

## **PART 1 - GENERAL**

### **1.1 Related Sections**

- .1 This section covers items common to sections of Division 26.

### **1.2 References**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-06, Canadian Electrical Code, Part 1 (20th Edition), Safety Standard for Electrical Installations.
  - .2 CAN3-C235-83(R2000), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
  - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
  - .2 EEMAC Y1-1-1955, Equipment Green Colour for Outdoor Electrical Equipment.
- .3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)  
IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.
- .4 City of Winnipeg
  - .1 Identification Standard – 510276-0000-40ER-0002.
  - .2 Tag Naming Standard – 612620-0014-40ER-0001.

### **1.3 Definitions**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

### **1.4 Design Requirements**

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.

### **1.5 Submittals**

- .1 Submittals: in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.
- .2 Shop drawings in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Provinces of Manitoba, Canada.
  - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
  - .3 Identify circuit terminals on wiring diagrams and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

- .4 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
- .5 Submit copies of 600 x 900 mm minimum size drawings and product data to authority having jurisdiction.
- .6 If changes are required, notify Contract Administrator of these changes before they are made.
- .3 Quality Control in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.
- .4 Provide CSA certified equipment and material. Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction for special approval before delivery to site.
  - .1 Submit test results of installed electrical systems and instrumentation.
  - .2 Permits and fees: in accordance with General Conditions of contract.
  - .3 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
  - .4 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Contract Administrator.
- .5 Manufacturer's Field Reports: submit to Contract Administrator manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

#### **1.6 Quality Assurance**

- .1 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor licenses or apprentices as per the conditions of Provincial Act respecting manpower vocational training and qualification.
  - .1 Employees registered in provincial apprenticeship program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
  - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

#### **1.7 Delivery, Storage and Handling**

- .1 Material Delivery Schedule: provide Contract Administrator with schedule within 2 weeks after award of Contract.

#### **1.8 Waste Management and Disposal**

- .1 Separate waste materials for reuse and recycling.
- .2 Collect and separate paper, plastic, polystyrene and corrugated cardboard packaging material for recycling.
- .3 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Contract Administrator.
- .4 Fold up metal banding, flatten and place in designated area for recycling.
- .5 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .6 Place materials defined as hazardous or toxic waste in designated containers.
- .7 Ensure emptied containers are sealed and stored safely for disposal away from children.

- .8 Unused sealant material must not be disposed of into sewer system, streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .9 Do not dispose of preservative treated wood through incineration.
- .10 Do not dispose of preservative treated wood with other materials destined for recycling or reuse.
- .11 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Contract Administrator.

## **1.9 Operating and Maintenance Manuals**

- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .2 Operating instructions to include following:
  - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
  - .2 Service instructions: Including a list of spare parts and replacement parts and the names and addresses of all suppliers.
  - .3 Maintenance instructions: Including start-up, proper adjustment, lubrication and shutdown procedures.
  - .4 Installation instructions.
  - .5 Operating instructions.
  - .6 Safety precautions.
  - .7 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .3 Operating instructions have to be laminated and placed within the station next to its equipment. Operating instructions to be reviewed by Engineer prior to laminating.
- .4 Post instructions where directed.
- .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

## **PART 2 - PRODUCTS**

### **2.1 Materials And Equipment**

- .1 Provide material and equipment.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from Electrical Inspections Department before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

### **2.2 Electric Motors, Equipment And Controls**

- .1 Provide all power and control wiring and connections including mechanical control wiring as specified on mechanical and electrical drawings.

- .2 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

### **2.3 Warning Signs**

- .1 Warning Signs: in accordance with requirements of Electrical Inspection Department and Contract Administrator.
- .2 Decal signs, minimum size 175 x 250 mm.

### **2.4 Wiring Terminations**

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

### **2.5 Equipment Identification**

- .1 Identify electrical equipment with nameplates and labels in accordance with Identification Standard – 510276-0000-40ER-0002.

### **2.6 Wiring Identification**

- .1 Identify conductors and cables in accordance with Identification Standard – 510276-0000-40ER-0002.

### **2.7 Finishes**

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1-1.
  - .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

### **2.8 Electrical Single Line Diagrams**

- .1 Provide electrical single line diagrams under plexiglass as follows:
  - .1 Electrical distribution system: locate in main electrical room
- .2 Drawings: 11 X 17 size.

## **PART 3- EXECUTION**

### **3.1 Installation**

- .1 Complete installation in accordance with the current edition of the Canadian Electrical Code, CSA C22.1, except where specified otherwise.
- .2 Do overhead and underground systems in accordance with the current edition of CSA C22.3 No.1 except where specified otherwise.
- .3 Perform all work in accordance with local codes and by-laws.

### **3.2 Nameplates and Labels**

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

### 3.3 Conduit and Cable Installation

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .1 Sleeves through concrete: PVC, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

### 3.4 Location of Outlets

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings, and as shown on the drawings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.
  - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

### 3.5 Mounting Heights

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation. Install electrical equipment at following heights unless indicated otherwise.
  - .1 Local switches: 1400 mm.
  - .2 Wall receptacles:
    - .1 General: 300 mm.
    - .2 Above top of continuous baseboard heater: 200 mm.
    - .3 Above top of counters or counter splash backs: 175 mm.
    - .4 In mechanical rooms: 1400 mm.
  - .3 Panelboards: as required by Code or as indicated.
  - .4 Telephone and interphone outlets: 300 mm.
  - .5 Wall mounted telephone and interphone outlets: 1500 mm.
  - .6 Fire alarm stations: 1500 mm.
  - .7 Fire alarm bells: 2100 mm.
  - .8 Wall mounted speakers: 2100 mm.

### 3.6 Co-ordination of Protective Devices

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

### 3.7 Field Quality Control

- .1 Load Balance:

- .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct and pay for the following tests in accordance with Section 01 00 01 – General Provisions of this Bid Opportunity.
- .1 Point to point wire continuity test for all conductors.
  - .2 Power generation and distribution system including phasing, voltage, grounding and load balancing.
  - .3 Circuits originating from branch distribution panels.
  - .4 Lighting and its control.
  - .5 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .6 Systems: fire alarm system and communications.
  - .7 Test resistance to ground of the completed grounding electrode.
  - .8 Insulation resistance testing:
    - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
    - .3 Check resistance to ground before energizing.
- .3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .4 Manufacturer's Field Services:
- .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.
- .5 Submit test results for Contract Administrator's review.

**3.8 Cleaning**

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 Section Includes**

- .1 Materials and installation for wire and box connectors.

### **1.2 References**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-C22.2 No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
  - .2 CSA C22.2 No.65-93 (R1999), Wire Connectors.
- .2 City of Winnipeg
  - .1 Identification Standard – 510276-0000-40ER-0002.
  - .2 Tag Naming Standard – 612620-0014-40ER-0001.

## **PART 2 - PRODUCTS.**

### **2.1 Materials**

- .1 Pressure type wire connectors to: CSA C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Clamps or connectors for armoured cable and flexible conduit as required to: CAN/CSA-C22.2 No.18.

