

**Part 1 General**

**1.1 REFERENCES**

- .1 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.
- .2 Reference Standards:
  - .1 CSA Group
    - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.
    - .2 CAN3-C235-83(R2010), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for items listed in Section 01 33 00 – Submittals Required and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Submit for review single line electrical diagrams and install in electrical room.
- .4 Shop drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of New Brunswick, 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 on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
  - .4 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
  - .5 Submit digital copy of drawings and product data to authority having jurisdiction.
  - .6 If changes are required, notify Departmental Representative of these changes before they are made.

- .5 Certificates:
  - .1 Provide CSA certified equipment and material.
  - .2 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.
  - .3 Submit test results of installed electrical systems and instrumentation.
  - .4 Permits and fees: in accordance with General Conditions of contract.
  - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
  - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Engineer.

### **1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Operation and Maintenance Data: submit operation and maintenance data for panels, breakers and disconnects for incorporation into manual.
  - .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 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
    - .3 Safety precautions.
    - .4 Procedures to be followed in event of equipment failure.
    - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
  - .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
  - .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.

### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 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 from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

## **Part 2 Products**

### **2.1 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 and French.
- .4 Use one nameplate and label for each language.

### **2.2 MATERIALS AND EQUIPMENT**

- .1 Provide material and equipment in accordance with Section 01 61 00 – Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

### **2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: by mechanical contractor.

### **2.4 WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction and Engineer.
- .2 Decal signs, minimum size 175 x 250 mm.

### **2.5 WIRING TERMINATIONS**

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

### **2.6 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates and labels as follows:

- .1 Nameplates: plastic laminate 3 mm matt white finish face, black core, lettering accurately aligned and engraved into core and mechanically attached with double faced tape.

- .2 Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.
- .8 Transformers: indicate capacity, primary and secondary voltages.

## 2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.

## 2.8 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

Prime	Auxiliary	
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

## **2.9 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.
  - .2 Paint indoor switchgear and distribution enclosures light gray.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative 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 Departmental Representative.

### **3.2 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.

### **3.3 NAMEPLATES AND LABELS**

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

### **3.4 CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves where required.
  - .1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.

### **3.5 LOCATION OF OUTLETS**

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

### **3.6 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.
- .3 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 Television outlets: 300 mm.
  - .9 Wall mounted speakers: 2100 mm.
  - .10 Clocks: 2100 mm.
  - .11 Door bell pushbuttons: 1500 mm.

### **3.7 CO-ORDINATION OF PROTECTIVE DEVICES**

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

### **3.8 FIELD QUALITY CONTROL**

- .1 Conduct following tests in accordance with Section 01 45 00 Testing and Quality Control.
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .4 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.
- .2 Carry out tests in presence of Departmental Representative.
- .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 - ACTION AND INFORMATIONAL 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.

### **3.9 SYSTEM STARTUP**

- .1 Instruct Departmental Representative in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

### **3.10 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1    CSA International
  - .1    CAN/CSA-C22.2 No.18-98(R2003), Outlet Boxes, Conduit Boxes and Fittings.
  - .2    CSA- C22.2 No. 65-13, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2    National Electrical Manufacturers Association (NEMA)

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets for wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3                CLOSEOUT SUBMITTALS**

- .1    Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2    Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.

**1.4                DELIVERY, STORAGE AND HANDLING**

- .1    Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2    Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3    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 wire and box connectors from nicks, scratches, and blemishes.
  - .3    Replace defective or damaged materials with new.

**Part 2            Products**

**2.1                MATERIALS**

- .1    Bushing stud connectors: to NEMA to consist of:
  - .1    Connector body and stud clamp for round copper conductors.
  - .2    Clamp for round copper conductors.
  - .3    Clamp for conductors round aluminum bar.

- .4 Stud clamp bolts.
- .5 Bolts for copper bar.
- .6 Sized for conductors as indicated.
- .2 Clamps or connectors for armoured cable, TECK cable, flexible conduit, non-metallic sheathed cable 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 fixture type connectors and tighten to CAN/CSA-C22.2 No.65. Replace insulating cap.
  - .2 Install bushing stud connectors in accordance with NEMA.

**3.2 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**

**Part 1 General**

**1.1 PRODUCT DATA**

- .1 Provide product data in accordance with Section 01 33 00 - Submittal Procedures.

**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 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE. Installations in conduit underground are to be RWU90 XLPE.

**2.2 TECK 90 CABLE**

- .1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Conductors:
  - .1 Grounding conductor: copper as indicated.
  - .2 Circuit conductors: copper as indicated, size as indicated.
- .3 Insulation:
  - .1 Cross-linked polyethylene XLPE.
  - .2 Rating: 600 V.
- .4 Armour: interlocking galvanized steel or aluminum.
- .5 Overall covering: thermoplastic polyvinyl chloride.
- .6 Fastenings:
  - .1 One hole aluminum 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 500 mm centers.
  - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .7 Connectors:
  - .1 Watertight, approved for TECK cable.

**2.3 ARMOURED CABLES**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from galvanized steel or aluminum strip.
- .4 Connectors: anti short connectors.

**Part 3 Execution**

**3.1 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

**3.2 GENERAL CABLE INSTALLATION**

- .1 Install cable in trenches in accordance with Section 33 71 73.02 - Underground Electrical Service.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .3 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .4 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

**3.3 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.
  - .2 In underground ducts in accordance with Section 26 05 43.01 – Installation of Cables in Trenches and In Ducts.

**3.4 INSTALLATION OF TECK90 CABLE (0 -1000 V)**

- .1 Group cables wherever possible on channels.
- .2 Install cable exposed, securely supported by straps for connections to exterior equipment.

**3.5 INSTALLATION OF ARMoured CABLES**

- .1 Group cables wherever possible on channels.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 26 05 00 - Common Work Results - Electrical.
- .2        Grounding conductors for all distribution grounding to be insulated copper, uninsulated where in contact with earth. Copper conductors shall, at a minimum, be used in the following areas: grounding of transformer neutrals, service entrance neutral, ground riser conductors from main ground station to telephone and server rooms.

**1.2                REFERENCES**

- .1        Codes and standards referenced in this section refer to the latest edition thereof.

**Part 2            Products**

**2.1                EQUIPMENT**

- .1        Clamps for grounding of conductor: size as indicated to electrically conductive underground water pipe.
- .2        Rod electrodes: copper clad steel 21mm dia by 3 m long.
- .3        Grounding conductors: bare stranded copper, soft annealed, size as indicated.
- .4        Insulated grounding conductors: green, type TW.
- .5        Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .6        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, as required by local authority having jurisdiction.
  - .4        Thermit welded type conductor connectors, as indicated.
  - .5        Bonding jumpers, straps.
  - .6        Pressure wire connectors.
  - .7        Compression type connectors.

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**Part 3 Execution**

**3.1 INSTALLATION GENERAL**

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories.
- .2 Provide insulated copper bonding conductor in all conduit, including flexible conduit.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process or compression fitting.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

**3.2 ELECTRODES**

- .1 Make ground connections to continuously conductive underground water pipe.
- .2 Install rod electrodes and make grounding connections.
- .3 Bond separate, multiple electrodes together.
- .4 Use size AWG copper conductors for connections to electrodes as required by code.
- .5 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

**3.3 SYSTEM AND CIRCUIT GROUNDING**

- .1 Install system and circuit grounding connections to neutral of 208V system.

**3.4 EQUIPMENT GROUNDING**

- .1 Install bonding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, frames of motors, starters, control panels, building steel work, distribution panels, outdoor lighting.

