

Part 1 General

1.1 RELATED SECTIONS

- .1 General Requirements:
- .2 Concrete:
- .3 Mechanical:

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-2006, Canadian Electrical Code, Part 1 (20th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.3 No.7, Underground Systems.
 - .3 CAN/CSA-C22.3 No. 1-01(Update March 2005), Overhead Systems.
 - .4 CAN3-C235-83(R2000), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
 - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.3 DEFINITIONS

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

1.4 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.5 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba, Canada.

- .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .3 Identify 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 If changes are required, notify Contract Administrator of these changes before they are made.
- .3 Quality Control:
- .1 Provide CSA certified equipment and material. Where CSA certified equipment and material is not available, submit such equipment and material inspection authorities for special acceptance approval before delivery to site.
 - .2 Submit test results of installed electrical systems and instrumentation.
 - .3 Permits and fees: in accordance with General Conditions of contract.
 - .4 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
 - .5 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Contract Administrator.
- .4 Manufacturer's Field Reports: submit to Contract Administrator manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

1.6 PERMITS, FEES AND INSPECTION

- .1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2 Pay associated fees.
- .3 Contract Administrator will provide drawings and specifications required by Electrical Inspection Department and Supply Authority at no cost.
- .4 Notify Contract Administrator of changes required by Electrical Inspection Department prior to making changes.
- .5 Furnish Certificates of Acceptance from authorities having jurisdiction on completion of work to Contract Administrator.

1.7 SYSTEM STARTUP

- .1 Instruct Contract Administrator and operating personnel 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 Arrange and pay for services of an instrumentation technician to check, adjust, balance and calibrate components and instruct operating personnel.
- .4 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.

1.8 OPERATING INSTRUCTIONS

- .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.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .2 Material and equipment shall be new and free from all defects.
- .3 Factory assemble control panels and component assemblies.

2.2 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction, inspection authorities, and Contract Administrator.

- .2 Lamacoid, red with white lettering, minimum size 175 x 250 mm

2.3 WIRING TERMINATIONS

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

2.4 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates as follows:
 - .1 Nameplates: lamacoid 3 mm thick plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
 - .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 Contract Administrator 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.

2.5 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, either numbered or 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.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.6 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
Telephone/LAN	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	

2.7 FINISHES

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

Part 3 Execution

3.1 INSTALLATION

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

3.2 GROUNDING

- .1 All circuits shall be installed with dedicated green insulated ground wire.

3.3 Dedicated Neutrals

- .1 Each circuit shall have its own dedicated neutral wire. Shared neutral for more than 1 circuit shall not be permitted.

3.4 NAMEPLATES AND LABELS

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

3.5 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.

- .1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.6 LOCATION OF OUTLETS

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

3.7 MOUNTING HEIGHTS

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

3.8 CO-ORDINATION OF PROTECTIVE DEVICES

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

3.9 FIELD QUALITY CONTROL

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

3.10 CLEANING

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2No.65-93(R1999), Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 or NEMA to consist of:
 - .1 Connector body and stud clamp for stranded copper conductors.
 - .2 Clamp for stranded copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper bar.
- .4 Clamps or connectors for armoured cable, flexible conduit as required to: CAN/CSA-C22.2No.18.

Part 3 Execution

3.1 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.

- .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.
- .3 Install fixture type connectors and tighten. Replace insulating cap.
- .4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

1.2 REFERENCES

- .1 CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 131-M89(R1994), Type TECK 90 Cable.

1.3 PRODUCT DATA

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

Part 2 Products

2.1 BUILDING WIRES

- .1 Conductors: stranded for 12 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 1000 V insulation for 600 volt system, and 600 V insulations for 208 volt system of chemically cross-linked thermosetting polyethylene material rated RW90

2.2 TECK CABLE

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Hazardous location rated.
- .3 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
- .4 Insulation:
 - .1 Type: ethylene propylene rubber.
 - .2 Chemically cross-linked thermosetting polyethylene rated type RW90, 1000 V for 600 volt system, and 600 V for 208 volt (or lower) system.
- .5 Inner jacket: polyvinyl chloride material.
- .6 Armour: interlocking aluminum.
- .7 Overall covering: thermoplastic polyvinyl chloride material.
- .8 Fastenings:

- .1 One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole aluminum straps for cables larger than 50 mm.
- .2 Channel type supports for two or more cables at 1000 mm centers.
- .3 Threaded rods: 9 mm dia. to support suspended channels.
- .9 Connectors:
 - .1 Watertight, approved for TECK cable.
 - .2 Explosion-proof approved for TECK cable, in Wet Well.

2.3 VFD TECK CABLE

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Conductors:
 - .1 Grounding conductors: three (3) bare copper.
 - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
 - .1 Type: ethylene propylene rubber.
 - .2 Chemically cross-linked thermosetting polyethylene rated 1000 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: continuously corrugated aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride material.
- .7 Fastenings:
 - .1 One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole aluminum straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables at 1000 mm centers.
 - .3 Threaded rods: 9 mm dia. to support suspended channels.
- .8 Connectors:
 - .1 Watertight, approved for TECK cable.
 - .2 Explosion-proof approved for TECK cable, in Wet Well.