## **PART 3 - EXECUTION**

### **3.1 Installation**

- .1 Remove insulation carefully from ends of conductors and:
  - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
  - .2 Install fixture type connectors and tighten. Replace insulating cap.

**END OF SECTION**



## **PART 1 - GENERAL**

### **1.1 Related Sections**

- .1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.
- .2 Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.
- .3 Section 01 00 01 – General Provisions.

### **1.2 References**

- .1 CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 131-M89(R1994), Type TECK 90 Cable.
- .3 City of Winnipeg
  - .1 Identification Standard – 510276-0000-40ER-0002.
  - .2 Tag Naming Standard – 612620-0014-40ER-0001.

### **1.3 Product Data**

- .1 Submit product data in accordance with Section 01 00 01 – General Provisions of this Bid Opportunity.

## **PART 2 - PRODUCTS**

### **2.1 Building Wires**

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 1000 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.

### **2.2 1 kV TECK90 Power Cable**

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper, size as indicated. (12 AWG minimum where not indicated)
- .3 Insulation:
  - .1 Type: ethylene propylene rubber.
  - .2 Chemically cross-linked thermosetting polyethylene rated type RW90, 1000 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride material.

- .7 Fastenings:
  - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables at 300 mm centers.
  - .3 Threaded rods: 6 mm dia. to support suspended channels.
- .8 Connectors:
  - .1 Watertight, explosion-proof approved for TECK cable.

**2.3 600 V TECK90 Control Cable**

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper, size as indicated. (14 AWG minimum where not indicated)
- .3 Insulation:
  - .1 Type: ethylene propylene rubber.
  - .2 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride material.
- .7 Fastenings:
  - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables at 300 mm centers.
  - .3 Threaded rods: 6 mm dia. to support suspended channels.
- .8 Connectors:
  - .1 Watertight, explosion-proof approved for TECK cable.

**2.4 300 V Instrument Cable – Armoured**

- .1 Conductors: 16 AWG, 7 strand concentric lay, Class B tinned copper, twisted pairs/triads.
- .2 Insulation: PVC TW75, 75 °C Wet, 105 °C Dry (-40 °C), 300 Volt.
- .3 Twisted pairs/triads cabled with staggered lays.
- .4 Shielding: Individual twisted pair(s)/triads Aluminum/mylar shield with ST drain wire, 100 % shield. Overall aluminum/mylar shield with ST drain wire. Individual drain wires one size smaller than conductor AWG. Overall drain wire the same AWG as conductors.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride material (90 °C, -40 °C).

- .7 Fastenings:
  - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables at 300 mm centers. .
- .8 Connectors:
  - .1 Watertight, explosion proof approved for armoured cable.

### **2.5 Type RW90 Conductor**

- .1 In accordance with CSA C22.2 No.38
- .2 Circuit conductors shall be concentric stranded soft copper, size as indicated (12 AWG minimum where not indicated).
- .3 Insulation to be chemically cross-linked thermosetting polyethylene rated type RW90 XLPE, 600V
- .4 Suitable for installation in temperatures down to -40 °C.
- .5 90 °C conductor operating temperature.

### **2.6 Wiring Identification**

- .1 Provide wiring identification in accordance with Section 26 05 01 – Common Work Results – For Electrical.

## **PART 3– EXECUTION**

### **3.1 Installation of Building Wires**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.

### **3.2 Installation of TECK Cable 0 -1000 V**

- .1 Install cables.
  - .1 Group cables wherever possible on channels.
- .2 Install cable in trenches in accordance with Section 26 05 43 – Installation of Cables in Trenches and in Ducts.
- .3 Terminate cables in accordance with Section 26 05 20 – Wire and Box Connectors - 0 - 1000 V.

### **3.3 Installation of Armoured Cables**

- .1 Group cables wherever possible.
- .2 Install cable in trenches in accordance with Section 26 05 43 – Installation of Cables in Trenches and in Ducts.
- .3 Terminate cables in accordance with Section 26 05 20 – Wire and Box Connectors - 0 - 1000 V.

**3.4 Installation of Control Cables**

- .1 Install control cables in conduit.
- .2 Ground control cable shield.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1        American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
  - .1            ANSI/IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.
- .2        Canadian Standards Association, (CSA International)

**Part 2            Products**

**2.1                EQUIPMENT**

- .1        Ground bus:
  - .1            Material: Tin plated copper
  - .2            Size: As per drawings.
- .2        Grounding conductors: bare stranded copper, soft annealed, size as indicated.
- .3        Insulated grounding conductors: green, type RW90.
- .4        Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1            Grounding and bonding bushings.
  - .2            Protective type clamps.
  - .3            Bolted type conductor connectors.
  - .4            Thermit welded type conductor connectors.
  - .5            Bonding jumpers, straps.
  - .6            Pressure wire connectors.

**Part 3            Execution**

**3.1                INSTALLATION GENERAL**

- .1        Install connectors in accordance with manufacturer's instructions.
- .2        Protect exposed grounding conductors from mechanical injury.
- .3        Use mechanical connectors for grounding connections to equipment provided with lugs.
- .4        Use Burndy compression connectors or approved equal in accordance with B6 for all grounding splices and terminations, unless otherwise indicated.
- .5        Soldered joints not permitted.

**3.2                EQUIPMENT GROUNDING AND BONDING**

- .1        Install grounding connections to transformers.

- .2 Install bonding connections to all electrical equipment.
- .3 Include a separate green bonding wire in all power conduits including branch circuit wiring sized according to the largest power conductor in the conduit:
  - .1 8 AWG green ground wire for up to 4 AWG power conductors.
  - .2 6 AWG green ground wire for up to 2/0 AWG power conductors.
- .4 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:
  - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Perform tests before energizing electrical system.

**END OF SECTION**

**Part 1            General**

**1.1                NONE**

- .1            None.

**Part 2            Products**

**2.1                FRAMING AND SUPPORT SYSTEM**

- .1            Materials:
- .2            Conduit support structures shall employ an aluminum strut framing system together with the manufacturer's connecting components and fasteners for a complete system.
- .3            Finishes:
  - .1            Wet locations: Aluminum.
  - .2            Indoors, dry locations: Aluminum.
  - .3            Nuts, bolts, machine screws: Stainless steel.

**2.2                CONCRETE AND MASONRY ANCHORS**

- .1            Materials: hardened steel inserts, zinc plated for corrosion resistance.
- .2            Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.
- .3            Manufacturer: Hilti (Canada) Limited or approved equal in accordance with B6.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1            Secure equipment to solid masonry, tile and plaster surfaces with galvanized anchors.
- .2            Secure equipment to poured concrete with expandable inserts.
- .3            Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts, unless otherwise indicated.
- .4            Do not drill through steel reinforcement encased in concrete.
- .5            Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6            Maximum spacing between conduit supports:
  - .1            As per 26 05 34.
- .7            Fasten exposed conduit or cables to building construction or support system using straps.
  - .1            One-hole aluminum straps to secure surface conduits and cables 50 mm and smaller.
  - .2            Two-hole aluminum straps for conduits and cables larger than 50 mm.