**3.5 GROUNDING BUS**

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical room.

**3.6 COMMUNICATION SYSTEMS**

- .1 Install grounding connections for telephone and data systems as follows:
  - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
  - .2 Data systems as indicated.

**3.7 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results – Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

**END OF SECTION**

**Part 1        General**

**Part 2        Products**

**2.1            SUPPORT CHANNELS**

- .1        U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

**Part 3        Execution**

**3.1            INSTALLATION**

- .1        Secure equipment to solid masonry, tile and plaster surfaces with nylon shields.
- .2        Secure equipment to poured concrete with expandable inserts.
- .3        Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4        Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5        Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6        Fasten exposed conduit or cables to building construction or support system using straps.
  - .1        One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2        Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3        Beam clamps to secure conduit to exposed steel work.
- .7        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.
- .8        For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.
- .9        Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10        Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11        Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12        Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.
- .13        Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1            Section 01 33 00 – Submittal Procedures.
- .2            Section 26 05 00 – Common Work Results – Electrical.

**1.2                SUBMITTALS**

- .1            Submit shop drawings and product data for cabinets.

**Part 2            Products**

**2.1                JUNCTION AND PULL BOXES**

- .1            Welded steel construction with screw-on flat covers for surface mounting.
- .2            Covers with 25 mm minimum extension all around for flush-mounted pull and junction boxes.

**Part 3            Execution**

**3.1                JUNCTION, PULL BOXES INSTALLATION**

- .1            Install pull boxes in inconspicuous but accessible locations.
- .2            Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

**3.2                IDENTIFICATION**

- .1            Equipment Identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2            Install size 2 identification labels indicating system name voltage and phase.

**END OF SECTION**

**Part 1           General**

**1.1               REFERENCES**

- .1 Canadian Standards referenced in this section refer to the latest edition thereof.
- .2 Canadian Standards Association (CSA):
  - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.

**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 for special devices.
- .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.

**2.2               SHEET STEEL OUTLET BOXES**

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .3 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .4 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster walls.

**2.3               MASONRY BOXES**

- .1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.
- .2 Flush mount devices in exposed block walls where possible.

**2.4               CONDUIT BOXES**

- .1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

**2.5 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 32 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit connections. Reducing washers are not allowed.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results – Electrical.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
  - .2 CSA C22.2 No. 45-M1981(R2003), Rigid Metal Conduit.
  - .3 CSA 22.2 No. 56-17, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CSA C22.2 No. 83-M1985(R2017), Electrical Metallic Tubing.
  - .5 CSA C22.2 No. 211.2-06(R2016), Rigid PVC (Unplasticized) Conduit.
  - .6 CSA C22.2 No. 227.3-15, Nonmetallic Mechanical Protection Tubing (NMPT) and fittings (Bi-National standard, with UL 1696)

**Part 2 Products**

**2.1 CONDUITS**

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .3 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .4 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal and aluminum.

**2.2 CONDUIT FASTENINGS**

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
  - .1 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 1.5 m on centre.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

**2.3 CONDUIT FITTINGS**

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified.  
Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.

**2.4 FISH CORD**

- .1 Polypropylene.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

**3.2 INSTALLATION**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .3 Use rigid galvanized steel threaded conduit where specified and below 2.4 m in exposed areas.
- .4 Use electrical metallic tubing (EMT) except in cast concrete and when exposed above 2.4 m not subject to mechanical injury.
- .5 Use rigid PVC conduit underground.
- .6 Use flexible metal conduit for connection to motors in dry areas connection to surface or recessed fixtures.
- .7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .8 Use explosion proof flexible connection for connection to explosion proof motors.
- .9 Install conduit sealing fittings in hazardous areas.
  - .1 Fill with compound.
- .10 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .11 Mechanically bend steel conduit over 25 mm diameter.
- .12 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .13 Install fish cord in empty conduits.
- .14 Run 2 25 mm spare conduits up to ceiling space.
  - .1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space.
- .15 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .16 Dry conduits out before installing wire.

**3.3 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

### **3.4 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.

### **3.5 CONDUITS IN CAST-IN-PLACE CONCRETE**

- .1 Locate to suit reinforcing steel.
  - .1 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 Conduits in slabs: minimum slab thickness 4 times conduit diameter.
- .5 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .6 Organize conduits in slab to minimize cross-overs.

### **3.6 CONDUITS UNDERGROUND**

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

### **3.7 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1           General**

**1.1               RELATED SECTIONS**

- .1       Section 26 05 00 – Common Work Results – Electrical.
- .2       Section 31 23 33.01 – Excavating, Trenching and Backfilling.

**1.2               REFERENCES**

- .1       Codes and standards referenced in this section refer to the latest edition thereof.
- .2       CSA Standards Association, (CSA)
- .3       Insulated Cable Engineers Association, Inc. (ICEA)

**Part 2           Products**

**2.1               NOT USED**

**Part 3           Execution**

**3.1               CABLE INSTALLATION IN DUCTS**

- .1       Install cables as indicated in ducts.
  - .1       Do not pull spliced cables inside ducts.
- .2       Install multiple cables in duct simultaneously.
- .3       Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .4       To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
- .5       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.
- .6       After installation of cables, seal duct ends with duct sealing compound.

**3.2               FIELD QUALITY CONTROL**

- .1       Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2       Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3       Check phase rotation and identify each phase conductor of each feeder.
- .4       Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .5       Pre-acceptance tests:

- .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
- .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
- .6 Acceptance Tests:
  - .1 Ensure that terminations and accessory equipment are disconnected.
  - .2 Ground shields, ground wires, metallic armour and conductors not under test.
  - .3 High Potential (Hipot) Testing.
    - .1 Conduct hipot testing at 100% of original factory test voltage in accordance with manufacturer's recommendations.
  - .4 Leakage Current Testing:
    - .1 Raise voltage in steps from zero to maximum values as specified by manufacturer for type of cable being tested.
    - .2 Hold maximum voltage for specified time period by manufacturer.
    - .3 Record leakage current at each step.
- .7 Provide Departmental Representative with list of test results showing location at which each test was made, circuit tested and result of each test. Include results in Commissioning Manual.
- .8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-C2-M91 (R2003), Single-Phase and Three-Phase Distribution Transformers, Types ONAN and LNAN.
- .2 Electrical and Electronic Manufacturer's Association of Canada
  - .1 EEMAC L9-3-1987, Interchangeability of HV Bushings on Pole Type Distribution Transformers.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, and limitations.
- .3 Submit shop drawings and indicate:
  - .1 Dimensioned positions of mounting devices.
  - .2 Dimensioned positions of terminations.
  - .3 Identified internal and external component layout on assembly drawing.
  - .4 Insulating liquid capacity.
- .4 Quality Assurance Submittals: submit following in accordance with Section 01 45 00 – Quality Control.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 Manufacturer's Representative will make available 1 copy of systems supplier's installation instructions.
- .5 Closeout Submittals
  - .1 Provide maintenance data for liquid filled transformers for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.
  - .2 Include insulating liquid maintenance data.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Ship transformer empty, with first fill of liquid shipped separately for field filling.
- .2 Waste Management and Disposal:

- .1 Separate waste materials for reuse recycling in accordance with Section 01 74 22 – Construction/Demolition Waste Management and Disposal.

## **1.5 MAINTENANCE**

- .1 Provide maintenance materials in accordance with Section 01 78 00 – Closeout Submittals.

