

**Part 1            General**

**1.1                REFERENCES**

- .1    American National Standards Institute (ANSI)
  - .1        ANSI C2-1990, National Electrical Safety Code.
  - .2        ANSI/NFPA 70-1990, National Electrical Code.
- .2    Canadian Standards Association (CSA)
  - .1        CSA C22.1-98, Canadian Electrical Code, Part 1.
  - .2        CAN/CSA C22.3No.1-M87, Overhead Systems.

**1.2                PERSONNEL QUALIFICATIONS**

- .1    Qualified supervisory personnel to:
  - .1        Continuously direct and monitor all work.

**Part 2            Products**

**2.1                SPECIAL SUPPORTS**

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

**2.2                WIRING**

- .1    As per requirements of Division 26.
- .2    For 70V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.
- .3    For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.
- .4    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: 20AWG stranded twisted pair.
  - .4        Analog input and output: shielded #20 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.

### **2.3 CONDUIT**

- .1 As per requirements of Division 26.
- .2 Electrical metallic tubing to CSA C22.2 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 56. Rigid steel threaded conduit to CSA C22.2 45.
- .3 Junction and pull boxes: welded steel.
  - .1 Surface mounting cast FS: screw-on flat covers.
  - .2 Flush mounting: covers with 25 mm minimum extension all round.
- .4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.
- .5 Outlet boxes: 100 mm minimum, square.
- .6 Conduit boxes, fittings:
  - .1 Bushings and connectors: with nylon insulated throats.
  - .2 With push pennies to prevent entry of foreign materials.
- .7 Fittings for rigid conduit:
  - .1 Couplings and fittings: threaded type steel.
  - .2 Double locknuts and insulated bushings: use on sheet metal boxes.
  - .3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.
- .8 Fittings for thin wall conduit:
  - .1 Connectors and couplings: steel, set screw type.

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

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

### **2.5 STARTERS, CONTROL DEVICES**

- .1 Starter diagrams:
  - .1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.
- .2 Auxiliary Control Devices:
  - .1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.
  - .2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.

- .3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.
- .4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.

## **2.6 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.
  - .2 Larger than 50 mm diameter: two-hole steel straps.
- .3 Suspended support systems:
  - .1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
  - .2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

## **Part 3 Execution**

### **3.1 INSTALLATION**

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

### **3.2 SUPPORTS**

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

### **3.3 ELECTRICAL GENERAL**

- .1 Do complete installation in accordance with requirements of:
  - .1 Division 26, this specification.
  - .2 CSA 22.1 Canadian Electrical Code.
  - .3 ANSI/NFPA 70.
  - .4 ANSI C2.
- .2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.
- .3 Do underground installation to CAN/CSA C22.3No.7, except where otherwise specified.
- .4 Conform to manufacturer's recommendations for storage, handling and installation.
- .5 Check factory connections and joints. Tighten where necessary to ensure continuity.
- .6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.

- .7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
- .8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
- .9 Install conduits, and sleeves prior to pouring of concrete.
- .10 Holes through exterior wall and roofs: flash and make weatherproof.
- .11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
- .12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

### **3.4 CONDUIT SYSTEM**

- .1 All wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to main control panel. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.
- .2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference. Conduit shall be installed tight to building structure unless authorized by the Engineer.
- .3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Engineer 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 parallel from hot pipes and at least 50 mm at crossovers.
- .5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.
- .6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.
- .7 Limit conduit length between pull boxes to less than 30 m.
- .8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.
- .9 Fastenings and supports for conduits, cables, and equipment:
  - .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
  - .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
  - .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Engineer.
- .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 Engineer'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.
- .17 Install bonding conductor for 120 volt and above in conduit.
- .18 No conduit shall be exposed in non-secure areas.
- .19 Particular care is to be taken when laying out and installing conduit and devices in secure Y-chases. Conduit and devices are to be mounted so they do not protrude into service space. Orient to back side of duct or pipe to be close to wall.

### **3.5 WIRING**

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

### **3.6 WIRING DEVICES, COVER PLATES**

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

### **3.7 STARTERS, CONTROL DEVICES**

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

### **3.8 GROUNDING**

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

### **3.9 TESTS**

- .1 General:
  - .1 Perform following tests.
  - .2 Give 14 days written notice of intention to test.
  - .3 Conduct in presence of Engineer and authority having jurisdiction. Engineer will have option to forego attendance and allow test to proceed.
  - .4 Conceal work only after tests satisfactorily completed.
  - .5 Report results of tests to Engineer 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 Engineer and authority having jurisdiction.

**END OF SECTION**

**Part 1            General**

**1.1                PURPOSE**

- .1        Control sequences are intended to relay the general intent of how mechanical systems are to operate. They are not intended to give direct instruction in the construction or programming of the system.
- .2        Each control sequence to be custom programmed for its intended function. Provide documentation of control sequence logic used herein.

**Part 2            Products**

**2.1                ELECTRIC OPERATORS (DAMPER)**

- .1        Provide 24 vac damper actuators which are 0-10 vac input proportional and designed to operate position dampers. Operator shall be synchronous motor driven with up to 100 in.lb. force sensor safety stops and spring return as required. Enclosure shall be cast aluminum.
  - .1        Acceptable product: Belimo

**2.2                FURNACE ZONING SYSTEM (F-4)**

- .1        Four zone control panel for non-variable air heating/cooling system. System capable of controlling up to four separate zones. System consists of Lennox LPZ-4 Zone control Panel, discharge air sensor, duct mounted motorized zone dampers with a thermostat in each zone and a bypass damper. Zoning system allows temperature setback in unoccupied areas while maintaining comfort in occupied areas. Zone thermostats to be Lennox ComfortSense 5000 model X4146.

**2.3                THERMOSTAT (F-3)**

- .1        Thermostat to be 7 day programmable thermostat equal to Robertshaw #300-229 c/w auxiliary occupied contact.

**Part 3            Execution**

**3.1                GENERAL**

- .1        Install damper motors on outside of ducts. Do not locate in air stream.

**3.2                SEQUENCE**

- .1        Heat Recovery Unit
  - .1        Occupied
    - .1        Relay closes 120 VAC contact from 24 VAC 'Occupied' signal.
    - .2        120 VAC/24 VAC opens motorized dampers, energizes HRV.
  - .2        Unoccupied

- .1 Relay opens 120 VAC contact from loss of 24 VAC 'Occupied' signal.
- .2 Motorized dampers spring close, HRV de-energizes.

**END OF SECTION**