- .8 Suspended support systems.
  - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .9 For surface mounting of two or more conduits use channels, with maximum centre spacing as indicated above.
- .10 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .11 Ensure adequate support for raceways and cables dropped vertically where there is no wall support.
- .12 Do not use wire lashing or perforated strap to support or secure cables.
- .13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Contract Administrator.
- .14 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .15 Touch up abraded surfaces and cut ends of galvanized members with an approved galvanizing repair compound.

**END OF SECTION**



**Part 1            General**

**1.1                REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1, Canadian Electrical Code, Part 1, 20th Edition.

**1.2                SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit product data in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.

**Part 2            Products**

**2.1                OUTLET AND CONDUIT BOXES GENERAL**

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.
- .6 Material Requirements:
  - .1 Outdoor and Buried: PVC
  - .2 Main Floor: PVC
  - .3 Dry Well: PVC
  - .4 Wet Well: PVC
  - .5 Secondary Clarifier Control Room: Metal
- .7 Where conduit serves an area where metal material is required, utilize metal conduit, boxes, and fittings for the entire conduit run.

**2.2                SURFACE MOUNTED OUTLET BOXES FOR METAL CONDUIT**

- .1 General Requirements:
  - .1 Acceptable materials:
    - .1 Cast Aluminum
    - .2 Cast ferrous alloy with corrosion resistant epoxy coating.
  - .2 Finish
    - .1 Epoxy Enamel
  - .3 Suitable for threaded rigid conduit
  - .4 Mounting lugs as required.
  - .5 Wet location covers for all locations unless otherwise approved by the Contract Administrator.
  - .6 To CSA 22.2
- .2 Round Boxes:

- .1 100mm (4") round.
- .2 Tapped conduit openings and plugs.
- .3 Manufacturer / Model:
  - .1 Crouse Hinds VXF series
- .3 Device Boxes
  - .1 FS or FD cast aluminum boxes with factory threaded hubs and mounting feet for surface wiring of receptacles.
  - .2 Single gang unless specified otherwise.
  - .3 Manufacturer / Model:
    - .1 Crouse Hinds FS/FD series

### **2.3 SURFACE MOUNTED OUTLET BOXES FOR PVC CONDUIT**

- .1 General Requirements:
  - .1 To CSA C22.2 No. 18.
  - .2 Acceptable materials:
    - .1 PVC
  - .3 Grounding stud.
  - .4 Mounting lugs as required.
  - .5 NEMA 4X, unless otherwise indicated.
- .2 Specific Requirements:
  - .1 Ceiling Outlets:
    - .1 IPEX OB series
  - .2 Device Boxes:
    - .1 IPEX FS/FD series

### **2.4 CONDUIT BOXES FOR METAL CONDUIT**

- .1 FS or FD cast aluminum boxes with factory-threaded hubs and mounting feet for surface wiring.

### **2.5 CONDUIT BOXES FOR PVC CONDUIT**

- .1 Non-metallic PVC boxes with mounting feet for surface wiring of devices.
- .2 Acceptable products: Ipex

### **2.6 FITTINGS - GENERAL**

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Provide boxes sized as required by the Canadian Electrical Code.
- .2 Support boxes independently of connecting conduits.
- .3 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .4 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .5 Provide permanent label or lamacoid for all device boxes indicating the circuit(s) contained within.
  - .1 Example: L10-2 (Panel L10, circuit 2)

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 References**

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
  - .2 CAN/CSA C22.2 No. 18-98, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
  - .3 CSA C22.2 No. 211.2-M1984 (R1999), Rigid PVC (Unplasticized) Conduit.
  - .4 C22.2 No. 45.2-08 (R2013) - Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel (Tri-national Standard, with NMX-J-576-ANCE and UL 6A).
- .2 City of Winnipeg
  - .1 Identification Standard – 510276-0000-40ER-0002.
  - .2 Tag Naming Standard – 612620-0014-40ER-0001.

### **1.2 Preferences**

- .1 In general power and control wiring shall be by TECK or armoured cable.

## **PART 2 - PRODUCTS**

### **2.1 Conduits**

- .1 Rigid PVC conduit: to CSA C22.2 No. 211.2.
- .2 Rigid aluminum conduit to CSA C22.2 No. 45.2-08

### **2.2 Conduit Fastenings**

- .1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at spacing as per Rule 12-1010 of the current edition of the Canadian Electrical Code for rigid metal conduit.
- .4 Channel type supports for two or more conduits at spacing as per Rule 12-1114 of the current edition of the Canadian Electrical Code for PVC conduit.
- .5 Threaded rods, 6 mm dia., to support suspended channels.

### **2.3 Conduit Fittings**

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90° bends are required for 25 mm and larger conduits.

### **2.4 Expansion Fittings for Rigid Conduit**

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 21 mm deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

## **2.5 Fish Cord**

- .1 Polypropylene.

## **PART 3 - EXECUTION**

### **3.1 Installation**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Surface mount conduits.
- .3 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .4 Minimum conduit size for lighting and power circuits: 21 mm.
- .5 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .6 Mechanically bend steel conduit over 21 mm dia.
- .7 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .8 Install fish cord in empty conduits.
- .9 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .10 Dry conduits out before installing wire.
- .11 Connect conduit to equipment securely to maintain continuity for the purpose of bonding to ground.
- .12 Provide for expansion and contraction of the conduit system.

### **3.2 Surface Conduits**

- .1 Run parallel or perpendicular to building lines.
- .2 Run conduits in flanged portion of structural steel.
- .3 Group conduits wherever possible on suspended or surface channels.
- .4 Do not pass conduits through structural members except as indicated.

### **3.3 Concealed Conduits**

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

**3.4 Conduits In Cast-In-Place Concrete**

- .1 Locate to suit reinforcing steel. Install in centre one third of slab.
- .2 Protect conduits from damage where they stub out of concrete.
- .3 Install sleeves where conduits pass through slab or wall.
- .4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.
- .5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.

**3.5 Conduits Underground**

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

**END OF SECTION**

**Part 1 GENERAL**

**1.1 REFERENCES**

- .1 Canadian Standards Association, (CSA International)
- .2 Insulated Cable Engineers Association, Inc. (ICEA)

**1.2 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect cables from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 CABLE PROTECTION**

- .1 38 x 190 mm planks pressure treated, water repellent preservative.

**Part 3 Execution**

**3.1 DIRECT BURIAL OF CABLES**

- .1 After sand bed is in place, lay cables, maintaining 75 mm clearance from each side of trench to nearest cable. Sand shall be as specified in City of Winnipeg Standard Construction Specification CW2030 – Excavation Bedding and Backfill, or according to the currently enforced version of the CSA Canadian Electrical Code.
- .2 Do not pull cable into trench.
- .3 Include offsets for thermal action and minor earth movements. Offset cables 150 mm minimum for each 60 m run, maintaining minimum cable separation and bending radius requirements.
- .4 Make termination only as indicated, leaving 0.6 m minimum of surplus cable in each direction.
- .5 Underground cable splices not acceptable.
- .6 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable or in accordance with manufacturer's written recommendations; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.
- .7 Cable separation:
  - .1 As indicated on drawings.
  - .2 Maintain 75 mm minimum separation between cables of different circuits.
  - .3 Maintain 300 mm minimum horizontal separation between low and high voltage cables.