## **Part 2 Products**

### **2.1 TRANSFORMER CHARACTERISTICS**

- .1 Transformers: to CAN/CSA C2.
- .2 Liquid cooled, outdoor, distribution transformer type ONAN with provision for fan cooling.
- .3 Primary voltage: 1247 KV, 60 Hz, wye connected, 3 phase, 4 wire, grounded.
- .4 Secondary voltage: 347/600 V, wye connected, 3 phase, 4 wire, grounded.
- .5 Capacity: as indicated.
- .6 Basic impulse level: standard.
- .7 Polarity: additive.
- .8 Impedance: standard to match NB Power.

### **2.2 MOUNTING**

- .1 Transformers suitable for platform mounting.

### **2.3 VIBRATION DAMPERS**

- .1 Anti-vibration mountings to isolate not less than 90% of disturbing vibrations.

### **2.4 VOLTAGE TAPS**

- .1 Four-2.5% taps, 2-FCAN, 2-FCBN.

### **2.5 TAP CHANGER**

- .1 Internally operated off-load tap changer, with provision for padlocking on 3 phase units.

### **2.6 HIGH VOLTAGE BUSHINGS**

- .1 Bushings: to EEMAC L9-3.
- .2 Four high voltage bushings on three phase transformers.

### **2.7 INSULATING LIQUID**

- .1 Insulating liquid: transformer oil.

### **2.8 THROAT CONNECTIONS**

- .1 Extend primary and secondary terminals through a throat connection to terminal board installed in separate enclosure, as indicated.

## **2.9 ACCESSORIES**

- .1 Hanger irons and adapter plates.
- .2 Top filter press connection.
- .3 Liquid Celsius temperature thermometer with two sets contacts.
- .4 Liquid level gauge with two sets contacts.
- .5 Winding Celsius temperature detector relay and sensing elements with two sets contacts.
- .6 Wiring and terminal box for protective devices.
- .7 Top non-flammable insulating liquid sampling device.
- .8 Anchor devices, setting templates means for bolting down.
- .9 Bi-directional skid base.
- .10 Wildlife proof shroud for each high voltage bushing.
- .11 Factory install accessories.
- .12 Drain valve with plug: 25 mm.
- .13 Sudden pressure relay.

## **2.10 FINISH**

- .1 Finish tank exterior in accordance with Section 26 05 00 – Common Work Results for Electrical.

## **2.11 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results for Electrical.
- .2 Owner's equipment reference label: size 7.

## **2.12 SOURCE QUALITY CONTROL**

- .1 Provide production test certificates to Departmental Representative.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 INSTALLATION**

- .1 Install transformers only after other work in area is completed and in accordance with manufacturer's instructions.
- .2 Ensure concrete pad fully cured for 28 days before installation of transformers.
- .3 Use spreader bars on slings when lifting transformers into place.

- .4 Set and secure transformers in place rigid, plumb, square.
- .5 Ensure internal connections are mechanically tight.
- .6 Make connections.
- .7 Connect transformer ground terminal to system ground.
- .8 Fill transformers when required with metal hose and ensure care is taken to prevent contamination of liquid and components.
- .9 Set taps to produce rated secondary voltage at no-load.

### **3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 – Common Work Results for Electrical.
- .2 Carry out following insulation tests using megger with 20,000 megohm scale and resulting insulation resistance corrected to base of 20 degrees C.
  - .1 High voltage to ground with secondary grounded for duration of test.
  - .2 Low voltage to ground with primary grounded for duration of test.
  - .3 High to low voltage.
- .3 Inspect primary and secondary connections for tightness and for signs of overheating.
- .4 Inspect and clean bushings and insulators.
- .5 Check oil level and temperature indicators.
- .6 Set transformer taps to rated voltage as specified.
- .7 Inspect for oil leaks and excessive rusting.
- .8 Inspect oil level.
- .9 Check fuses for correctness of type and size.
- .10 Check for grounding and neutral continuity between primary and secondary circuits of transformer.

### **3.4 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1        General**

**1.1            RELATED REQUIREMENTS**

- .1        Section 26 05 00 – Common Work Results - Electrical.

**1.2            REFERENCES**

- .1        CSA International
  - .1        CAN/CSA C22.2 No. 47-M90(R2012), Air-Cooled Transformers (Dry Type).
  - .2        CSA C9-17, Dry-Type Transformers.
  - .3        CAN/CSA C802.2-12(R2017), Minimum Efficiency Values for Dry Type Transformers.
- .2        National Electrical Manufacturers Association (NEMA)

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for dry type transformers and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4            CLOSEOUT SUBMITTALS**

- .1        Submit in accordance with Section 01 78 00 – Closeout Submittals.
- .2        Operation and Maintenance Data: submit operation and maintenance data for dry type transformers for incorporation into manual.

**1.5            DELIVERY, STORAGE AND HANDLING**

- .1        Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements.
- .2        Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3        Storage and Handling Requirements:
  - .1        Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2        Store and protect dry type transformers from nicks, scratches, and blemishes.
  - .3        Replace defective or damaged materials with new.
- .4        Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 22 – Construction/ Demolition Waste Management and Disposal.

**Part 2 Products**

**2.1 DESIGN DESCRIPTION**

- .1 Design 1.
  - .1 Type: Distribution.
  - .2 3 phase, 30 kVA, 600V input, 208Y/120 V output, 60 Hz.
  - .3 Voltage taps: 4-2.5%.
  - .4 Insulation: Class 220, 115 degrees C temperature rise.
  - .5 Basic Impulse Level (BIL): standard.
  - .6 Hipot: standard.
  - .7 Average sound level: 45dBA
  - .8 Impedance at 17 degrees C: 4.57%
  - .9 Enclosure: CSA Type 1, removable metal front panel.
  - .10 Mounting: wall.
  - .11 Finish: in accordance with Section 26 05 00 – Common Work Results for Electrical.
  - .12 Copper windings.
  - .13 Winding configuration to be as noted on drawings.
  - .14 Voltage Regulation to be 4% or better.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results for Electrical.
- .2 Label size: 7.
- .3 Nameplate wording: as indicated on drawings.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for dry type transformers installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative 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 Departmental Representative.

**3.2 INSTALLATION**

- .1 Mount dry type transformers up to 75 kVA as indicated.

- .2 Mount dry type transformers above 75 kVA on floor.
- .3 Ensure adequate clearance around transformer for ventilation.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.
- .7 Make primary and secondary connections in accordance with wiring diagram.
- .8 Energize transformers after installation is complete.
- .9 Make conduit entry into bottom 1/3 of transformer enclosure.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 – Cleaning.
- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 22 – Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.4 PROTECTION**

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

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results – Electrical.

**1.2 REFERENCES**

- .1 CSA Group
  - .1 CSA C22.2 No.31-10, Switchgear Assemblies.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for service entrance board and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Test and Evaluation Reports:
  - .1 Submit 3 copies of certified test results.

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Submit maintenance materials in accordance with Section 01 78 00 – Closeout Submittals.
- .2 Provide:
  - .1 3 extra fuses for each type above 600 A.
  - .2 6 extra fuses for each type up to and including 600 A.

**1.5 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 – Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for service entrance board for incorporation into manual.
- .3 Submit 3 copies of operation and maintenance manual.

**1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect service entrance board from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

## **Part 2 Products**

### **2.1 SERVICE ENTRANCE BOARD**

- .1 Service Entrance Board: to CSA C22.2 No.31.
- .2 Rating: 600 V, 3 phase, 3 wire, 250 A, short circuit current 10 kA (rms symmetrical).
- .3 Cubicles: free standing, dead front, size as indicated.
- .4 Distribution section.
- .5 Access panels with captive knurled thumb screws.
- .6 Bus bars and main connections: 99.3% copper.
- .7 Bus from load terminals of main breaker to main lugs of distribution section.
- .8 Identify phases with colour coding.