2.4 CONTROL CABLES

- .1 Type LVT: soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.
- .2 Low energy 300 V control cable: stranded annealed copper conductors sized as indicated, with PVC insulation type TW with shielding of braid and metallized tapes over each pair and over all conductors and overall covering of PVC jackets and interlocked armour of aluminum strip.
- .3 600 V type: stranded annealed copper conductors, sizes as indicated cross-linked polyethylene type RW90 (x-link) with shielding of braid over each pair of conductors and overall covering of thermoplastic jacket and interlocked armour.

Part 3 Execution

3.1 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 260534.

3.2 INSTALLATION OF TECK CABLE 0 -1000 V

- .1 Install cables.
 - .1 Group cables wherever possible on channels.
- .2 Lay cable in cabletroughs in accordance with Section 260534.
- .3 Use approved connectors
- .4 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0 - 1000 V.

3.3 INSTALLATION OF VFD TECK CABLE 0 -1000 V

- .1 Install cables from output of VFD drives to motor
 - .1 Group cables wherever possible on channels.
- .2 Use approved connectors
- .3 Terminate cables in accordance with manufactures recommendations and Section 26 05 20- Wire and Box Connectors - 0 - 1000 V.

3.4 INSTALLATION OF CONTROL CABLES

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

3.5 INSTALLATION OF NON-METALLIC SHEATHED CABLE

- .1 Install cables.
- .2 Install straps and box connectors to cables as required.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
 - .1 ANSI/IEEE 837-1989(R1996), Qualifying Permanent Connections Used in Substation Grounding.
- .2 Canadian Standards Association, (CSA International)
- .3 CAN/CSA Z32-1999, Electrical Safety and Essential Electrical Systems in Health Care Facilities.

Part 2 Products

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .2 Copper conductor: minimum 6 m long for each concrete encased electrode, bare, stranded, tinned, soft annealed, size as indicated.
- .3 Rod electrodes: copper clad steel 19 mm dia by 3 m long.
- .4 Plate electrodes: galvanized surface area 0.2 m², 1.6 mm thick.
- .5 Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated.
- .6 Insulated grounding conductors: green, type RW90.
- .7 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .8 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Thermit welded type conductor connectors.
 - .5 Bonding jumpers, straps.
 - .6 Pressure wire connectors.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where conduit is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .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.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Install separate ground conductor to outdoor lighting standards.
- .10 Connect building structural steel and metal siding to ground by welding copper to steel.
- .11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .12 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- .13 Ground secondary service pedestals.

3.2 ELECTRODES

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter.
- .2 Install water meter shunt.
- .3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
- .4 Install rod, plate electrodes and make grounding connections.
- .5 Bond separate, multiple electrodes together.
- .6 Use size 2/0 3/0 4/0 AWG copper conductors for connections to electrodes.

- .7 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 Field Quality Control

- .1 Perform tests.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Contract Administrator and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

3.4 SYSTEM AND CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to neutrals of primary 600 V system, secondary 208 V system.

3.5 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting.

3.6 GROUNDING BUS

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical room.
- .2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 2/0AWG.

3.7 COMMUNICATION SYSTEMS

- .1 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:
 - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
 - .2 Sound, fire alarm, intercommunication systems as indicated.

3.8 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 Contract Administrator and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

- .4 Disconnect ground fault indicator during tests.

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 and suspended.
- .2 Material: Aluminum

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to masonry, tile and plaster surfaces with lead anchors.
- .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 aluminum straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole aluminum straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 9 mm dia stainless steel threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 9 mm dia stainless steel 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 stainless steel 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 Contract Administrator.
- .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 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data for cabinets in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 SPLITTERS

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2 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.

2.3 CABINETS

- .1 Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
- .2 Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing sheet steel backboard for surface mounting.

Part 3 Execution

3.1 SPLITTER INSTALLATION

- .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor.
- .3 Install terminal block as indicated in Type T cabinets.

- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

3.3 IDENTIFICATION

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA C22.1-2006, Canadian Electrical Code, Part 1.

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.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 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.

2.4 CONCRETE BOXES

- .1 Electro-glavanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 CONDUIT BOXES

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

2.6 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 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, mineral insulated and armoured cable connections. Reducing washers are not allowed.

END OF SECTION

Part 1 General

1.1 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 C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83-M1985(R2003), Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2-M1984(R2003), Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3-05, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

Part 2 Products

2.1 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, aluminum threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .4 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .5 Flexible metal conduit: to CSA C22.2 No. 56, aluminum liquid-tight flexible metal.

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 m on centre.
- .4 Threaded stainless steel rods, 9 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.
- .3 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

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 Surface mount conduits.
- .4 Use rigid aluminum threaded conduit except where specified otherwise.
- .5 Use epoxy coated conduit underground in corrosive areas.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .7 Use explosion proof flexible connection for connection to explosion proof motors.
- .8 Install conduit sealing fittings in hazardous areas.
 - .1 Fill with compound.
- .9 Minimum conduit size for lighting and power circuits: 19 mm.
- .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 19 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 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .15 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 mounted aluminum channels.
- .5 Do not pass conduits through structural members except as indicated. Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- .6 Install RPVC conduits with lettering towards wall.

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 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed.
 - .1 Use cold mastic between sleeve and conduit.
- .5 Conduits in slabs: minimum slab thickness 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.

