

## PART 1 - GENERAL

1.1 RELATED SECTIONS	.1	Section 07 84 00 - Firestopping.
	.2	Section 22 13 17 - Drainage Waste and Vent Piping - Cast Iron and Copper.
	.3	Section 23 05 05 - Installation of Pipework.
	.4	Section 23 05 29 - Bases, Hangers and Supports.
	.5	Section 23 07 13 - Thermal Insulation of Ducting.
	.6	Section 23 07 19 - Thermal Insulation of Piping.
	.7	Section 23 21 13 - Steel Piping and Fittings Hydronic Systems.
	.8	Section 26 05 00 - Electrical General Requirements
1.2 REFERENCES (ANSI)	.1	American National Standards Institute .1 ANSI/ASME B16.22-01, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings. .2 ANSI/IEEE C2-2012, National Electrical Safety Code. .3 ANSI/NFPA 70-2012, National Electrical Code.
	.2	Canadian Standards Association (CSA) .1 CSA C22.1-12, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations. .2 CAN/CSA C22.3 No.1-10, Overhead Systems. .3 CSA C22.3 No. 7-2010, Underground Systems. .4 CSA C22.2 No. 45.1-07, Electrical Rigid Metal Conduit - Steel. .5 CSA C22.2 No. 56-04 (R2009), Flexible Metal Conduit and Liquid Tight Metal Conduit. .6 CSA C22.2 No. 83-M1985(R2008), Electrical Metal Tubing.

- |                              |   |
|------------------------------|---|
| 1.3 SYSTEM DESCRIPTION       | .1 Electrical:<br>.1 Provide power wiring from power panels to controls field panels. Provide UPS Device for each panel. Circuits are for exclusive use of controls equipment. Identify panel breakers on panel legends tagged and locks applied to breaker switches.<br>.2 Hard wiring between field control devices and controls field panels.<br>.3 Communication wiring between controls field panels and OWS's including main control centre BECC. |
|                              | .2 Mechanical:<br>.1 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Mechanical. Costs will be carried by designated trade.   |
|                              | .3 Structural:<br>.1 Special steelwork as required for installation of work.  |
| 1.4 PERSONNEL QUALIFICATIONS | .1 Qualified factory trained supervisory personnel to:<br>.1 Continuously direct and monitor all work.<br>.2 Attend site meetings.  |
| 1.5 EXISTING CONDITIONS      | .1 Repair all surfaces damaged during execution of work.<br>.2 Turn over to Departmental Representative the existing materials removed from work not identified for re-use.   |
-

## PART 2 - PRODUCTS

### 2.1 WIRING

- .1 As per requirements of Division 26.
- .2 For 50V and above copper conductor with cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.
- .3 For wiring under 50 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.
- .5 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
- .6 Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.
- .7 Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair. Wiring must be continuous without joints.
- .8 More than 4 conductors: #22 minimum solid copper.
- .9 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 Divisions 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 25mm minimum extension all round.
-

- |  |    |  |
|--|----|--|
| 2.2 CONDUIT<br>(Cont'd)                                  | .4 | Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, two (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: 100mm minimum, square.   |
|  | .6 | Conduit boxes, fittings:<br>.1 Bushings and connectors: with nylon insulated throats.<br>.2 With push pennies to prevent entry of foreign materials.   |
|  | .7 | Fittings for rigid conduit:<br>.1 Couplings and fittings: threaded type steel.<br>.2 Double locknuts and insulated bushings: use on sheet metal boxes.<br>.3 Use factory "ells" where 90 degree bends required for 25mm and larger conduits. |
|  | .8 | Fittings for thin wall conduit:<br>.1 Connectors and couplings: steel, set screw type.   |
| 2.3 WIRING<br>DEVICES,<br>COVER PLATES                   | .1 | Conform to CSA.  |
|  | .2 | Receptacles:<br>.1 Duplex: CSA type 5-15R.<br>.2 Single: CSA type 5-15R.<br>.3 Cover plates and blank plates: finish to match other plates in area.  |
| 2.4 SUPPORTS<br>FOR CONDUIT,<br>FASTENINGS,<br>EQUIPMENT | .1 | Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.   |
|  | .2 | Hollow masonry walls, suspended drywall ceilings: toggle bolts.  |
|  | .3 | Exposed conduits or cables:<br>.1 50mm diameter and smaller: one-hole steel straps.<br>.2 Larger than 50mm diameter: two-hole steel straps.  |
-