### **2.2 MOULDED CASE CIRCUIT BREAKERS**

- .1 Bolt on type.

### **2.3 GROUNDING**

- .1 Copper ground bus extending full width of cubicles and located at bottom.
- .2 Lugs at each end for size 3/0 grounding cable.

### **2.4 GROUND FAULT UNIT**

- .1 As required.

### **2.5 FINISHES**

- .1 Apply finishes in accordance with Section 26 05 00 – Common Work Results for Electrical.
  - .1 Service entrance board exterior: gray.

### **2.6 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Nameplates:
  - .1 White plate, black letters, size 7.
  - .2 Complete board labelled: "600 V."
  - .3 Main disconnect labelled: "Main Breaker".
  - .4 Branch disconnects labelled: as indicated.

## **2.7 SOURCE QUALITY CONTROL**

- .1 Departmental Representative to witness final factory tests.
- .2 Notify Departmental Representative in writing 5 days in advance that service entrance board is ready for testing.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for service entrance board installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative 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 Departmental Representative.

### **3.2 INSTALLATION**

- .1 Locate service entrance board.
- .2 Connect main secondary service to line terminals of main breaker.
- .3 Connect load terminals of distribution breaker's to feeders.
- .4 Check factory made connections for mechanical security and electrical continuity.
- .5 Run one grounding conductor 3/0 AWG bare copper in 25 mm conduit from ground bus to building ground.
- .6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 – Cleaning.
- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 22 – Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.29-15, Panelboards and Enclosed Panelboards.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for panelboards and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Include on drawings:
    - .1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for panelboards for incorporation into manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 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 panelboards from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**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 Panelboards: bus and breakers rated for 10 KA (symmetrical) interrupting capacity or as indicated.
- .3 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.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Minimum of 2 flush locks for each panel board.
- .6 Two keys for each panelboard and key panelboards alike.
- .7 Copper bus with neutral of same ampere rating of mains.
- .8 Mains: suitable for bolt-on breakers.
- .9 Trim with concealed front bolts and hinges.
- .10 Trim and door finish: baked enamel.
- .11 Include grounding busbar with terminals for bonding conductor equal to breaker capacity of the panel board.

## **2.2 BREAKERS**

- .1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to Owner.
- .4 Lock-on devices for fire alarm, emergency and exit circuits.

## **2.3 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for 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, mounted in plastic envelope at inside of panel door.

## **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 00 - Common Work Results for Electrical or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.

### **3.2 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.3 PROTECTION**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 CSA International
  - .1 CAN/CSA C22.2 No. 42-10 (R2015), General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2 CAN/CSA C22.2 No. 42.1-13, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  - .3 CSA C22.2 No. 55-15, Special Use Switches.
  - .4 CSA C22.2 No. 111-10 (R2015), General-Use Snap Switches (Bi-national standard, with UL 20).

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 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 wiring devices from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 SWITCHES**

- .1 15 A, 120 V, single pole, switches to: CSA C22.2 No.55.
- .2 Manually-operated general purpose AC switches with following features:

- .1 Terminal holes approved for No. 10 AWG wire.
  - .2 Silver alloy contacts.
  - .3 Urea or melamine moulding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 Ivory toggle.
- .3 Switches of one manufacturer throughout project.

## **2.2 RECEPTACLES**

- .1 Duplex receptacles, CSA type 5-20 R, 125 V, 15/20 A, U ground, to: CSA C22.2 No.42 with following features:
- .1 Ivory urea moulded housing, tamper proof.
  - .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 rivetted grounding contacts.
- .2 Other receptacles with ampacity and voltage as indicated.
- .3 Receptacles of one manufacturer throughout project.

## **2.3 COVER PLATES**

- .1 Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Plastic ivory cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.
- .4 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

## **2.4 SOURCE QUALITY CONTROL**

- .1 Cover plates from one manufacturer throughout project.

## **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 00 - Common Work Results for 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 00 - Common Work Results for Electrical.
  - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
  - .4 Install GFI type receptacles as indicated.
- .3 Cover plates:
  - .1 Install suitable common cover plates where wiring devices are grouped.
  - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

### **3.2 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

### **3.3 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .3 Repair damage to adjacent materials caused by wiring device installation.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No. 5-16, Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures (Tri-national standard with UL 489 and NMX-J-266-ANCE-2016).

**Part 2 Products**

**2.1 BREAKERS GENERAL**

- .1 Moulded-case circuit breakers, Circuit breakers, ground-fault circuit-interrupters: to CSA C22.2 No. 5.
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .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 with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum 10 KA symmetrical rms interrupting capacity rating.
- .7 Breakers to match existing.

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative 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 Departmental Representative.

**3.2 INSTALLATION**

- .1 Install circuit breakers as indicated.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CAN/CSA 22.2 No. 4-16, Enclosed and dead-front switches (Tri-national standard, with NMX-J-162-ANCE-2016 and UL 98).
  - .2 CSA C22.2 No. 39-13, Fuseholder Assemblies.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.

**1.3 HEALTH AND SAFETY**

- .1 Do construction occupational health and safety in accordance with Section 01 35 29 – Health and Safety Requirements.

**Part 2 Products**

**2.1 DISCONNECT SWITCHES**

- .1 Non-fusible, 30A disconnect switch in CSA Enclosure NEMA 3R for outdoor installations to CAN/CSA C22.2 No.4.
- .2 Provision for padlocking in on-off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Quick-make, quick-break action.
- .5 ON-OFF switch position indication on switch enclosure cover.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install disconnect switches at locations where indicated.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 International Electrotechnical Commission (IEC)
  - .1 IEC 60947-4-1-2012, Part 4: Electromechanical contactors and motor-starters.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .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 33 00 - Submittal Procedures.
    - .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 types.
      - .5 Wiring diagram.
      - .6 Interconnection diagrams.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Starters: to IEC 947-4 with AC4 utilization category.

## **2.2 MANUAL MOTOR STARTERS**

- .1 Single phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
  - .1 Switching mechanism, quick make and break.
  - .2 One overload heater, manual reset, trip indicating handle.
- .2 Accessories:
  - .1 Toggle switch: heavy duty labelled as indicated.
  - .2 Locking tab to permit padlocking in "ON" or "OFF" position.

## **2.3 FINISHES**

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

## **2.4 EQUIPMENT IDENTIFICATION**

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

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire starters and controls as indicated.
- .3 Ensure correct fuses installed.
- .4 Confirm motor nameplate and adjust overload device to suit.

### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - 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.

### **3.3 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.46-13, Electric Air-Heaters.
- .2 Underwriters' Laboratories (UL)
  - .1 UL 1042-2009, Standard for Electric Baseboard Heating Equipment.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for convectors and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence and cleaning procedures.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 – Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for convectors for incorporation into manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 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 convectors from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 BASEBOARD CONVECTORS**

- .1 Heaters: to CSA C22.2 No.46 density as indicated on drawings with connection box both ends.