3.6 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

- .1 Run conduits 25 mm and larger below slab and encase in 75 mm concrete envelope.
 - .1 Provide 50 mm of sand over concrete envelope below floor slab.

3.7 CONDUITS UNDERGROUND

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

1.2 RELATED SECTIONS

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

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2 No.47-M90(R2001), Air-Cooled Transformers (Dry Type).
 - .2 CSA C9-M1981(R2001), Dry-Type Transformers.
 - .3 CAN/CSA-C802.2-00
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 Nema TP-1

1.4 PRODUCT DATA

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

Part 2 Products

2.1 TRANSFORMERS

- .1 Use transformers of one manufacturer throughout project and in accordance with CAN/CSA-C22.2No.47 and CSA-C9.
- .2 Energy efficiency rating in accordance with CAN/CSA-C802.2-00 and NEMA TP-1.
- .3 Design 1.
 - .1 Type: ANN.
 - .2 kVA and voltage rating as indicated on plans.
 - .3 Voltage taps: standard.
 - .4 Insulation: Class H, 220 degrees C temperature rise.
 - .5 Basic Impulse Level (BIL): standard.
 - .6 Hipot: standard.
 - .7 Average sound level: standard
 - .8 Impedance at 17 degrees C: standard
 - .9 Enclosure: CSA 1, removable metal front panel, drip hood

- .10 Mounting: as indicated on plans
- .11 Finish: in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .12 Acceptable Manufacturer: Square D, Siemens, Cutler-Hammer or approved equivalent.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Label size: 7.
 - .1 KVA
 - .2 Primary voltage
 - .3 Secondary voltage
 - .4 1 phase or 3 phase
 - .5 Circuit number

Part 3 Execution

3.1 INSTALLATION

- .1 Mount dry type transformers up to 75 kVA as indicated.
- .2 Mount dry type transformers above 75 kVA on floor. Provide 100 mm concrete housekeeping pad.
- .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.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 26 05 00 - Common Work Results - Electrical.
- .3 Section 26 28 21 - Moulded Case Circuit Breakers.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2No.29-M1989(R2000), Panelboards and enclosed Panelboards.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

Part 2 Products

2.1 PANELBOARDS

- .1 Panelboards: to CSA C22.2No.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.
- .2 600 V panelboards: bus and breakers rated for 14 kA (symmetrical) interrupting capacity or as indicated.
- .3 120/208 V panelboards: bus and breakers rated for 10 kA (symmetrical) interrupting capacity or as indicated.
- .4 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .5 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .6 Two keys for each panelboard and key panelboards alike.

- .7 Copper bus with neutral of same ampere rating as mains.
- .8 Mains: suitable for bolt-on breakers.
- .9 Trim with concealed front bolts and hinges.
- .10 Trim and door finish: baked grey enamel.

2.2 BREAKERS

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

2.3 EQUIPMENT IDENTIFICATION

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

Part 3 Execution

3.1 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.
- .3 Mount panelboards to height specified in Section 26 05 00 - Common Work Results – Electrical or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.

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.
- .3 Section 26 29 10 – Motor Starters to 600 V.

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data sheets for sills, busbars and compartments. Include product characteristics, physical size and finish.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, cleaning procedures.
- .4 Submit shop drawings and indicate:
 - .1 Outline dimensions.
 - .2 Configuration of identified compartments.
 - .3 Floor anchoring method and dimensioned foundation template.
 - .4 Cable entry and exit locations.
 - .5 Dimensioned position and size of busbars and details of provision for future extension.
 - .6 Schematic and wiring diagrams.
- .5 Closeout Submittals: provide operation and maintenance data for motor control centre for incorporation into manual specified in Section 01 78 00 - Closeout Submittals
 - .1 Include data for each type and style of starter.

1.3 EXTRA MATERIALS

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

Part 2 Products

2.1 SUPPLY CHARACTERISTICS

- .1 600 V, 60Hz, delta connected, 3 phase, 3 wire, grounded neutral.

2.2 GENERAL DESCRIPTION

- .1 Compartmentalized vertical sections with common power busbars.

- .2 Floor mounting, free standing, enclosed dead front.
- .3 Indoor CSA 1 gasketed enclosure, front mounting.
- .4 Class I, Type B-t complete with pull-apart terminals.

2.3 VERTICAL SECTION CONSTRUCTION

- .1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.
- .2 Each vertical section divided into compartment units, minimum 305 mm high, as indicated.
- .3 Each unit to have complete top and bottom steel plate for isolation between units.
- .4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.
- .5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.
- .6 Openings, with removable cover plates, in side of vertical sections for horizontal wiring between sections.
- .7 Incoming cables to enter at top with terminals.
- .8 Provision for outgoing cables to exit via top with terminals.
- .9 Removable lifting means.
- .10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.
- .11 Divide assembly for shipment to site, as indicated complete with hardware and instructions for re-assembly.

2.4 SILLS

- .1 Continuous 25 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 BUSBARS

- .1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment bare self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:
 - .1 Main horizontal busbars: as indicated, minimum 600 A.
 - .2 Branch vertical busbars: 300 A.
- .2 Branch vertical busbars for distribution of power to units in vertical sections.