- .4 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.
- .5 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.
- .8 After sand protective cover in item 3.1.1 above is in place, install continuous row of 38 X 190 mm pressure treated planks as indicated to cover length of run.
- .9 Arrange for inspection by the Contract Administrator prior to covering the remainder of the trench. Inspection to occur with base sand and cables installed and 3m length of trench with cover sand and planks in place, but not backfilled.
- .10 Following the inspection of and approval by the Contract Administrator, install remaining protective sand cover and 38 x 190 mm pressure treated planks, then install the warning tape and backfill the remainder of the trench.

### **3.2 CABLE INSTALLATION IN DUCTS**

- .1 Install cables as indicated in ducts.
- .2 Do not pull spliced cables inside ducts.
- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .5 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non leaded cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

### **3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests using qualified personnel.
- .3 Include necessary instruments and equipment.
- .4 Check phase rotation and identify each phase conductor of each feeder.
- .5 Check each feeder for continuity, short circuits and grounds.
- .6 Ensure resistance to ground of circuits is not less than 50 megaohms.
- .7 Acceptance Tests shall be in accordance with Section 26 08 05 – Acceptance Testing.
- .8 Provide the consultant with list of test results showing location at which each test was made, circuit tested and result of each test.
- .9 Remove and replace entire length of cable if cable fails to meet any of test criteria.



**3.4 CLEANING**

- .1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

**3.5 PROTECTION**

- .1 Repair damage to adjacent materials caused by cable installation.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 NETA Acceptance Testing Specifications, 2003 (ATS-2003)

**1.2 TESTING EQUIPMENT**

- .1 All test equipment shall be in good mechanical and electrical condition.
- .2 Accuracy of metering in test equipment shall be appropriate for the test being performed.
- .3 Wave shape and frequency of test equipment output waveforms shall be appropriate for the test and the tested equipment.
- .4 The test equipment shall be calibrated as specified below:
  - .1 The testing organization shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.
  - .2 The firm providing calibration service shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.
  - .3 Instruments shall be calibrated in accordance with the following frequency schedule:
    - .1 Field instruments: Analog, 6 months maximum. Digital, 12 months maximum.
    - .2 Laboratory instruments: 12 months maximum.
    - .3 Leased specialty equipment: 12 months maximum.
    - .4 Dated calibration labels shall be visible on all test equipment.
    - .5 Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.
    - .6 Calibrating standard shall be of higher accuracy than that of the instrument tested.
- .5 Specific requirements of insulation resistance meters:
  - .1 Must be digital units. Crank-type analog insulation resistance meters will not be acceptable.
- .6 Specific requirements of low-resistance meters:
  - .1 Measure resistance range from 1  $\mu\Omega$  to 1000  $\Omega$ .
  - .2 Standard electrician multimeters will not be accepted.

**1.3 TESTING REPORT**

- .1 Prepare an overall inspection and test report that details all investigations and tests.
- .2 The Contractor shall furnish five paper copies and two electronic copies on CD of each final report.
  - .1 The electronic copies of the report, including the test forms, shall be provided in PDF format.
  - .2 The Microsoft Word version of the all completed test forms provided to the Contractor shall also be included on the CDs.

- .3 The report shall be neat and organized. Any omissions, inconsistencies, or incomplete work identified by the Contract Administrator shall be corrected and incorporated into the report in the appropriate section, and completely resubmitted.
- .4 A draft of each report shall be completed and sent to the Contract Administrator for review a maximum of one month after the completion of the inspections at the Site.
- .5 The final report shall be submitted a maximum of two weeks after the Contractor receives the mark-up of the draft report from the Contract Administrator.
- .6 The report shall include the following:
  - .1 Summary of project.
  - .2 Testing Equipment.
  - .3 Detail the type, manufacturer, model, and last calibration date of all testing equipment.
  - .4 Description of equipment tested.
  - .5 Description of all tests.
  - .6 Typed inspection forms including:
    - .1 Identification of the testing organization.
    - .2 Equipment identification.
    - .3 Humidity, temperature, and other conditions that may affect the results of the tests/calibrations.
    - .4 Date of inspections, tests, maintenance, and/or calibrations.
    - .5 Identification of the testing technician.
    - .6 Indication of inspections, tests, maintenance, and/or calibrations performed and recorded, along with charts, and graphs as applicable. All measurements and readings taken shall be noted for inclusion in the report. Where repairs are made, measurements and readings before and after the repair shall be included.
    - .7 Indication of expected results, when calibrations are to be performed.
    - .8 Indication of “as-found” and “as-left” results, as applicable.
  - .7 Itemized list of all repaired deficiencies which shall include:
    - .1 Detailed description of the deficiency.
    - .2 The cost associated with the deficiency repair.
  - .8 Itemized list of all un-repaired deficiencies encountered which shall include:
    - .1 Detailed description of the deficiency.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used

**Part 3 Execution**

**3.1 SCOPE OF TESTING**

- .1 MS-Z004
- .2 MS-Z005

- .3 MS-Z604
- .4 Motor for P-Z004
- .5 Motor for P-Z005
- .6 Motor for SF-Z604
- .7 Circuit breaker for P-Z004
- .8 Circuit breaker for P-Z005
- .9 Circuit breaker for SF-Z604
- .10 Circuit breaker for HCE-Z603
- .11 Circuit breaker for UH-Z606
- .12 Circuit breaker for UH-Z607
- .13 Cables:
  - .1 All 600 V and 1000V rated cables.

### **3.2 INSPECTION, TESTING AND MAINTENANCE PROCEDURES**

- .1 General
  - .1 All tests are based on NETA (InterNational Electrical Testing Association) standard ATS-2007. Where manufacturer's specifications, tolerances, and/or published data are not available, refer to the appropriate tables in ATS-2007.
  - .2 Torque all accessible bolted electrical connections. Additional requirements apply as specified.
  - .3 Utilize the existing drawings for reference while performing the specified electrical inspection work. Where the existing installation deviates from that shown on the drawings, mark-up the drawings with red pen as required to reflect the installation. Include the marked-up drawings in the report.
  - .4 The scope of required drawing checks is limited to the equipment and components that are part of the electrical inspection work.
  - .5 Any repairs made that affect the accuracy of the drawings shall be marked up on the drawings.
  - .6 Drafting of drawings is not required.
  - .7 All inspection values, readings, corrections, and assessments shall be clearly recorded for inclusion within the report.
  - .8 Where corrections or repairs are made, record both as found/as left test readings on the inspection sheet. If space is not provided on the inspection form, record the readings in the Note fields or on a separate sheet.
- .2 Inspection Forms
  - .1 The inspection forms to be completed by the Contractor are provided for reference in PDF format.
  - .2 Microsoft Word form templates will be provided prior to the work being initiated.
  - .3 Make appropriate print-outs of the inspection forms and utilize for entry of data and test results on site.