- .1 Element through-type fitted with aluminum convector vanes and resistor wire enclosed in mineral insulation in sheath. Wattages as indicated on drawings.
- .2 Element: locked to cabinet and supported at additional points throughout length to allow for linear expansion.
- .3 Cabinet: to CSA C22.2 No.46, pre-drilled back for securing to wall. Integral air diffusion reflector with wireway at bottom.
  - .1 Sloped top.
  - .2 Panel: steel, metal thickness, bottom 18 gauge, front 16 gauge.
  - .3 Finish: phosphatized and finished with epoxy-polyester powder coated finish colour to be determined by Architect.
- .4 Blank cabinet sections and corners complete with wireway in sections including splice plates, to match heater cabinets in respects for continuous baseboard effect as indicated.

## **2.2 FAN FORCED HEATERS**

- .1 Heaters: to CSA C22.2 No.46 with connection box both ends.
  - .1 Wattages as indicated on drawings.
- .2 Thermal protection with automatic reset.
- .3 Cabinet: to CSA C22.2 No.46, pre-drilled back for securing to wall.
  - .1 Sloped top.
  - .2 Panel: steel, metal thickness, 20 gauge steel cabinet, 18 gauge steel grille.
  - .3 Finish: phosphatized and finished with epoxy-polyester powder coated finish colour to be determined by Architect.
- .4 75 CFM fan at 1250W, helicoidal fan for larger wattages.

## **2.3 UNIT HEATERS**

- .1 Unit heater: to CSA C22.2 No. 46, horizontal discharge complete with adjustable louves finished to match cabinet.
- .2 Fan type unit heaters with built-in high-heat limit protection.
- .3 Fan motor: totally enclosed, permanently lubricated ball bearing.
  - .1 Built-in fan motor thermal overload protection.
- .4 Hangers: as indicated.
- .5 Elements: Nichrome.
- .6 Cabinet: steel 18 gauge fitted with bracket for rod or wall mounting.
  - .1 Epoxy-polyester powder coat in almond colour.

## **2.4 CONTROLS**

- .1 Wall mounted thermostats: by mechanical controls contractor.
- .2 Relays as indicated on drawings.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install baseboard convector or fan forced heaters and blank sections.
- .2 Suspend unit heaters from ceiling or mount on wall as indicated.
- .3 When wireway is used, remove knock-outs and insert insulating bushing between units.
- .4 Install grounding wire to maintain ground integrity between heating, blank, and auxiliary sections.
- .5 Make power connections.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 – Common Work Results for Electrical.
- .2 Ensure heaters and controls operate correctly.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 – Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.4 PROTECTION**

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

**END OF SECTION**

**Part 1 General**

**1.2 SECTION INCLUDES**

- .1 Materials and installation for diesel generating unit.

**1.3 RELATED SECTIONS**

- .1 Section 26 05 00 – Common Work Results – Electrical
- .2 Section 26 32 23 – Automatic Transfer Switch

**1.4 REFERENCES**

- .1 Canadian Standards Association
  - .1 CSA C22.2
- .2 International Organization for Standardization (ISO)
  - .1 ISO 3046-1-2002, Reciprocating internal combustion engines – Performance - Part I: Declarations of power, fuel and lubricating oil consumptions, and test methods - Additional requirements for engines for general use.
  - .2 ISO 3046-4:2009, Reciprocating internal combustion engines – Performance - Part 4: Speed governing.
- .3 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA MG 1-22, & 33 Motors and Generators.
- .4 The Society of Automotive Engineers (SAE)

**1.5 DESCRIPTION**

- .1 Provide an automatic, unattended, emergency power supply system consisting of:
  - .1 Radiator cooled low voltage diesel electric generating unit with control panel.
  - .2 Accessories and equipment specified in this specification.

**1.6 LONG TERM SERVICEABILITY**

- .1 The equipment packager must be the same manufacturer of the engine to insure long term product support and longevity of the complete package.
- .2 The equipment supplier must have a parts and service depot within 50 km of the project site.
  - .1 The facility must be a reliable and longstanding business with at least 20 years experience in the industry.
  - .2 It must maintain a parts warehouse and service personnel.
- .3 The equipment supplier must have its own in house oil analysis lab. This lab must be capable of analysing the engine fluids to determine if abnormal wear patterns occur. A report of findings must be produced and available for the owner.

**1.7 DESIGN REQUIREMENTS**

- .1 Design equipment suitable to meet the following requirements:

□

- .1 Total load: 200 kw.
  - .2 Voltage: 600/347 V, 3PH, 4 wire.
  - .3 Frequency: 60 Hz.
  - .4 3 PH, 4W.
  - .5 Power factor: 0.8 lag.
  - .6 Maximum rotational speed: 1800 rpm.
  - .7 Duty Rating: Standby power in accordance with ISO8528 and based on # 2 diesel fuel with 35° API gravity.
  - .8 Ambient temperature: 40 °C.
- .2 Design unit capable of starting, attaining settled voltage and frequency limits and accepting full rated load within 10 seconds.

### **1.8 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .1 Dimensions for the complete package generating set in metric and imperial units.
  - .2 Engine: make, model and rating.
  - .3 Generator: make, model and rating, motor starting curve, decrement curve, reactances and time constants.
  - .4 Voltage Regulator: make, model, type.
  - .5 Engine Electronic Control Module specifications.
  - .6 Battery: make, type, voltage, capacity.
  - .7 Charger: make, model, input and output rating.
  - .8 Generator package control panel specifications.
  - .9 Schematic and wiring diagrams of engine, generator and control panel.

### **1.9 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance manual in electronic or paper format. Include maintenance schedules.
- .2 Provide following in English for incorporation into instruction manuals:
- .1 Site test data for generator set including:
    - .1 4 hour load test form as completed.
    - .2 Block loading data in graph format showing kw load, amps, volts and Hz.
    - .3 Letter indicating acceptance or deficiencies.
- .3 Forward an electronic version of data to contractor after completion of commissioning.

### **1.10 WARRANTY**

- .1 Provide 24 month warranty to cover the complete package generator set.
- .2 Provide also Platinum level Extended Service Coverage for a total of 60 months with no deductible.

**1.11 MAINTENANCE - EXTRA MATERIALS**

- .1 Provide generator unit with standard set of engine manufacturer's spare parts for the first service interval. Spares to include:
  - .1 Two fuel filter elements.
  - .2 Two fuel water separator elements.
  - .3 Two lubricating oil filter elements.
  - .4 Two sets of fuses.
  - .5 One spare oil sample extraction container complete with pre-paid mailer, pre-addressed to the supplier's oil analysis lab.

**Part 2 Products**

**2.2 ASSEMBLY**

- .1 Provide following items plus such other items as necessary to make unit complete.
  - .1 Diesel Engine.
  - .2 Diesel Engine Accessories.
  - .3 Double walled fuel tank base.
  - .4 Outdoor sound attenuated enclosure.
  - .5 Vibration isolators.
  - .6 Electronic engine control.
  - .7 Engine Exhaust Silencer and Flex Connector.
  - .8 Engine Cooling System.
  - .9 Batteries and Rack.
  - .10 Battery Charger.
  - .11 Generator and Exciter.
  - .12 Voltage Regulator and Accessories.

**2.3 MOUNTING**

- .1 Complete engine generator package shall be mounted on a common tank base.

**2.4 DIESEL ENGINE**

- .1 The heavy duty diesel engine shall be a product of the same manufacturer as the complete generator set package. The manufacturer shall have a record of at least 10 years in the electric power business. The engine shall have at a minimum:
  - .1 Certified to EPA Emergency Standby emission level. (Previous Tier 2 and Tier 3 levels)
  - .2 6 cylinder liquid cooled.
  - .3 After cooler and cooling radiator skid mounted with blower fan.
  - .4 Control panel mounted on the common skid.
- .2 Engine with auxiliary starting aids (e.g., glow plug assist start) are not acceptable.
- .3 Equip engine air intake with dry type heavy duty air cleaners located close to inlet manifold.

