing)
  - .3 Economizer Temperature Controllers (x2 New)
  - .4 Deaerator Level Controllers (x2 Existing)
  - .5 Pump Controller (x1 New)
- .3 The Modbus Master Controller will also be connected to six existing sensors to monitor and log the following parameters:
  - .1 Boiler 1 Steam Flow
  - .2 Boiler 2 Steam Flow
  - .3 Boiler 3 Steam Flow
  - .4 100mm Steam Flow to Farm
  - .5 75mm Steam Flow to Farm
  - .6 City Water Pressure
- .4 The Modbus Master Controller will log the following parameters, in addition to those listed above, for a minimum of 4 weeks:
  - .1 Boiler alarm messaging
  - .2 Boiler steam pressure actual value
  - .3 Boiler steam pressure setpoint
  - .4 Boiler firing rate
  - .5 Boiler runtime
  - .6 Boiler gas and oil consumption
  - .7 Actuator position
  - .8 VFD speed
  - .9 VFD power consumption
  - .10 O2 concentration
  - .11 Stack and ambient temperatures
  - .12 Burner status and alarm status
  - .13 Drum level control setpoint
  - .14 Master Panel (steam header) pressure setpoint
  - .15 Steam header actual pressure

**.3 Boiler Combustion Management Controller**

- .1 Siemens LMV52, comes with burner package, mounted to burner
- .2 Communicates with Master Boiler Controller using Modbus RTU via RS485 (through AZL52 user interface installed in boiler control panel)
- .3 Inputs:
  - .1 Safety Loop:
    - .1 Burner Flange Limit Switch (NEW)
    - .2 Low Water Level Cut-Off
    - .3 High Water Level Cut-Off
    - .4 High Pressure Cut-Off
  - .2 Low Oil Pressure (NEW)
  - .3 High Oil Pressure (NEW)
  - .4 Boiler Air Pressure Switch (NEW)
  - .5 CPI Oil (NEW)
  - .6 CPI Gas (NEW)
  - .7 High Gas Pressure
  - .8 Low Gas Pressure
  - .9 Flame Detector QRB (NEW)
  - .10 Flame Detector QRI (NEW)
  - .11 Temp Sensor
  - .12 Pressure Sensor
  - .13 Blower Motor Speed Sensor (NEW)
  - .14 Gas Meter Pulse
  - .15 Oil Meter Pulse
  - .16 O<sub>2</sub> Module (NEW)
  - .17 Flue Gas Temperature (NEW)
  - .18 Ambient Temperature (NEW)
  - .19 VSD Alarm
- .4 Outputs:
  - .1 Ignition (NEW)
  - .2 Start Signal (NEW)
  - .3 Oil Pump Motor Starter (NEW)
  - .4 Main Oil Valve 1 (NEW)
  - .5 Main Oil Valve 2 (NEW)
  - .6 Blower Motor Starter (NEW)
  - .7 Pilot Gas Valve (NEW)
  - .8 Main Gas Valve 1 (NEW)
  - .9 Main Gas Valve 2 (NEW)
  - .10 VSD (NEW)

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- .5 CANBUS Connections:
    - .1 Air Actuator
    - .2 Gas Actuator
    - .3 Oil Actuator
    - .4 Burner Sleeve Actuator
    - .5 AZL52 User Interface (Mounted to Boiler Control Panel)
  
  - .4 Drum Level Controller**
    - .1 Siemens RWF55
    - .2 Monitors boiler drum level using existing pressure transducer installed on boiler drum
    - .3 Modulates feedwater control valve with PID to regulate drum level
    - .4 Dry contacts for low water level and high water level
    - .5 Communicates with Master Boiler Controller using Modbus RTU via RS485.
    - .6 Installed in Local Boiler Control Panel
    - .7 Triggers alarm for high and low drum levels.
  
  - .5 Economizer Temperature Controller**
    - .1 Siemens RWF55
    - .2 Monitors the economizer exit gas temperature using the existing temperature transducer installed in the flue
    - .3 Modulates the position of the economizer air damper to regulate the exit gas temperature
    - .4 Communicates with Master Modbus Controller using Modbus RTU via RS485
    - .5 Installed in Local Boiler Control Panel
  
  - .6 Deaerator Level Controller (Existing Siemens RWF40)**
    - .1 Modulates the flow of city water and condensate to regulate the deaerator level.
    - .2 Connect to Modbus Master Controller to enable monitoring and control using Modbus RTU via RS485.
  
  - .7 Pump Controller**
    - .1 Siemens PLC, connected to Modbus Master Controller using Modbus RTU via RS485
    - .2 Pump Controller controls on/off operation and monitors the status of the following pumps:
      - .1 Feedwater Pump No. 1
      - .2 Feedwater Pump No. 2

- .3 Hot Well Pump No. 1
- .4 Hot Well Pump No. 2
- .5 Oil Pump No. 1
- .6 Oil Pump No. 2
- .3 Changes to the on/off signal for each pump shall be entered by the operator on an OWS, and pushed to the Pump Controller through the network by the Modbus Master Controller.
- .4 On loss of communication with the Modbus Master Controller, the Pump Controller shall continue to operate pumps in the same manner prior to loss of communication, until communication is reconnected.

## **2.2 LEVELS OF ADDRESS**

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

## **2.3 POINT NAME SUPPORT**

- .1 Controllers to support PSPC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

## **Part 3 Execution**

### **3.1 LOCATION**

- .1 Location of Controllers as noted on drawings.

### **3.2 INSTALLATION**

- .1 Install Controllers in secure locking enclosures as specified.
- .2 Provide necessary power from local 120 V branch circuit panel as shown on drawings.
- .3 Install tamper locks on breakers of circuit breaker panel.
- .4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode. UPS backup power supply to be supplied and installed by electrical contractor.