- .4 Utilizing the Microsoft Word form templates, enter the data recorded manually into the forms electronically.
- .5 Complete the inspection forms in the entirety and include them in the report.
- .6 Submit electronic PDF copies of the inspection forms.
- .7 The scope of work required in the specifications is in no way limited by the inspection forms, or spaces provided. Provide additional pages, documents, and forms as required to provide a complete report.
- .8 The inspection forms may be updated during the Work by the City or Contract Administrator. Utilize the latest forms provided.

### **3.3 CABLES, < 1000 V (ALSO FEEDERS IN CONDUIT)**

- .1 Inspection and testing shall be comprised of the following:
  - .1 For cables/wires 4/0 AWG or larger, inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate and correct values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - .2 Torque all accessible bolted electrical connections.
  - .3 Inspect compression applied connectors for correct cable match and indentation.
  - .4 Inspect grounding and cable/conduit support.
  - .5 Verify that visible cable bends meet or exceed the minimum allowable bending radius.
  - .6 Measure length of cable/conduit and record in meters.
  - .7 If cables/wires are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.
  - .8 Perform an insulation-resistance test on each conductor. Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 1000 megohms. The voltage applied shall be 500 Vdc for 300 V rated cables, and 1000 Vdc for 600 V or 1000 V rated cables.

### **3.4 CONTROL POWER TRANSFORMERS, < 1000 V**

- .1 Inspection and testing shall be comprised of the following:
  - .1 Record the equipment nameplate data for inclusion in the report.
  - .2 Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
  - .3 Verify that primary and secondary fuse ratings or circuit breakers match available drawings. Where drawings are not available, note fuses that appear to be sized incorrectly, based upon application of the Canadian Electrical Code. Mark fuse sizes and type on the drawings, where not shown.
  - .4 Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be:
    - .1 windings < 250 V: 500 Vdc
    - .2 windings > 250 V: 1000 Vdc

### **3.5 MOTORS, INDUCTION, AC, 600 V**

- .1 Inspection and testing shall be comprised of the following:
  - .1 Note the equipment nameplate data for inclusion in the report.
  - .2 Inspect physical and mechanical condition.
  - .3 Inspect anchorage, alignment, and grounding.

- .4 Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging. Air baffles and filter media should be clean. Cooling fans should operate. Slip ring wear and brushes should be within manufacturer's tolerances for continued use. Brush rigging should be intact.
- .5 Clean the unit.
- .6 Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
- .7 Verify the application of appropriate lubrication and lubrication systems.
- .8 Verify the absence of unusual mechanical or electrical noise or signs of overheating.
- .9 Perform a rotation test to insure correct shaft direction.
- .10 Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43. Test voltage shall be in accordance with manufacturer's published data or 500 Vdc.
  - .1 Where possible, test each winding separately. Ground all windings not under test.
  - .2 Ensure all cables and accessories are disconnected during the test.
  - .3 For motors  $\leq 150\text{kW}$  (200 HP), the test duration is to be one (1) minute. Calculate the dielectric absorption ratio.
  - .4 For motors  $> 150\text{kW}$  (200 HP), the test duration is to be ten (10) minutes. Calculate the dielectric absorption ratio and polarization index.
  - .5 Correct test results to 40 °C.
  - .6 Investigate readings below 100 megaohms. Investigate dielectric absorption ratios less than 1.4 and polarization index ratios less than 2.0 for Class B insulation and Class F insulation.
- .11 Where it is not possible to perform an insulation resistance test separately on each winding, perform a winding resistance test on each winding using a low resistance ohmmeter.
- .12 Measure running voltage and current and evaluate relative to load conditions and nameplate full-load amperes. Utilize a true RMS meter.
  - .1 Where powered by a VFD with bypass, perform test with the motor powered by the VFD and by the bypass starter.
- .13 Perform insulation-resistance test on insulated bearings in accordance with manufacturer's published data, if applicable.
- .14 Perform resistance tests on resistance temperature detector (RTD) circuits. RTD circuits should conform to design intent and/or machine protection device manufacturer's specifications.

### 3.6 MOTOR STARTERS, 600 V

- .1 Inspection and testing shall be comprised of the following:
  - .1 Note the equipment nameplate data for inclusion in the report.
  - .2 Record all adjustable settings, size of overload, etc.
  - .3 Inspect physical and mechanical condition.
  - .4 Inspect anchorage, alignment, and grounding.
  - .5 Verify the unit is clean.
  - .6 Torque all accessible bolted power connections.
  - .7 Inspect contactors for evidence of overheating or stress.
  - .8 Visually inspect and exercise circuit breaker.

- .9 If power fuses are present, record fuse size and type. Measure the resistance of each fuse. Investigate inconsistent resistance values.

### 3.7 VARIABLE FREQUENCY DRIVE, 600V < 37 kW

- .1 Inspection and testing shall be comprised of the following:
  - .1 Inspect physical and mechanical condition.
  - .2 Inspect anchorage, alignment, and grounding.
  - .3 Inspect for evidence of corrosion.
  - .4 Clean the unit.
  - .5 Check the air filters.
  - .6 Ensure vent path openings are free from debris and that heat transfer surfaces are not contaminated by oil, dust, or dirt.
  - .7 Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
  - .8 Visually inspect VFD grounding to ensure continuity.
  - .9 Inspect condition of line reactors, if present.
  - .10 Inspect DC bus capacitors for bulging and leakage.
  - .11 Cooling fans and heat sinks:
    - .1 Visually inspect and listen for any abnormal noises or vibration.
    - .2 Verify that fans rotate freely.
    - .3 Verify correct direction of airflow.
    - .4 Clean and verify integrity of heat sinks.
    - .5 Verify the operation of the grounding switch, if present.
- .2 Record the following VFD Parameters:
  - .1 Motor voltage, current, frequency, nominal speed, nominal power.
  - .2 Control mode / method.
  - .3 Minimum and maximum control frequency.
  - .4 Acceleration and deceleration time.
  - .5 Compare drive overcurrent set points with motor full-load current rating to verify correct settings.
- .3 Power fuses:
  - .1 Record fuse data. Confirm that the fuses are of the correct type and rating. Utilize manufacturer's published data where available.
  - .2 Measure fuse resistance.
- .4 Bolted connections:
  - .1 Perform resistance measurements through bolted connections with a lowresistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - .2 Torque all bolted connections.
- .5 Inverter / Supply Module Power Connections:
  - .1 Remove each power module and visually inspect the contacts.
  - .2 Torque all cable connections.
  - .3 Clean all contact surfaces and apply suitable joint compound as recommended by manufacturer.