- .1 Cleaner element: directly replaceable with elements that are readily available from the manufacturer's distributor.
- .4 Provide engine wiring for AC and DC services.
  - .1 Use stranded, minimum No.16 AWG with ink marked numbered circuits.
  - .2 Terminate wiring with coded terminals.
- .5 Provide personnel safety guards for exposed moving parts and exhaust manifolds.
- .6 The generator set manufacturer will use an engine of its own manufacture that is commonly used in other machines and applications to insure long term parts availability and serviceability. Engines from a third party will not be allowed.

## **2.5 OUTDOOR SOUND ATTENUATED ENCLOSURE**

- .1 The complete diesel engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, sound attenuated enclosure mounted on the fuel tank base.
- .2 A weather resistant, sound attenuated enclosure of steel with electrostatically applied powder coated baked polyester paint. The enclosure shall have a resulting sound level of 75 dba at a distance of 7 meters with the genset running under full load. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.
- .3 Enclosure Sound Attenuation: Acoustical foam shall be provided between all supports and inside doors and sound baffles on air intake and air discharge.
- .4 Enclosure doors shall open to allow for convenient access to all serviceable components and controls.
- .5 Cooling air intakes shall be on the sides with air outlet in the roof.
- .6 The exhaust system shall be completely contained within the enclosure.
- .7 The enclosure color shall be white.

## **2.6 LUBRICATION SYSTEM**

- .1 Provide full pressure lubricating system complete with engine oil sump, oil filters, oil cooler and oil level gauge.
  - .1 Filter elements to be directly replaceable with elements that are provided by the local engine distributor.
- .2 Equip engine oil sump with an oil drain plumbed outside the package to permit complete oil drainage in convenient manner.
  - .1 Provide an oil drain shut off valve at the oil sump to prevent accidental oil draining.

## **2.7 FUEL SYSTEM**

- .1 Provide complete fuel system including fuel lift pump and filters.
- .2 Diesel Fuel System:
  - .1 The fuel system shall be integral with the engine. It shall consist of fuel water separator, high efficiency fuel filter, transfer pump and common rail style fuel injection pumps.

- .2 The transfer pump shall deliver fuel under low pressure to injection pump. The pumps shall be of a variable displacement type to alter the volume of fuel delivered to the spray nozzles according to load demand. The nozzles shall inject fuel directly into the cylinder in the optimum spray pattern for efficient combustion.
- .3 Fuel/Water Separator:
  - .1 The fuel system shall include a primary fuel water separator filter between the fuel tank and transfer pump to screen large contaminants and water.
- .4 Primary Fuel Filter:
  - .1 A high efficiency, 2 micron fuel filter shall protect the fuel system from contaminates.
- .5 Fuel Priming Pump:
  - .1 A manual fuel-priming pump shall facilitate priming and bleeding air from the system.
- .6 Fuel System Maintenance:
  - .1 Filter elements to be directly replaceable with elements that are provided by the local engine distributor.

## **2.8 FUEL SUB BASE TANK**

- .1 Provide a fuel tank base of 1495 liter capacity for 27 hours operation at full load, mounted under the generator set skid.
  - .1 It shall be double wall constructed to ULC-S601
  - .2 It shall be contained in a rupture basin with 110% capacity.
  - .3 The filler shall have a spill containment basin.
  - .4 Include a mechanical reading fuel level gauge, vent and 1 spare connection. The vent shall extend to 3.66 meters above grade.
  - .5 Provide low fuel level alarm with the genset control system to cause an alarm if the tank level falls below 25%.
  - .6 Provide fuel leak alarm contact, connected to the genset control system to cause an alarm should the inner tank leak.

## **2.9 EXHAUST SYSTEM**

- .1 The engine exhaust system shall be installed to discharge combustion gases quickly and silently with minimum restriction. System including silencer shall be designed for minimum restriction, and in no case shall backpressure exceed 6.7 kPa (27 in H2O).
- .2 The exhaust system shall be completely contained within the genset enclosure.

## **2.10 SPEED GOVERNOR**

- .1 The engine shall be fully electronically control by an electronic engine control module.
  - .1 Governing system: in accordance with ISO 3046-4.
- .2 Governor with following features:

- .1 Speed adjustable from 59.8 Hz to 60.2 Hz using the genset mounted control panel.
- .2 Speed regulation, steady state, no-load to full load and vice versa: +/-0.2 Hz.
- .3 Transient peak, no-load to full-load and vice versa: +/-20%.
- .4 Recovery time to steady state condition on application of 80% from no load not to exceed 3 seconds.

## **2.11 STARTING SYSTEM**

- .1 Provide complete starting system including cranking starting motor, batteries, heavy-duty battery cables and battery charger.
- .2 Provide positive engaging type cranking motor.
- .3 Provide 1 - 12 volt, 950 CCA lead acid batteries. Batteries shall be able to crank through 9 consecutive crank cycles.
- .4 Provide battery rack on the genset package to support batteries.
- .5 Provide battery charger with 120 volt AC input and 12 VDC output.
  - .1 Output shall be 10 amps minimum.
  - .2 Output voltage ripple: shall be 3% or less.
  - .3 Battery charger shall have an ammeter.
  - .4 Charger: CSA approved.

## **2.12 GENERATOR**

- .1 Provide generator, drip proof to IP23, single bearing and close coupled to engine with flex plate coupling.
  - .1 Generator: full amortisseur winding, direct connected brushless exciter with easily removable bolt-on diodes with surge protection.
- .2 Maximum deviation of open circuit terminal voltage waveform not to exceed 0.25%.
- .3 Provide excitation system capable of sustaining short circuit output not less than 2.4 times rated current for 10 seconds.
- .4 Generator winding insulation: Class H; winding temperature rise not to exceed 105°C as measured by resistance in ambient temperature of 40°C.
- .5 Provide digital voltage regulation system integrated into genset control system.
  - .1 The digital voltage regulator shall be microprocessor based with fully programmable operating and protection characteristics. The regulator shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. The voltage regulator shall include a VAR/Pf control feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic in order to optimize voltage and frequency response for site conditions. The voltage regulator shall include standard the capability to provide generator paralleling with reactive droop compensation and reactive differential compensation.
  - .2 The voltage regulation system shall be integrated into the Generator Control Panel with generator voltage adjustments made via the controller keypad.

Additionally, the controller shall allow system parameter setup and monitoring, and provide fault alarm and shutdown information through the controller. A PC-based user interface shall be available to allow viewing and modifying operating parameters in a windows compatible environment.