- .3 No other cables, wires, equipment in main and branch busbar compartments.
- .4 Brace buswork to withstand effects of short-circuit current of 42 kA rms symmetrical.
- .5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.6 GROUND BUS

- .1 Copper ground bus extending entire width of motor control centre.
- .2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab

2.7 MOTOR STARTERS AND DEVICES

- .1 See Section 26 29 10 – Motor Starters to 600 V.

2.8 STARTER UNIT COMPARTMENTS

- .1 Units EEMAC size 5 and smaller, circuit breaker units 225A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.
- .2 Unit mounting:
 - .1 Engaged position - unit stabbed into vertical bus.
 - .2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.
 - .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
 - .4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.
 - .5 Racking lever for unit removal and installation.
- .3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.
- .4 Hinge unit doors on same side.
- .5 Overload relays manually reset from front with door closed.
- .6 Pushbuttons and indicating lights mounted on door front.
- .7 Devices and components by one manufacturer to facilitate maintenance.
- .8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.9 WIRING IDENTIFICATION

- .1 Provide wiring identification in accordance with Section 26 05 00 - Common Work Results - For Electrical.

2.10 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - For Electrical.
 - .1 Motor control centre main nameplate: size No. 7, engraved as indicated.
 - .2 Individual compartment nameplates: size No. 5, engraved as indicated.

2.11 FINISHES

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results - For Electrical.
- .2 Paint motor control centre exterior light gray and interiors white.

2.12 SOURCE QUALITY CONTROL

- .1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.
- .2 Contract Administrator to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.
- .3 Manufacturer to provide proof of quality control program in accordance with CAN/CSA-Q9000.

Part 3 Execution

3.1 INSTALLATION

- .1 Supply and install concrete housekeeping pad for motor control centre.
- .2 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.
- .3 Make field power and control connections as indicated.
- .4 Ensure correct overload heater elements are installed.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - For Electrical.
- .2 Ensure moving and working parts are lubricated where required.
- .3 Operate starters in sequence to prove satisfactory performance of motor control centre during 8 hours period.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 RELATED SECTIONS

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

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No.42-99(R2002), General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CSA-C22.2 No.42.1-00, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - .3 CSA-C22.2 No.55-M1986(July 2001), Special Use Switches.
 - .4 CSA-C22.2 No.111-00, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 SWITCHES

- .1 15 or 20 A, 120 V, single pole, double pole, three-way, four-way switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111.
- .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 brown toggle.
- .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 Switches of one manufacturer throughout project.

2.2 RECEPTACLES

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

2.3 RATED SWITCHES

- .1 20 A, 120 V, single pole, switches rated for Class I Div I, Groups C & D.
- .2 Manually-operated tumbler ac switches.
- .3 Hubbell FXS Series or approved equal in accordance with B6.

2.4 RATED RECEPTACLES

- .1 20 A, 120 V, rated for Class I Div I, Groups C & D.
- .2 NEMA configuration 5-20R.
- .3 Supply five (5) NEMA 5-20P plugs c/w mesh grip.
- .4 Hubbell UGP/UGR Acceptor Series or approved equal in accordance with B6.

2.5 COVER PLATES

- .1 Cover plates for wiring devices to: CSA-C22.2 No.42.1.
- .2 Cover plates from one manufacturer throughout project.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .4 Stainless steel, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .5 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

- .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

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 - Electrical as indicated.
- .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 - Electrical as indicated.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Cover plates:
 - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
- .4 Rated Switches:
 - .1 Install rated switches in all hazardous locations.
 - .2 Use rated connectors and install according to manufactures recommendations.
- .5 Rated Receptacles:
 - .1 Install rated receptacles in all hazardous locations.
 - .2 Use rated connectors and install according to manufactures recommendations.
 - .3 Turn over spare plugs to City.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials for moulded-case circuit breakers.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include time-current characteristic curves for breakers with ampacity of 100 A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers: 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 3-10 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum 10 kA symmetrical rms interrupting capacity rating. Rating to match panel.

2.2 THERMAL MAGNETIC BREAKERS DESIGN A

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

2.3 MAGNETIC BREAKERS DESIGN B

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

2.4 SOLID STATE TRIP BREAKERS DESIGN D

- .1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase and ground fault short circuit protection.

2.5 MANUFACTURERS

- .1 Acceptable manufacturer: Square D, Cutler Hammer, Siemens.

Part 3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for fused and non-fused disconnect switches.

1.2 RELATED SECTIONS

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

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.
 - .2 CSA C22.2 No.39-M89 (R2003), Fuseholder Assemblies.

1.4 SUBMITTALS

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

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Heavy duty non-fusible, horsepower rated disconnect switch in CSA Enclosure 12, to CAN/CSA C22.2 No.4 size as indicated.
- .2 Provision for padlocking in 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.
- .6 Acceptable Manufacturer: Square D, Cutler Hammer, Siemens.

2.2 EQUIPMENT IDENTIFICATION

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

Part 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches as indicated and as required by CSA C22.1.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

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

1.2 REFERENCES

- .1 International Electrotechnical Commission (IEC)
 - .1 IEC 947-4-1-1990, Part 4: Contactors and motor-starters.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include operation and maintenance data for each type and style of starter.