- .6 Operator Interface:
  - .1 Check the display and keypad for proper operation and communication.
  - .2 Retrieve fault history log and note any faults.
- .7 Grounding/Bonding measurements:
  - .1 Measure the resistance of the ground bonding connection between the VFD and the main grounding bus in the corresponding electrical room.
- .8 Control Wiring:
  - .1 Check for tightness of all accessible control wiring and torque any loose connections.
- .9 Perform operational tests by initiating control devices.
  - .1 Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.
  - .2 Verify operation of drive from local start/stop and speed control signals.
  - .3 Verify operation of all local pilot lights.
  - .4 Verify the operation of any emergency stop switches.
- .10 Voltage and Current Testing:
  - .1 With the VFD under load, measure and record the following:
    - .1 Incoming AC voltage and currents.
- .11 With the VFD output in START/RUN mode, and at zero speed:
  - .1 Measure and record the AC output voltage. Voltages above 40 VAC should be investigated.

### **3.8 CIRCUIT BREAKERS, INSULATED-CASE/MOLDED CASE, 600 V**

- .1 Inspection and testing shall include the following:
  - .1 Note the equipment nameplate data for inclusion in the report.
  - .2 Record all adjustable settings.
  - .3 Inspect physical and mechanical condition.
  - .4 Inspect anchorage and alignment.
  - .5 Clean the unit.
  - .6 Torque all accessible bolted power connections.
  - .7 Operate the circuit breaker to insure smooth operation.
  - .8 Test all breakers utilizing the "Push-To-Trip" button, if equipped.
  - .9 Move operating handle to the off and on position.
  - .10 Restore breaker position to original position.
- .2 For cables 4/0 AWG and larger, inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
- .3 For breakers with a frame size greater or equal to 250A, or as specified elsewhere in the specification:
  - .1 Perform an insulation resistance test.
  - .2 Breakers rated < 600V, test voltage is to be 500 VDC.



- .3 Breakers rated  $\geq 600\text{V}$ , test voltage is to be 1000 VDC.
- .4 Perform a contact/pole-resistance test.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Section Includes**

- .1 Materials and installation for standard and custom breaker type panelboards.

### **1.2 Related Sections**

- .1 Section 26 05 01 - Common Work Results - Electrical.
- .2 Section 26 28 21 - Moulded Case Circuit Breakers.
- .3 Section 01 00 00 – General Provisions.

### **1.3 References**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.2 No.29-M1989 (R2000), Panelboards and Enclosed Panelboards.
- .2 City of Winnipeg
  - .1 Identification Standard – 510276-0000-40ER-0002.
  - .2 Tag Naming Standard – 612620-0014-40ER-0001.

### **1.4 Shop Drawings**

- .1 Submit shop drawings in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

## **PART 2 - PRODUCTS**

### **2.1 Panelboards**

- .1 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
  - .1 Install circuit breakers in panelboards before shipment.
  - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .2 250 V panelboards: Bus and breakers rated as indicated on drawings. 10 kA (symmetrical) interrupting capacity minimum.
- .3 600 V panelboards: Bus and breakers rated as indicated on drawings. 22 kA (symmetrical) interrupting capacity minimum.
- .4 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .5 Panelboards: tin plated copper mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .6 Two keys for each panelboard and key panelboards alike.
- .7 Tin plated copper bus with neutral of same ampere rating as mains.

- .8 Mains: suitable for bolt-on breakers.
- .9 Trim with concealed front bolts and hinges.
- .10 Trim and door finish: baked grey enamel.

## **2.2 Breakers**

- .1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to City of Winnipeg.

## **2.3 Equipment Identification**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Nameplate for each panelboard Size 4 engraved as indicated.
- .3 Nameplate for each circuit in distribution panelboards Size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit.

## **PART 3 - EXECUTION**

### **3.1 Installation**

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.
- .3 Mount panelboards to height specified in Section 26 05 01 - Common Work Results - Electrical or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.
- .6 Provide lesser of 20% spare 15A breakers or 5 spare breakers.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Section Includes**

- .1 Switches, receptacles, wiring devices, cover plates and their installation.

### **1.2 Related Sections**

- .1 Section 26 05 01 - Common Work Results - Electrical.
- .2 Section 01 00 00 – General Provisions of this Bid Opportunity.

### **1.3 References**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA-C22.2 No.42-99 (R2002), General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2 CSA-C22.2 No.42.1-00, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  - .3 CSA-C22.2 No.55-M1986 (July 2001), Special Use Switches.
  - .4 CSA-C22.2 No.111-00, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).
- .2 City of Winnipeg
  - .1 Identification Standard – 510276-0000-40ER-0002.
  - .2 Tag Naming Standard – 612620-0014-40ER-0001.

### **1.4 Shop Drawings And Product Data**

- .1 Submit shop drawings and product data in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.

## **PART 2 - PRODUCTS**

### **2.1 Switches**

- .1 15 A, 120 V, single pole, double pole, three-way, four-way industrial grade switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111 as required.
- .2 Manually-operated general purpose AC switches with following features:
  - .1 Terminal holes approved for No. 10 AWG wire.
  - .2 Silver cadmium oxide contacts.
  - .3 Fully enclosed with urea or melamine moulding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 Brown toggle.
- .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 Switches of one manufacturer throughout project.
- .5 Acceptable materials: Hubbell 1200 Series or equivalent.

## 2.2 Receptacles

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA-C22.2 No.42 with following features:
  - .1 Brown urea moulded housing.
  - .2 Suitable for No. 10 AWG for back and side wiring.
  - .3 Break-off links for use as split receptacles.
  - .4 Eight back wired entrances, four side wiring screws.
  - .5 Triple wipe contacts and riveted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
  - .1 Brown urea moulded housing.
  - .2 Suitable for No. 10 AWG for back and side wiring.
  - .3 Four back wired entrances, 2 side wiring screws.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.
- .5 Acceptable materials: Hubbell 5252 or equivalent.

## 2.3 Cover Plates

- .1 Stainless steel or PVC cover plates for wiring devices.
- .2 Cover plates from one manufacturer throughout project.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .4 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .5 Weatherproof double lift spring-loaded stainless steel or PVC cover plates, complete with gaskets for duplex receptacles as indicated on the drawings.
- .6 Weatherproof spring-loaded stainless steel or PVC cover plates complete with gaskets for single receptacles or switches as indicated on the drawings.

## PART 3 - EXECUTION

### 3.1 Installation

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height in accordance with Section 26 05 01 - Common Work Results - Electrical.

- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height in accordance with Section 26 05 01 - Common Work Results - Electrical.
  - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
  - .4 Mount lighting fixture receptacles local to fixtures.
- .3 Cover plates:
  - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
  - .2 Install suitable common cover plates where wiring devices are grouped.
  - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Section Includes**

- .1 Materials for moulded-case circuit breakers, circuit breakers, and ground-fault circuit-interrupters, fused circuit breakers, and accessory high-fault protectors.

### **1.2 Related Sections**

- .1 Section 01 00 00 – General Provisions of this Bid Opportunity.

### **1.3 References**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA-C22.2 No. 5-02, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).
- .2 City of Winnipeg
  - .1 Identification Standard – 510276-0000-40ER-0002.
  - .2 Tag Naming Standard – 612620-0014-40ER-0001.

### **1.4 Submittals**

- .1 Submit product data in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.