**END OF SECTION**

## **Part 1            General**

### **1.1                SUMMARY**

- .1    Section Includes:
- .2    This section provides requirements for gauges, meters, and sensors that will be installed or replaced as part of the project work. Note: existing gauges, meters, and sensors that are part of the control system(s) being upgraded but not identified for replacement on the drawings and found faulty during testing and commissioning shall be repaired or replaced by the Contractor as part of this contract.
  - .1    Related Sections:
    - .1    Section 25 30 01 - EMCS: Building Controllers Family of Controllers.
    - .2    Section 23 05 19 - Meters and Gauges for HVAC Piping

### **1.2                REFERENCE STANDARDS**

- .1    National Electrical Manufacturer's Association (NEMA).
  - .1    NEMA 250-2014, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .2    Canadian Standards Association (CSA International).
  - .1    CSA-C22.1-18, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

### **1.3                DEFINITIONS**

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

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

- .1    Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.
- .2    Manufacturer's Instructions:
  - .1    Submit manufacturer's installation instructions for specified equipment and devices.

### **1.5                EXISTING CONDITIONS**

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

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## **Part 2        Products**

### **2.1            GENERAL**

- .1     Install new control devices as indicated on drawings and in all locations where existing control devices have failed or are incompatible with the specified control system upgrades.
- .2     Control devices of each category to be of same type and manufacturer.
- .3     External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant, assemblies where necessary.
- .4     Operating conditions: 0 - 32 degrees C with 10 - 90 % RH (non-condensing) unless otherwise specified.
- .5     Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .6     Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
- .7     Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .8     Noise generated by any device must not be detectable above space ambient conditions.

### **2.2            TEMPERATURE SENSORS**

- .1     General: to be resistance or thermocouple type to following requirements:
  - .1     Thermocouples: limit to temperature range of 200 degrees C and over.
  - .2     RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
  - .3     Sensing element: hermetically sealed.
  - .4     Stem and tip construction: copper or type 304 stainless steel.
  - .5     Time constant response: less than 3 seconds to temperature change of 10 degrees C.
  - .6     Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 150 mm.

### **2.3            TEMPERATURE TRANSMITTERS**

- .1     Requirements:
  - .1     Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.
  - .2     Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees C per volt change.
  - .3     Output signal: 4 - 20 mA into 500 ohm maximum load.
  - .4     Input and output short circuit and open circuit protection.

- .5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.
- .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.
- .7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25 mA.
- .8 Integral zero and span adjustments.
- .9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50 degrees C.
- .10 Long term output drift: not to exceed 0.25 % of full scale/ 6 months.
- .11 Transmitter ranges: select narrowest range to suit application from following:
  - .1 Minus 50 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.
  - .2 0 to 100 degrees C, plus or minus 0.5 degrees C.
  - .3 0 to 50 degrees C, plus or minus 0.25 degrees C.
  - .4 0 to 25 degrees C, plus or minus 0.1 degrees C.
  - .5 10 to 35 degrees C, plus or minus 0.25 degrees C.

## 2.4 PRESSURE TRANSDUCERS

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

## 2.5 DIFFERENTIAL PRESSURE TRANSMITTERS

- .1 Requirements:
  - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
  - .2 Output signal: 4 - 20 mA into 500 ohm maximum load.
  - .3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.
  - .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.
  - .5 Integral zero and span adjustment.

- .6 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 degrees C.
- .7 Over-pressure input protection to at least twice rated input pressure.
- .8 Output short circuit and open circuit protection.
- .9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

## **2.6 LIQUID AND STEAM FLOW METERS**

- .1 Requirements:
  - .1 Pressure rating: as specified in I/O summaries.
  - .2 Temperature rating: as specified in I/O summaries.
  - .3 Repeatability: plus or minus 0.2 %.
  - .4 Accuracy and linearity: plus or minus 1.0 %.
  - .5 Flow rangability: at least 10:1.
  - .6 Ends:
    - .1 NPS 2 and under: screwed.
    - .2 NPS 2.5 and over: flanged.

## **2.7 ELECTRONIC / ELECTRIC VALVE ACTUATORS**

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

## **2.8 WIRING**

- .1 In accordance with Division 26.
- .2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
- .3 Wiring must be continuous without joints.
- .4 Sizes:
  - .1 Field wiring to digital device: #18AWG.
  - .2 Analog input and output: shielded #18 minimum solid copper.

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**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. Note: all enclosures installed in boiler room and control room shall be suitable for a sprinklered environment.
- .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 Refer to electrical control schematics included as part of control design schematics on drawings. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Departmental Representative before beginning Work.
  - .3 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
  - .4 Install communication wiring in conduit.
    - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s), as indicated on drawings.
    - .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%.
  - .5 Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

**3.2 TEMPERATURE AND HUMIDITY SENSORS**

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Thermowells: install for piping installations.
  - .1 Locate well in elbow where pipe diameter is less than well insertion length.
  - .2 Thermowell to restrict flow by less than 30%.

- .3 Use thermal conducting paste inside wells.

### **3.3 PANELS**

- .1 Arrange for conduit and tubing entry from top, bottom or either side.
- .2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
- .3 Identify wiring and conduit clearly.

### **3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS**

- .1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.
  - .1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

### **3.5 I/P TRANSDUCERS**

- .1 Install air pressure gauge on outlet.

### **3.6 AIR PRESSURE GAUGES**

- .1 Install pressure gauges on pneumatic devices, I/P, pilot positioners, motor operators, switches, relays, valves, damper operators, valve actuators.
- .2 Install pressure gauge on output of auxiliary cabinet pneumatic devices.

### **3.7 IDENTIFICATION**

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

### **3.8 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**