1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contacts, auxiliary.
 - .4 1 control transformers.
 - .5 1 operating coil.
 - .6 2 fuses.
 - .7 10% indicating lamp bulbs used.

Part 2 Products

2.1 MATERIALS

- .1 EEMAC rated motor starters.

2.2 MANUAL MOTOR STARTERS

- .1 Single phase manual motor starters of size, type, rating, and enclosure type EEMAC 12, 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: oil tight labelled as indicated.
- .2 Indicating light: oil tight type and colour as indicated. LED lamp
- .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE MAGNETIC STARTERS

- .1 EEMAC rate magnetic and combination magnetic starters of size (half size not acceptable), type, rating and enclosure type as indicated with components as follows:

- .1 Contactor solenoid operated, rapid action type, 120VAC coil.
- .2 Motor overload protective device in each phase, manually reset from outside enclosure.
- .3 Wiring and schematic diagram inside starter enclosure in visible location.
- .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .5 Enclosures shall be EEMAC 12.

- .2 Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:

- .1 Locking in "OFF" position with up to 3 padlocks.
- .2 Independent locking of enclosure door.
- .3 Provision for preventing switching to "ON" position while enclosure door open.

- .3 Accessories:

- .1 Pushbuttons and selector switches: oil tight, labelled as indicated.
- .2 Indicating lights: oil tight type and color as indicated, LED lamp.
- .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.4 FINISHES

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

2.5 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, black plate, white letters, size 3 engraved as indicated.

Part 3 Execution

3.1 INSTALLATION

- .1 Install starters, connect power and control as indicated.
- .2 Ensure correct fuses and overload devices elements installed.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and manufacturer's instructions.
- .2 Operate switches, contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Mechanical: Division 23

1.2 SCOPE

- .1 Division 23 Contractor shall supply Variable Frequency Drive (VFD) controllers for heating, ventilation, and air conditioning (HVAC) equipment as herein specified.
- .2 Division 26 Contractor shall install, wire and connect HVAC VFD controllers and indicated on the drawings.

1.3 STANDARD MOTOR

- .1 All VFDs supplied under this Contract meet or exceed the following specifications.
- .2 Provide a complete inventory (as specified) of spare cooling fans, and fuses, for each VFD supplied.
- .3 The adjustable frequency controller shall be designed to operate standard squirrel cage induction motor with a 1.15 S.F. or definite purpose motors meeting National Electric Manufacturers Association (NEMA) MG1 Part 31.
- .4 Harmonic loading will not exceed a motor service factor of 1.0.
- .5 Products shall comply with Institute of Electrical and Electrical Engineers (IEEE) Standard 519.
- .6 VFD unit shall be Underwriters Laboratories (UL) listed and Canadian Standards Association (CSA) certified.
- .7 VFD unit shall comply with applicable requirements of the latest standards of CSA, American National Standards Institute (ANSI), IEEE and the Canadian Electrical Code.

1.4 TESTS

- .1 Factory testing
 - .1 VFD units are to be factory tested prior to shipment. Provide confirmation from factory of actual tests completed and results.
 - .2 Provide certified copies of production test results required by CSA and Electrical and Electronic Manufacturer's Association of Canada (EEMAC), prior to acceptance of the equipment.
- .2 Field testing
 - .1 The VFD supplier shall provide on site startup, fine-tuning, commissioning, operator training and instruction.

- .2 The VFD supplier shall provide site functionality test reports indicating loading/current levels during testing as well as control point proving results.
- .3 The VFD supplier shall ensure shaft to ground voltages do not exceed 1.5 volts at any speed or load requirement.
- .4 Allow for all costs and labour for as many trips as necessary to complete requirements.
- .5 It is the intent of this specification to provide a VFD installation that does not adversely affect the electrical system. Included in the Contract Documents is information on the electrical system including:
 - .1 Single line drawing.
 - .2 Additional information on electrical system layout and load profile.
 - .3 The VFD supplier can use this information to evaluate the predicted effect of the VFD installation on the electrical system and advise the Contract Administrator of these effects. For the purposes of analysis, the point of common coupling (PCC) will be taken as the secondary of the main distribution transformers.
- .6 The Contractor, in conjunction with the Contract Administrator, will conduct a harmonic analysis upon completion of fine-tuning and commissioning phase of the installation. The harmonic analysis will be conducted at 50%, 75%, and 100% speed under normal load conditions and perform a Fourier (FFT) transform analysis spectrum for each waveform covering the fundamental to the 31st harmonic. Should the waveform analysis indicate that either the input or output voltage and current levels of the VFD(s) exceed NEMA Standards for electric motors and IEEE 519, the VFD supplier shall provide, at their cost, all the necessary line filtering equipment to correct the harmonic distortion back to the levels prior to the installation of the VFD(s).
- .3 Provide certified copies of all production test results required by CSA and NEMA.

1.5 WARRANTY

- .1 The VFD supplier shall provide a warranty coverage for a period of two (2) years upon the Contractor being granted Total Performance and the warranty period has commenced.
- .2 VFD supplier will review specifications of motors for application compatibility. The Contractor shall obtain and submit written approval from both the motor and VFD suppliers confirming that both pieces of equipment are compatible when used together to maintain the required warranty.
- .3 The Contractor shall indicate the level of local support detailing response time if a piece of equipment should happen to fail or malfunction. Details are to include estimated replacement part delivery times, as well as nearest parts depot location and a contact name and phone number. This must be included with all bid submissions.
- .4 The VFD supplier shall guarantee that parts for drive units will be available for a minimum of ten (10) years from time of delivery.