- .6 Provide main generator output circuit breaker.
  - .1 The circuit breaker shall be isolated from generator set vibration and connected to the generator output.
  - .2 It shall be 3 pole with and have a solid neutral connection point in the enclosure.
  - .3 It shall have an interrupting capacity above that of the generator output capacity.
  - .4 The rating shall be 250 amps.
  - .5 The breaker shall have an adjustable LS/I trip unit.
  - .6 The circuit breaker shall have a load side single lug arrangement accepting cable up to 350MCM

## 2.13 CONTROL PANEL

- .1 Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls via SAE J1939.
- .2 The following functionality shall be integral to the control panel.
  - .1 The control shall include a minimum 33 x 132 pixel, 24mm x 95mm, positive image, transfective LCD display with text based alarm/event descriptions.
  - .2 Audible horn for alarm and shutdown with horn silence switch
  - .3 Remote start/stop control
  - .4 Control function for Run/Off/Auto control integral to system microprocessor
  - .5 Cooldown timer
  - .6 Speed adjust
  - .7 Lamp test
  - .8 Emergency stop push button
  - .9 Voltage adjust
  - .10 Voltage regulator V/Hz slope – adjustable
  - .11 Password protected system programming
- .3 The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units
  - .1 Engine oil pressure
  - .2 Engine coolant temperature
  - .3 Engine RPM
  - .4 Battery volts
  - .5 Engine hours
  - .6 Engine crank attempt counter
  - .7 Engine successful start counter
  - .8 Service maintenance interval

- .9 Real time clock
- .10 Generator AC volts (Line to Line, Line to Neutral and Average)
- .11 Generator AC current (Avg and Per Phase)
- .12 Generator AC Frequency
- .13 Generator kW (Total and Per Phase)
- .14 Generator kVA (Total and Per Phase)
- .15 Generator kVAR (Total and Per Phase)
- .16 Power Factor (Avg and Per Phase)
- .17 Total kW-hr
- .18 Total kVAR-hr
- .19 % kW
- .20 % kVA
- .21 % kVAR
- .22 Excitation voltage
- .23 Excitation current

## **2.14 ENGINE - GENERATOR CONTROLLER**

- .1 The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence:
  - .1 Low oil pressure alarm/shutdown
  - .2 High coolant temperature alarm/shutdown
  - .3 Loss of coolant shutdown
  - .4 Overspeed shutdown
  - .5 Overcrank shutdown
  - .6 Emergency stop shutdown
  - .7 Low coolant temperature alarm
  - .8 Low battery voltage alarm
  - .9 High battery voltage alarm
  - .10 Control switch not in auto position alarm
  - .11 Generator over voltage
  - .12 Generator under voltage
  - .13 Generator over frequency
  - .14 Generator under frequency
  - .15 Generator overcurrent
  - .16 Loss of excitation alarm/shutdown
  - .17 Instantaneous over excitation alarm/shutdown
  - .18 Time over excitation alarm/shutdown
  - .19 Rotating diode failure
  - .20 Loss of sensing

## **2.15 INPUTS AND OUTPUTS**

- .1 Programmable Digital Inputs
  - .1 The Controller shall include the ability to accept programmable digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.
- .2 Programmable Relay Outputs
  - .1 The control shall include the ability to operate programmable relay output signals, integral to the controller. The output relays shall be rated for 2A @ 30VDC and consist of 2 Form A (Normally Open) contacts.
- .3 Programmable Discrete Outputs
  - .1 The control shall include the ability to operate two (2) discrete outputs, integral to the controller, which are capable of sinking up to 300mA.

## **2.16 MAINTENANCE**

- .1 All engine, voltage regulator, control panel and accessory units shall be accessible through a single electronic service tool. The following maintenance functionality shall be integral to the generator set control
  - .1 Engine running hours display
  - .2 Service maintenance interval (running hours or calendar days)
  - .3 Engine crank attempt counter
  - .4 Engine successful starts counter
  - .5 40 events are stored in control panel memory

## **2.17 START-UP AND TESTING**

- .1 Coordinate all start-up and testing activities with the Departmental Representative. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following tests without subject the equipment to abnormal conditions.
- .2 Protection and control; demonstrate the following:
  - .1 Overheat protection.
  - .2 Low oil pressure protection.
  - .3 Cranking cut out.
  - .4 Overcrank protection (3 tries).
  - .5 Overspeed protection.
- .3 Site specific testing.
  - .1 With generator set control in Auto, remove normal power and record time from normal power off to emergency power on.
  - .2 Restore normal power and record re-transfer and cool down times.
  - .3 Load test generator set at full load for 4 continuous hours using a resistive loadbank. Record the following parameters at 30 minute intervals:
    - .1 Generator voltage on phases A to B, B to C and C to A.
    - .2 Generator output current on phases A, B and C.
    - .3 Generator frequency.

- .4 Generator output kw.
- .5 Engine speed.
- .6 Engine oil pressure.
- .7 Engine coolant temperature.
- .4 Using the manufacturers service tool in its data recording mode, provide colored graphs showing voltage and frequency transient and steady state limits for full load to no load, 3/4 load to no load, 1/2 load to no load, 1/4 load to no load and vice versa.
- .5 Record battery voltage drop during cranking.
- .4 After the completion of the load testing, remove a sample of oil from the engine and have it analysed at the generator set supplier's lab. Include the oil sample report with the other test reports to form a baseline of engine ware condition.

## **2.18 TRAINING**

- .1 Provide on-site training to instruct the owner's personnel in the proper operation and maintenance of the equipment. Review operation and maintenance manuals, parts manuals, and emergency service procedures.

## **Part 3 Execution**

- .1 Install diesel/generator package on site and hook up power and control wiring as per drawing.
- .2 Supply fuel for testing and commissioning. On completion of verification of operation of the emergency power system the fuel tank shall be filled with diesel fuel.
- .3 Provide to the engineer start-up, commissioning and certification report.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 – Common Work Results – Electrical.
- .2 Section 26 32 13.05 – Diesel Electric Generator.

**1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No. 5-16, Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures (Tri-national standard with UL 489 and NMX-J-266-ANCE-2016).
  - .2 CSA C22.2 No. 178.1-14, Transfer Switch Equipment.
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA ICS 2-1996(R2009), Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for transfer switch and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 – Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for transfer switch for incorporation into manual.
- .3 Detailed instructions to permit effective operation, maintenance and repair.
- .4 Technical data:
  - .1 Schematic diagram of components, controls and relays.
  - .2 Illustrated parts lists with parts catalogue numbers.
  - .3 Certified copy of factory test results.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect transfer switches from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 Automatic load transfer equipment to:
  - .1 Monitor voltage on phases of normal power supply.
  - .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
  - .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.
  - .4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.
  - .5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

### **2.2 MATERIALS**

- .1 Instrument transformers: to CAN/CSA C60044-1.
- .2 Contactors: to NEMA ICS2.

### **2.3 CONTACTOR TYPE TRANSFER EQUIPMENT**

- .1 Contact Type Transfer Equipment: to CSA C22.2 No.178.1.
- .2 Two 3 pole contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked, open type.
- .3 Rated: 600 V, 60Hz, 400 A. 4 wire, solid neutral.
- .4 Main contacts: silver surfaced, protected by arc disruption means.
- .5 Switch and relay contacts, coils, spring and control elements accessible for inspection and maintenance from front of panel without removal of switch panel or disconnection of drive linkages and power conductors.
- .6 Auxiliary contact: silver plated, to initiate emergency generator start-up on failure of normal power.

- .7 Fault withstand rating: 35 kA symmetrical for 3 cycles.
- .8 Lever to operate switch manually when switch is isolated.
- .9 Neutral bar, solid rated: 400 A.

## 2.4 CONTROLS

- .1 Digital controller interface.
- .2 Control transformers: dry type with 120 V secondary to isolate control circuits from:
  - .1 Normal power supply.
  - .2 Emergency power supply.
- .3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:
  - .1 Voltage sensing: 3 phase for normal power and on one phase only for emergency, solid state type, adjustable drop out and pick up, close differential, 2 V minimum undervoltage and over voltage protection.
  - .2 Time delay: normal power to standby, adjustable solid state, 0 s to 60 minutes.
  - .3 Time delay on engine starting to override momentary power outages or dips, adjustable solid state, 0 to 60 s delay.
  - .4 Time delay on retransfer from standby to normal power, adjustable 0 s to 10 hours.
  - .5 Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable solid state, 0 s to 60 minutes.
  - .6 Frequency sensing, to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.
- .4 Solid state electronic in-phase monitor.