2.4 SUPPORTS  
FOR CONDUIT,  
FASTENINGS,  
EQUIPMENT  
(Cont'd)

- .4 Suspended support systems:
  - .1 Individual cable or conduit runs: support with 6mm diameter threaded rods and support clips.
  - .2 Two (2) or more suspended cables or conduits: support channels supported by 6mm 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 ELECTRICAL  
GENERAL

- .1 Do complete installation in accordance with requirements of:
  - .1 Electrical Divisions, this specification.
  - .2 CSA 22.1 Canadian Electrical Code, latest edition.
  - .3 ANSI/NFPA 70.
  - .4 ANSI/IEEE C2.
- .2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage (above 50 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 0.9m and 1.8m 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.

- |                                       |     |  |
|---------------------------------------|-----|--|
| 3.2 ELECTRICAL<br>GENERAL<br>(Cont'd) | .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.                      |
- 
- |                       |    |   |
|-----------------------|----|---|
| 3.3 CONDUIT<br>SYSTEM | .1 | Install communication wiring in conduit. Provide complete conduit system to link Building Controllers. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fills 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 150mm from parallel steam or hot water pipes and at least 50mm 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 30m.   |
|                       | .8 | Use conduit outlet boxes for conduit up to 32mm diameter and pull boxes for larger sizes.   |
-

3.3 CONDUIT  
SYSTEM  
(Cont'd)

---

- .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 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 to Electrical Division.
  - .17 Install bonding conductor for 120 volt and above in conduit.
-

### 3.4 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 all 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 strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

### 3.5 WIRING DEVICES, COVER PLATES

- .1 Receptacles:
  - .1 Install vertically in gang type outlet box when more than one (1) receptacle is required in one (1) 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.



3.6 STARTERS,  
CONTROL DEVICES

- .1 Install and make control connections as indicated. Power connections above 50V by Electrical Division.
- .2 Install correct over-current devices.
- .3 Identify each control 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.

3.7 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 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.

3.8 TESTS

- .1 General:
  - .1 Give fourteen (14) days written notice of intention to test.
  - .2 Conduct in presence of Departmental Representative and authority having jurisdiction.
  - .3 Conceal work only after tests satisfactorily completed.
  - .4 Report results of tests to Departmental Representative in writing.
  - .5 Preliminary tests:
    - .1 Conduct as directed to verify compliance with specified requirements.
    - .2 Make needed changes, adjustments, replacements.

- 3.8 TESTS  
(Cont'd)
- .1 General:(Cont'd)
- .6 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.

PART 1 - GENERAL

- 1.1 REFERENCES
- .1 American National Standards Institute (ANSI)
    - .1 ANSI C12.7-05, Requirements for Watthour Meter Sockets.
    - .2 ANSI/IEEE C57.13-2008, Requirements for Instrument Transformers.
  - .2 Canadian Standards Association
    - .1 CSA Type 1 Enclosure
    - .2 CSA Type 4X Enclosures
    - .3 CSA Type 12 Enclosures
- 1.2 SUBMITTALS
- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Include:
    - .1 Information as specified for each device.
    - .2 Manufacturer's detailed installation instructions.
  - .3 Pre-Installation Tests: 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: Submit manufacturer's installation instructions for specified equipment and devices.
- 1.3 CLOSEOUT SUBMITTALS
- .1 Submit operating and maintenance data for inclusion in operation and maintenance manual in accordance with Section 01 78 00 - Closeout Submittals.
- 1.4 WARRANTY
- .1 Provide a five (5) year parts and labour warranty for all field devices, starting from the date of Substantial Completion.
-

## PART 2 - PRODUCTS

- |                                    |    |  |
|------------------------------------|----|--|
| <u>2.1 GENERAL</u>                 | .1 | Control devices of each category to be of same type and manufacturer.  |
|                                    | .2 | External trim materials to be corrosion resistant. Assemble internal parts in watertight, shockproof, vibration-proof, heat resistant assembly.                          |
|                                    | .3 | Operating conditions: 0 - 32 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 to be unaffected by external transmitters (eg. walkie talkies).   |
|                                    | .6 | Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.   |
|                                    | .7 | Outdoor installations: use weatherproof construction in CSA 4X enclosures.   |
|                                    | .8 | Devices installed in user occupied space must not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions. |
| <u>2.2 ROOM TEMPERATURE SENSOR</u> | .1 | Provide as part of air conditioning system.  |
|                                    | .2 | Provide all wall-mounted temperature sensors as shown on control drawings.   |
| <u>2.3 PROGRAMMABLE THERMOSTAT</u> | .1 | Wall mounted 7-day programmable thermostat control electric heating at 24V.  |