1.6 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

1.7 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include operation and maintenance data for each type and style of VFD.
- .3 Provide parameter settings for each VFD.

1.8 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contacts, auxiliary.
 - .4 1 control transformers.
 - .5 1 operating coil.
 - .6 2 fuses.
 - .7 10% indicating lamp bulbs used.

Part 2 Products

2.1 VARIABLE FREQUENCY DRIVES

- .1 Variable Frequency Drives as supplied by one of the following acceptable manufacturers:
 - .1 Asea Brown Boveri Ltd. (ABB) - ACS 800 series.
- .2 Variable speed controller shall be electronic adjustable frequency and voltage output unit.
- .3 The VFD shall employ a minimum 6-pulse pulse width modulated (PWM) inverter system utilizing Insulated Gate Bipolar Transistors (IGBT) power switching devices and come complete with line reactors or DC link filters.
- .4 The drive shall be rated for continuous duty while operating a NEMA design induction motor of the sizes and operating voltages as shown in the following schedules and indicated on the drawings. Drive output shall be sized for a 1.0 motor service factor. The VFD shall have a current rating at least 10% in excess of the motor full load amp rating.

Overload service factors of 110% for thirty minutes and 135% for one minute must be provided to ensure adequate safety margins. VFD selection shall be based on load current at constant torque ratings. Do not size VFD's based on variable torque maximums.

- .5 Input voltage shall be as indicated on motor schedules and drawings (line voltage variation $\pm 10\%$) Based on 347/600 volt systems (Not 575V). Line frequency variation $\pm 5\%$. Output voltage shall vary with motor speed to nominal motor voltage. Speed stability shall be $\pm 1\%$. Drive shall match torque characteristic of load.
- .6 Input frequency setting signal will be selective between 4-20 mA or 0-10v DC. Output speed monitoring signal shall be selective between 4-20 mA or 0-10 v DC.
- .7 Enclosure:
 - .1 Drive shall be installed in individual CSA 1 enclosure, drip proof or Nema 12 as indicated on drawings. Filters to be provided for any forced air-cooled enclosures as required by the supplier. VFD(s) shall be suitable for mounting in a typical building electrical room and shall be able to operate under these conditions with no special cleaning requirements. VFD cabinets shall be mounted in such a way that there is adequate room for ventilation and no build up of heat. The minimum clearance in front of VFDs is 1m.
- .8 Protective devices to be incorporated are:
 - .1 Fast acting electronic circuit board protective devices for protection of electronic components.
 - .2 Line reactor, DC link or filter in the drive input to protect electronic components from transient voltage conditions.
 - .3 Integral electronic motor overload protection adjustable up to 150% of motor rating for sixty (60) seconds.
 - .4 Overcurrent instantaneous trip 250%.
 - .5 Programmable short-circuit protection.
 - .6 Programmable ground fault protection.
 - .7 Overvoltage/overcurrent DC bus monitor/protection.
 - .8 Undervoltage protection.
 - .9 Loss of phase and phase unbalance protection.
 - .10 Inverter over-temperature protection.
 - .11 Capable of running without motor for startup.
 - .12 Output filter package (as required) to limit motor voltage to 1200 volts maximum at motor terminals. A reflective wave trap mounted at the motor may be used to accomplish this.
 - .13 Longlead (motor feeder) filter package, as required for these installations. Supplier is responsible to determine where this will be required, and must indicate as to the requirement or non-requirement of longlead filter package components in their bid submission, and the Contractor is responsible for carrying all such costs in their bid price.
 - .14 Maximum acceptable noise level is 80 dBA at 1 m.
- .9 Operation features:

- .1 Integral flush mounted display in VFD cover with keypad for programming, monitoring and operating of drive, accessible through password or other acceptable security measure only. Remote keypads, completely duplicating functions of integral keypads, shall also be provided for all VFD(s) located inside a fan plenum. The remote keypads in these cases shall be located adjacent to the door entering the plenum.
- .2 Fault shutdown and indication.
- .3 Automatic restart following power outage.
- .4 Ability to disconnect motor load for setup or trouble.
- .5 Manual speed control (potentiometer or keypad).
- .6 Adjustable maximum and minimum speed.
- .7 Acceleration and deceleration time adjustment.
- .8 Controller “stop” interlock from a NC dry contact.
- .9 Drive fault contact.
- .10 Stop/start push buttons on keypad.
- .11 Transient voltage protection.
- .12 Provide three (3) dry “C” type contacts programmable for any combination of the following:
 - .1 Running (output frequency being generated).
 - .2 Fault lockout.
 - .3 Stopped.
 - .4 At speed.
 - .5 Under speed.
 - .6 Forward/Reverse.
 - .7 Low reference.
 - .8 Manual/Auto Mode.
 - .9 Local/Remote Mode.
- .13 Soft start sequence.
- .14 Minimum of three (3) skip frequencies.
- .15 Provide Hand/Off/Auto selector switch. Keypad HOA is not an acceptable replacement.
- .16 Password protection of parameter programming or some method to prevent unauthorized changes.
- .17 Output speed monitoring signal to be selective between 4-20 mA. or 0-10 volt.
- .18 Data communication link.
 - .1 Data communication links shall be provided with various components in the electrical distribution system as defined in various Section of this Division and as shown on drawings. The data communication link shall be Modbus Ethernet.
 - .2 Motor control data communication link.
 - .3 Each variable frequency drive shall be provided with Ethernet data communication link capable of communicating with the DSC System.
- .10 Environmental Capabilities: The drive shall operate without mechanical or electrical damage under any combination of conditions as follows:

- .1 Ambient temperature -0° to 40°C.
- .2 Humidity 0 to 90% (non condensing).
- .3 Vibration up to 0.5 g.
- .4 Altitude 0 to 1250 m.
- .11 Diagnostic and indicating features:
 - .1 Power On indication.
 - .2 Percentage speed indicator.
 - .3 Overload indication.
 - .4 Short circuit indication.
 - .5 Ground fault indication.
 - .6 Overvoltage indication.
 - .7 Undervoltage indication.
 - .8 High temperature (controller).
 - .9 AC voltmeter (output).
 - .10 AC ammeter (output).
 - .11 Inverter ready.
 - .12 Inverter fault.
 - .13 External fault.
- .12 Cooling System:
 - .1 VFD supplier to provide adequate proven cooling devices for VFD equipment.
 - .2 VFD supplier to ensure any enclosure utilized will not allow a build up of heat. This can be accomplished by use of fans and / or sufficient guarded, filtered openings.
- .13 Control wiring shall be TEW 105° C rise.
- .14 Terminal blocks in separate control enclosures for remote interface shall be Weidmueller SAK6N or approved equivalent.
- .15 Provide wire markers at both ends of all control wires, Electrovert Type Z or approved equivalent.

Part 3 Execution

3.1 INSTALLATION

- .1 Identify mounting requirements and include all materials and labour, including concrete pads for all floor-mounted equipment.
- .2 Install VFD(s) in locations as indicated on drawings, and connect up all necessary wiring. All VFD(s) are to be mounted as close to the motor as possible. Follow manufacturer's recommendations for maximum distance between the VFD and the motor. The minimum clearance in front of VFDs is 1 m. Where required, install longlead motor package.

- .3 This Division shall extend analog input signal cable, analog speed indicating output cable, shutdown contact and drive fault contact from the drive to the DCS System. Analog cable shall be No. 16 shielded twisted pair cable. Control wiring shall be run in conduit separate from VFD supply and motor feeder conduits.
- .4 Contractor shall connect all interlocks including (but not limited to) vibration switch, freeze stats, and fire alarms to the VFD. These interlocks will be active in both the Hand (local) and Auto (remote) configurations.
- .5 Contractor shall ensure that all control and stop commands shut down the drive as per manufacture's recommended procedure (example, ramp to stop, ramp and hold, or coast to stop). Contactors on the line or load side of the drive are not an approved method of control.
- .6 MCC disconnect switch, VFD and motor isolation switch are to be labelled with proper shutdown procedures as follows:
 - “Caution”
 - “Ensure VFD is stopped before operating this switch”
 - “Record all faults before resetting”

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and manufacturer's instructions.
- .2 Operate switches, 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.
- .5 Contractor shall be responsible to bring Factory representative back to reset, repair, and re-commission the VFD during the two (2) year warranty period if problems arise with the normal operation of the VFD. This includes prevention of any motor shaft voltages exceeding 1.5 volts when referenced to ground.

Part 1 General

1.1 SECTION INCLUDES

- .1 Natural gas engine driven generator sets above 30kW rating, normally 3 phase.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 78 00 - Closeout Submittals.
- .3 Section 26 05 00 - Common Work Results - Electrical.

1.3 REFERENCES

- .1 American National Standards Institute (ANSI)/National Electrical Manufacturers' Association (NEMA)
 - .1 ANSI/NEMA MG1-1998, Motors and Generators.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CSA-C282-00, Emergency Electrical Power Supply for Buildings.
 - .2 CSA B149.1-00 Natural Gas and Propane Installation Code.
- .3 International Organization for Standardization (ISO)
 - .1 ISO 3046-1-2002, Reciprocating Internal Combustion Engines - Performance - Part 1: Declarations Of Power, Fuel And Lubricating Oil Consumptions, And Test Methods.

1.4 SYSTEM DESCRIPTION

- .1 Generating system consists of:
 - .1 Natural gas engine.
 - .2 Alternator.
 - .3 Alternator control panel.
 - .4 Automatic transfer equipment, including closed transition re-transfer and manual by-pass switch.
 - .5 Battery charger and battery.
 - .6 Automatic engine room ventilation system.
 - .7 Fuel supply system.
 - .8 Exhaust system.
 - .9 Steel mounting base with vibration isolation springs.
- .2 System designed to operate as emergency standby power source and shall be meet CSA-C282.