## 2.5 ACCESSORIES

- .1 Ensure pilot lights indicate power availability normal and standby, switch position, green for normal, red for standby, mounted remote.
- .2 Plant exerciser: 168 hours timer to start standby unit once each week for selected interval but does not transfer load from normal supply. Timer adjustable 0-168 hours in 15 minute intervals.
- .3 Auxiliary relay to provide 2 N.O. and 2 N.C. contacts for remote alarms.
- .4 Instruments:
  - .1 Digital true RMS, indicating type 2 % accuracy, flush panel mounting:
    - .1 Voltmeter: ac, scale 0 to 1000 V.
    - .2 Ammeter: ac, scale 0 to 1000 A.
    - .3 Frequency meter: scale 55 to 65 Hz.
- .5 Voltmeter selector for each phase.
- .6 Potential transformers as required.

- .7 Ammeter selector for each phase.
- .8 Current transformers as required.

## **2.6 EQUIPMENT IDENTIFICATION**

- .1 Identify equipment in accordance with Section 26 05 00 – Common Work Results for Electrical.

## **2.7 SOURCE QUALITY CONTROL**

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Departmental Representative.
- .2 Notify Departmental Representative 5 days minimum in advance of date of factory test.
- .3 Tests:
  - .1 Operate equipment both mechanically and electrically to ensure proper performance.
  - .2 Check selector switch, in modes of operation Test, Auto, Manual, Engine Start and record results.
  - .3 Check voltage sensing and time delay relay settings.
  - .4 Check:
    - .1 Automatic starting and transfer of load on failure of normal power.
    - .2 Retransfer of load when normal power supply resumed.
    - .3 Automatic shutdown.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for transfer switches installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative 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 Departmental Representative.

### **3.2 INSTALLATION**

- .1 Locate, install and connect transfer equipment as indicated.
- .2 Check relays solid state monitors and adjust as required to ensure correct operation.
- .3 Install and connect battery remote alarms.

### **3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 – Common Work Results for Electrical.
- .2 Energize transfer equipment from normal power supply.
- .3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
- .4 Set selector switch in "Manual" position and check to ensure proper performance.
- .5 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.
- .6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .7 Repeat, at 1 hour intervals, 3 times, complete test with selector switch in each position, for each test.

### **3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 – Cleaning.
- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 –Submittal Procedures.

**1.2 SUBMITTALS**

- .1 Submit product data in accordance with Section 01 33 00 – Submittals Procedures.

**1.3 ACCEPTABLE PRODUCTS**

- .1 Luminaires described in the Lighting Fixture Schedule identify quality, performance criteria and other parameters, as indicated for this project.

**Part 2 Products**

**2.1 LAMPS**

- .1 LED as indicated.

**2.2 FINISHES**

- .1 Baked enamel finish:
- .1 Conditioning of metal before painting:
    - .1 For corrosion resistance conversion coating to ASTM F1137.
    - .2 For paint base, conversion coating to ASTM F1137.
  - .2 Metal surfaces of luminaire housing and reflectors finished with high gloss baked enamel polyester powdercoat alzak aluminum to give smooth, uniform appearance, free from pinholes or defects.
  - .3 Reflector and other inside surfaces finished as follows:
    - .1 White, minimum reflection factor 85%.
    - .2 Colour fastness: yellowness factor not above 0.02 and after 250 hours exposure in Atlas fade-ometer not to exceed 0.05.
    - .3 Film thickness, not less than 0.03 mm average and in no areas less than 0.025 mm.
    - .4 Gloss not less than 80 units as measured with Gardner 60° gloss meter.
    - .5 Flexibility: withstand bending over 12 mm mandrel without showing signs of cracking or flaking under 10 times magnification.
    - .6 Adhesion: 24 mm square lattice made of 3 mm squares cut through film to metal with sharp razor blade. Adhesive cellulose tape applied over lattice and pulled. Adhesion satisfactory if no coating removed.
- .2 Alzak finish:
- .1 Aluminium sheet fabricated from special aluminum alloys and chemically brightened, subsequently anodically treated to specifications established by Alcoa, to produce:

- .1 Finish for mild commercial service, minimum density of coating 7.8 g/m<sup>2</sup>, minimum reflectivity 83% for specular, 80.5% for semi-specular and 75% for diffuse.
- .2 Finish for regular industrial service, minimum density of coating 14.8 g/m<sup>2</sup>, minimum reflectivity 82% for specular and 73% for diffuse.
- .3 Finish for heavy duty service, minimum density of coating 21.8 g/m<sup>2</sup>, minimum reflectivity 85% for specular, 65% for diffuse.

### **2.3 LUMINAIRES**

- .1 Refer to the Lighting Fixture Schedule on the drawings and the floor plans for detailed requirements of luminaires to be supplied and installed under this contract. The referenced manufacturer is given as a standard of acceptance only. Other manufacturers may be accepted provided they comply with the standard of noted fixture.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated. Install lamps in all fixtures.

### **3.2 WIRING**

- .1 Connect luminaires to lighting circuits using methods as detailed or described.

### **3.3 LUMINAIRE SUPPORTS**

- .1 For suspended ceiling installations support luminaires independently of ceiling support luminaires from ceiling grid in accordance with local inspection requirements.
- .2 Support luminaires mounted in continuous row once every 2.4m.
- .3 Provide aircraft cable safety cord to structure for features suspended in hangar.

### **3.4 LUMINAIRE ALIGNMENT**

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 74 11 – Cleaning.
- .3 Section 26 05 00 – Common Work Results – Electrical.

**1.2 REFERENCES**

- .1 Codes and standards referenced in this section refer to the latest edition thereof.
- .2 Atomic Energy Control Board Regulations.
- .3 Canadian Code for Preferred Packaging.
- .4 National Building Code of Canada, 2010 Edition.
- .5 Canadian Standards Association (CSA)
  - .1 CSA C22.2 No. 141-15, Emergency Lighting Equipment.
  - .2 CSA C860-11 (R2016), Performance of Internally Lighted Exit Signs.
- .6 National Fire Protection Association (NFPA)
  - .1 NFPA 101, Life Safety Code, 2014 Edition.

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, cleaning procedures and disposal.

**Part 2 Products**

**2.1 STANDARD UNITS**

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Electrical Code for Preferred Packaging guidelines.
- .2 Housing: steel, white finish.
- .3 Face and back plates: steel, white finish.
- .4 Lamps: multiple LED, over 500,000 hours with average surface brightness of 2000 candela.
- .5 Operation: designed for 25 years of continuous operation without relamping.
- .6 Signage: Green ISO pictogram on white background. Arrow as indicated.

- .7 Opening voltage: Universal (120 and 347 Vac).
- .8 Self-powered design with integral rechargeable battery for operation for 90 minutes minimum.

## **2.2 FEATURES**

- .1 Flat on wall, end to wall, ceiling mounting as indicated.
- .2 Single or double face as indicated.
- .3 Arrow: right or left as indicated.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits using RW90 wire in EMT conduit.
- .3 Ensure that exit light circuit breaker is locked in on position.
- .4 Provide tests in accordance with Section 26 05 00 – Common Work Results – Electrical.

### **3.2 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**