## **PART 2 - PRODUCTS**

### **2.1 Breakers General**

- .1 Moulded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters: to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick-make, quick-break over center switching mechanism that is mechanically trip-free, for manual and automatic operation with temperature compensation for 40 °C ambient. Automatic tripping of the breaker shall be clearly indicated by the handler position. Contacts shall be non-welding silver alloy, and arc extinguishing shall be accomplished by means of DE-ION arc chutes.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers to have minimum symmetrical rms interrupting capacity rating as indicated on the drawings.

### **2.2 Thermal Magnetic Breakers**

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.
- .2 Acceptable Product: Cutler-Hammer Series C or approved equal in accordance with B6.

**2.3 Magnetic Breakers**

- .1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

**PART 3 - EXECUTION**

**3.1 Factory Testing**

- .1 Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of the CSA standard.

**3.2 Installation**

- .1 Install circuit breakers as indicated on drawings per the manufacturer's recommendations.

**3.3 Field Settings**

- .1 The contractor shall perform field adjustments of the circuit breakers as required to place the equipment in final operating condition. The settings shall be in accordance with the drawings.

**END OF SECTION**



## **PART 1 - GENERAL**

### **1.1 Section Includes**

- .1 Materials and installation for industrial control devices including pushbutton stations and control and relay panels.

### **1.2 Related Sections**

- .1 Section 26 05 01 - Common Work Results - Electrical.
- .2 Section 01 00 00 – General Provisions of this Bid Opportunity.

### **1.3 References**

- .1 Canadian Standards Association (CSA International)
- .1 CSA C22.2 No.14-95 (R2001), Industrial Control Equipment.
- .2 National Electrical Manufacturers Association (NEMA)
- .1 NEMA ICS 1-2001, Industrial Control and Systems: General Requirements.
- .3 City of Winnipeg
  - .1 Identification Standard – 510276-0000-40ER-0002.
  - .2 Tag Naming Standard – 612620-0014-40ER-0001.

### **1.4 Shop Drawings**

- .1 Submit shop drawings in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.
- .2 Include schematic, wiring, interconnection diagrams.

### **1.5 Quality Assurance**

- .1 Submit to Contract Administrator one copy of test results.

### **1.6 Waste Management and Disposal**

- .1 Separate and recycle waste materials.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate paper, plastic, polystyrene and corrugated cardboard packaging material for disposal in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Contract Administrator.

## **Part 2 PRODUCTS**

### **2.1 AC Control Relays**

- .1 Control Relays: to CSA C22.2 No.14 and NEMA ICS 1.

- .2 Convertible contact type: contacts field convertible from NO to NC, electrically held, with poles to suit. Coil rating: 120 VAC. Contact rating: 120 VAC, 10 A minimum or 24 VDC, 2 A minimum as required.
- .3 Fixed contact plug-in type: general purpose with poles to suit. Coil rating: 120 V. Contact rating: 120 VAC, 10 A minimum or 24 VDC, 2 A minimum as required.
- .4 Relay to have visual status indication.

## **2.2 DC Control Relays**

- .1 Control Relays: to CSA C22.2 No.14 and NEMA ICS 1.
- .2 Convertible contact type: contacts field convertible from NO to NC, electrically held, with poles to suit. Coil rating: 24 VDC. Contact rating: 120 VAC, 10 A minimum or 24 VDC, 2 A minimum as required.
- .3 Fixed contact plug-in type: general purpose with poles to suit. Coil rating: 24 VDC. Contact rating: 120 VAC, 10 A minimum or 24 VDC, 2 A minimum as required.
- .4 Relay to have visual status indication.

## **2.3 Relay Accessories**

- .1 Standard contact cartridges: normally-open - convertible to normally-closed in field.

## **2.4 Solid State Timing Relays**

- .1 Construction: AC operated electronic timing relay with solid-state timing circuit to operate output contact. Timing circuit and output contact completely encapsulated to protect against vibration, humidity and atmospheric contaminants.
- .2 Operation: on-delay or off-delay, or as indicated on drawings.
- .3 Supply voltage: 120 V, AC, 60 Hz.
- .4 Temperature range: -20 °C to 60 °C.
- .5 Output contact rating: maximum voltage 300 V AC or DC. Current: NEMA ICS 1.
- .6 Timing ranges: minimum 1.0 s, maximum 12 minutes.
- .7 Relay to have visual status indication.

## **2.5 Operator Control Stations**

- .1 Enclosure:
  - .1 In general CSA Type 4X, surface mounting.

## **2.6 Pushbuttons**

- .1 Heavy duty oil tight. Operator extend type. Black, with 1-NO and 1-NC contacts rated at 2 A minimum, AC, labels as indicated. Stop pushbuttons coloured red, labelled as indicated.

## **2.7 Selector Switches**

- .1 Maintained, 2 or 3 position as required, labelled as indicated on drawings, heavy duty oil tight operators standard, contact arrangement as indicated, rated 120 VAC, 10 A minimum, or 24 VDC, 2 A minimum as required.

## **2.8 Indicating Lights**

- .1 Heavy duty oil tight, full voltage, LED type, lens colour as indicated, supply voltage: 120 V, lamp voltage: 120 V, labels as indicated.

## **2.9 Control and Relay Panels**

- .1 CSA Type 12 sheet steel enclosure with hinged padlockable access door, accommodating relay timers, labels, as indicated, factory installed and wired to identified terminals.

## **2.10 Control Circuit Transformers**

- .1 Single phase, dry type.
- .2 Primary: 600 V, 60 Hz AC.
- .3 Secondary: 120 V, AC.
- .4 VA Rating: as required by loads plus 25%.
- .5 Secondary fuse rating: as required by loads
- .6 Close voltage regulation as required by magnet coils and solenoid valves.

## **Part 3 EXECUTION**

### **3.1 Installation**

- .1 Install pushbutton stations, control and relay panels, control devices and interconnect.

### **3.2 Field Quality Control**

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check operation of section.
- .3 Upon completion of sectional test, undertake group testing.
- .4 Check complete system for operational sequencing.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 National Electrical Manufacturer's Association (NEMA)
  - .1 NEMA Standards Publication ICS 2-2000: Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.

**1.2                SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Provide shop drawings: in accordance with Section 01 00 00 – General Provisions.
    - .1 Provide shop drawings for each type of starter to indicate:
      - .1 Mounting method and dimensions.
      - .2 Starter size and type.
      - .3 Layout and components.
      - .4 Enclosure type.

**1.3                CLOSEOUT SUBMITTALS**

- .1 Provide maintenance materials in accordance with Section 01 00 00 – General Provisions.
- .2 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.
- .3 Extra Materials:
  - .1 Provide listed spare parts for each different size and type of starter.
    - .1 All control fuses.
    - .2 1 indicating lamp bulb.

**Part 2            Products**

**2.1                GENERAL**

- .1 Starters to NEMA ICS 2-2000.
- .2 Motor starters are to be completely compatible with existing MCC. Use products from the manufacturer of the existing MCC in order to ensure physical and electrical compatibility.