- |   |    |  |
|---|----|--|
| <u>2.4 HYDRONIC<br/>HEATING ROOM<br/>THERMOSTAT</u>   | .1 | Provide wall-mounted electronic proportional thermostat.   |
|   | .2 | LCD display, 0-10 Vdc or 4-20 mA outputs, 60 Hz, setback capability.   |
| <u>2.5 HYDRONIC<br/>HEATING VALVE</u>                 | .1 | Modulating 2-way valve and electronic actuator size to match existing. Brass forged 300psig body, equal percentage flow, meets ANSI IV std. for close-off.                                     |
|   | .2 | Pop-top spring return actuator with 1-10 Vdc or 4-20 mA proportional control. UL listed, position indicator, manual override.  |
| <u>2.6 CONTROL<br/>RELAY (SOLID STATE)</u>            | .1 | Technical Performance: 240V 10 amp capacity. Normally open or normally closed to suit the application, suitable for switching inductive AC loads.  |
| <u>2.7 CONTROL<br/>RELAY (ELECTRO<br/>MECHANICAL)</u> | .1 | Technical Performance: a high impedance relay to produce a dry contact.  |
| <u>2.8 PANELS</u>                                     | .1 | Wall mounted enameled steel abinets with hinged and key-locked front door.   |
|   | .2 | Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as required by Departmental Representative without adding additional cabinets. |
|   | .3 | Panels to be lockable with same key.   |
| <u>2.9 WIRING</u>                                     | .1 | All wiring to run in conduit.  |
|   | .2 | Wiring must be continuous without joints.  |
|   | .3 | Refer to Division 26.  |
-

### PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Install field control devices.
  - .2 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in CSA 2 enclosures or as required for specific applications. Provide for electrolytic isolation in all cases when dissimilar metals make contact.
  - .3 Support field-mounted transmitters, sensors on pipe stands or channel brackets.
  - .4 Install wall mounted devices on plywood panel properly attached to wall.
- 3.2 TEMPERATURE AND HUMIDITY SENSORS
- .1 Stabilize to ensure minimum field adjustments or calibrations.
  - .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
  - .3 Outdoor installation:
    - .1 Protect from solar radiation and wind effects by stainless steel shields.
    - .2 Install in CSA 4X enclosures.
  - .4 Duct installations:
    - .1 Do not mount in dead air space.
    - .2 Location to be within sensor vibration and velocity limits.
    - .3 Securely mount extended surface sensor used to sense average temperature.
    - .4 Thermally isolate elements from brackets and supports so as to respond to air temperature only.
    - .5 Support sensor element separately from coils, filter racks.
  - .5 Averaging duct type temperature sensors:
    - .1 Sensor length to be not less than 1.0m per 1.0m<sup>2</sup> of duct cross- sectional area.
    - .2 Use multiple sensors where single sensor does not meet minimum length ratio. Wire
-

- 3.2 TEMPERATURE AND HUMIDITY SENSORS (Cont'd)
- .5 (Cont'd)
  - .2 (Cont'd)
  - multiple sensors in series for freeze protection applications.
  - .3 Wire multiple sensors separately for temperature measurement.
  - .4 Use either software averaging algorithm to derive overall average for control purposes or separate inputs, based on site requirements.
  - .6 Thermowells: install for piping installations. Where pipe diameter is less than well insertion length, locate well in elbow. Thermowell to restrict flow by less than 30%.
- 3.3 PANELS
- .1 Arrange for conduit and tubing entry from top, bottom or either side.
  - .2 Use modular multiple panels if necessary to handle all requirements, with space for additional 20% PCU or FID if applicable without adding additional panels. Space to accommodate maximum capacity of associated controller (ECU, LCU, MCU, PCU, TCU).
  - .3 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
  - .4 Identify wiring and conduit clearly.
- 3.4 IDENTIFICATION
- .1 Identify field devices properly.
- 3.5 TESTING
- .1 Calibrate and test field devices for accuracy and performance. Submit report detailing tests performed, results obtained to Departmental Representative for approval. Departmental Representative will verify results at random. Provide testing equipment and manpower necessary for this verification.