**2.2                FULL VOLTAGE MAGNETIC STARTERS**

- .1 UL/CSA listed, NEMA size as shown on the drawings.
  - .1 Smallest size of starter: NEMA size 1, unless otherwise indicated
  - .2 IEC rated starters are not acceptable.

- .2 Magnetic of size, type, rating and enclosure type as indicated with components as follows:
  - .1 All coils to be epoxy coated.
  - .2 Contactor solenoid operated, rapid action type.
  - .3 Motor overload protective device in each phase, manually reset from outside enclosure, electronic type. Heater element type overload protection is not acceptable.
  - .4 Wiring and schematic diagram inside starter enclosure in visible location.
  - .5 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .3 Accessories:
  - .1 1-N/O spare auxiliary contact.

### **2.3 CONTROL TRANSFORMER**

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with primary and secondary fuses, installed in with starter as indicated.
- .2 Size control transformer as indicated.

### **2.4 ACCESSORIES**

- .1 Pushbutton: heavy duty, oil tight as required.
- .2 Selector switches: heavy duty, oil tight as required.
- .3 Indicating lights: heavy duty, oil tight, LED type and colour as indicated.

### **2.5 FINISHES**

- .1 Apply finishes to enclosure in accordance with Section 26 05 01 - Common Work Results for Electrical.

### **2.6 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Magnetic starter designation label, white plate, black letters, as indicated on lamacoid schedule.

### **2.7 SPARE PARTS**

- .1 Fuses: two of each type and rating.
- .2 Indicating lamps: two (2) indicating lamp bulbs of each type.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install starters in locations as shown on drawings.
- .2 Install starters and control devices in accordance with manufacturer's instructions.
- .3 Install and wire starters and controls as indicated.

- .4 Ensure correct fuses installed.
- .5 Confirm motor nameplate and adjust / replace overload device to suit.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results for Electrical and manufacturer's instructions.
- .2 Operate switches and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

**END OF SECTION**

## **Part 1        General**

### **1.1            REFERENCES**

- .1        Institute of Electrical and Electronics Engineers, Inc. (IEEE)
  - .1        IEEE 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
- .2        CSA International
  - .1        CAN/CSA-B72, Installation Code for Lightning Protection Systems.

### **1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Shop Drawings:
  - .1        Indicate materials and methods of attachment of conductors to air terminals and electrodes.

## **Part 2        Products**

### **2.1            MATERIALS**

- .1        Lightning Rods: copper, solid rod.
- .2        Conductor: copper, stranded, #2 AWG.
- .3        Fastenings and attachment straps: copper.
- .4        Ground electrodes: 3 m x 19 mm diameter copper coated steel.
- .5        Use copper conductors, terminals, connectors and fastenings for buildings sheathed in other than aluminum.
- .6        Connections: bronze connections formed by thermit process or inspectable wrought copper compression connectors to IEEE 837.

### **2.2            DESCRIPTION**

- .1        System to consist of metallic air terminals, lightning conductors connecting air terminals to ground and interconnected ground electrodes, and/or ground cables.

### **2.3            REGULATORY REQUIREMENTS**

- .1        System subject to: approval by authority having jurisdiction.

## **Part 3        Execution**

### **3.1            EXAMINATION**

- .1        Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for lightning protection installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Consultant.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

### **3.2 INSTALLATION**

- .1 Install lightning protection to CAN/CSA-B72.
- .2 Bond discharge conductors to service mast or other non-current-carrying electrical parts.
- .3 Submit certificate of installation to Consultant.

### **3.3 INSPECTION**

- .1 Obtain inspection certificate from Consultant for discharge conductor passing through any fire supporting membrane.

### **3.4 CLEANING**

- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

### **3.5 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by lightning protection installation.

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1 ANSI/IEEE C62.41-1991, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 ASTM International Inc.
  - .1 ASTM F1137-00(2006), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .3 Canadian Standards Association (CSA International).
- .4 ICES-005-07, Radio Frequency Lighting Devices.
- .5 Underwriters' Laboratories of Canada (ULC).

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

**Part 2 Products**

**2.1 LAMPS**

- .1 Lamps shall be as indicated on luminaire schedule on drawings.
- .2 LED lamps shall have a minimum estimated lifespan of 50,000 hours, with colour temperature as indicated on luminaire schedule.

**2.2 BALLASTS**

- .1 LED Driver: CSA certified, energy efficient type, IC electronic.
  - .1 Rating: 120 V, 60 Hz.
  - .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
  - .3 Start-up ambient temperature of -20°C for indoor luminaires, and -40°C for outdoor luminaires.
  - .4 Power factor: minimum 95% with 95% of rated lamp lumens.
  - .5 Harmonics: 10 % maximum THD.
  - .6 Estimated lifespan equal or greater than LED lamps of respective luminaire.
  - .7 Sound rated: Class A.
  - .8 Mounting: integral with luminaire.

**2.3 FINISHES**

- .1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

**2.4 OPTICAL CONTROL DEVICES**

- .1 As indicated in luminaire schedule.

**2.5 LUMINAIRES**

- .1 As indicated in luminaire schedule.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated.
- .2 Provide adequate support to suit ceiling system.
- .3 Install a permanent label or lamacoid for all luminaires indicating the circuit(s) contained within.
- .4 Example: L10-2 (Panel L10, circuit 2)

**3.2 WIRING**

- .1 Connect luminaires to lighting circuits:
- .2 Install rigid PVC conduit for luminaires as indicated.

**3.3 LUMINAIRE SUPPORTS**

- .1 Support luminaires from ceiling or wall as indicated on drawings in accordance with local inspection requirements.

**3.4 LUMINAIRE ALIGNMENT**

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line, or as otherwise indicated on the drawings.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Materials and installation for emergency lighting systems.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.2 No.141-M1985(R1999), Unit Equipment for Emergency Lighting.

**1.3 SUBMITTALS**

- .1 Submit product data in accordance with Section 01 00 00 – General Provisions of this Bid Opportunity.
- .2 Data to indicate system components, mounting method, source of power and special attachments.

**Part 2 Products**

**2.1 EQUIPMENT**

- .1 Emergency lighting equipment: to CSA C22.2 No.141 and according to Luminaire Schedule on drawings.
- .2 Supply voltage: 120 V ac.
- .3 Output voltage: 12 V dc.
- .4 Operating time: as shown in schedule on drawings.
- .5 Battery: sealed, maintenance free.
- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations.
- .7 Solid state transfer circuit.
- .8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for ‘Fault’.
- .10 Lamp heads: integral on unit and remote, 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: LED, 4 W.
- .11 Cabinet: Integral with pictogram exit luminaire and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 Finish: white.
- .13 Auxiliary equipment:
  - .1 Test switch.

.2 Battery disconnect device.

**2.2 WIRING OF REMOTE HEADS**

.1 Conductors: RW90 type in accordance with Section 26 05 21 - Wires and Cables 0-1000V, sized 10 AWG, or larger as required..

**Part 3 Execution**

**3.1 INSTALLATION**

.1 Install unit equipment and remote mounted fixtures.

.2 Direct heads.

.3 Demonstrate emergency lighting operation and coverage to Contract Administrator.

**END OF SECTION**