1.5 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include:
 - .1 Engine: make and model, with performance curves.
 - .2 Alternator: make and model.
 - .3 Voltage regulator: make, model and type.
 - .4 Automatic transfer switch: make, model and type.
 - .5 Manual bypass switch: make and model.
 - .6 Battery: make, type and capacity.
 - .7 Battery charger: make, type and model.
 - .8 Alternator control panel: make and type of meters and controls.
 - .9 Governor type and model.
 - .10 Automatic engine room ventilation system.
 - .11 Cooling air requirements in m³/s.
 - .12 British standard or DIN rating of engine.
 - .13 Flow diagrams for:
 - .1 Fuel.
 - .2 Cooling air.
 - .14 Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, and total weight.
 - .15 Continuous full load output of set at 0.8PF lagging.
 - .16 Description of set operation including:
 - .1 Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
 - .2 Manual starting.
 - .3 Automatic shut down and alarm on:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator overvoltage.
 - .7 Lube oil high temperature.
 - .8 Over temperature on alternator.
 - .4 Manual remote emergency stop.
 - .17 Break-in period for engine, operating hours at 80% load.

1.6 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for diesel generator for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

- .2 Include in Operation and Maintenance Manual instructions for particular unit supplied and not general description of units manufactured by supplier and:
 - .1 Operation and maintenance instructions for engine, alternator, control panel, automatic transfer switch, manual bypass switch, battery charger, battery, fuel system, engine room ventilation system, exhaust system and accessories, to permit effective operation, maintenance and repair.
 - .2 Technical data:
 - .1 Illustrated parts lists with parts catalogue numbers.
 - .2 Schematic diagram of electrical controls.
 - .3 Flow diagrams for:
 - .1 Fuel system.
 - .2 Lubricating oil.
 - .3 Cooling system.
 - .4 Certified copy of factory test results.
 - .5 Maintenance and overhaul instructions and schedules.
 - .6 Precise details for adjustment and setting of time delay relays or sensing controls which require on site adjustment.

1.7 WARRANTY

- .1 For Work of this Section 12 month warranty period prescribed in subsection GC32.1 of General Conditions "C" is extended to 60 months or 1500 operating hours, whichever occurs first.

1.8 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Include:
 - .1 2 fuel filter replacement elements.
 - .2 2 lube oil filter replacement elements.
 - .3 2 air cleaner filter elements.
 - .4 2 sets of fuses for control panel.
 - .5 Special tools for unit servicing.

1.9 SOURCE QUALITY CONTROL

- .1 Factory test generator set including engine, alternator, control panels, and accessories in presence of Contract Administrator. Include travel, lodging, etc for the City and his representative to witness the generator testing at the manufacturer's facility.
- .2 Notify Contract Administrator 5 days in advance of date of factory test.
- .3 Test procedure:
 - .1 Prepare blank forms and check sheet with spaces to record data. At top of first sheet record:
 - .1 Date.

- .2 Generator set serial no.
- .3 Engine, make, model, serial no.
- .4 Alternator, make, model, serial no.
- .5 Voltage regulator, make and model.
- .6 Rating of generator set, kW, kV.A, V, A, r/min, Hz.
- .2 Mark check sheet and record data on forms in duplicate as test proceeds.
- .3 Contract Administrator's signature on completed forms to indicate concurrence in results of test.
- .4 Tests:
 - .1 With 100% rated load, operate set for 6 h, taking readings at 30 min intervals, and record following:
 - .1 Time of reading.
 - .2 Running time.
 - .3 Ambient temp in C.
 - .4 Lube oil pressure in kPa.
 - .5 Lube oil temp in C.
 - .6 Engine coolant temp in C.
 - .7 Exhaust stack temp in C.
 - .8 Alternator voltage: phase 1, 2, 3.
 - .9 Alternator current: phase 1, 2, 3.
 - .10 Power in kW.
 - .11 Frequency in Hz.
 - .12 Power Factor.
 - .13 Battery charger current in A.
 - .14 Battery voltage.
 - .15 Alternator cooling air outlet temp.
 - .2 After completion of 6 h run, demonstrate following shut down devices and alarms:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator overvoltage.
 - .7 Low battery voltage, or no battery charge.
 - .8 Manual remote emergency stop.
 - .9 High alternator temperature.
 - .3 Next install continuous strip chart recorders to record frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments to include:
 - .1 No load to full load to no load.
 - .2 No load to 70% load to no load.

- .3 No load to 20% load to no load.
- .4 20% load to 40% load to no load.
- .5 40% load to 60% load to no load.
- .6 60% load to 80% load to no load.
- .5 Demonstrate:
 - .1 Automatic starting of set and automatic transfer of load on failure of normal power.
 - .2 Automatic shut down of engine on resumption of normal power.
 - .3 That battery charger reverts to high rate charge after cranking.
 - .4 Automatic changeover from primary fuel (natural gas) to secondary fuel (propane gas).
- .6 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.
- .7 All tests to be repeated on site in their entirety.

Part 2 Products

2.1 NATURAL GAS ENGINE

- .1 Natural gas engine: to ISO 3046-1.
 - .1 Engine: standard product of current manufacture, from company regularly engaged in production of such equipment.
 - .2 Naturally aspirated or turbo charged and after cooled, synchronous speed 1800 r/min.
 - .3 Capacity:
 - .1 Rated continuous power in kW at rated speed, after adjustment for system losses in auxiliary equipment necessary for engine operation; to be calculated as follows: Rated continuous output = Generator kW divided by Generator efficiency at full load.
 - .1 Under following site conditions:
 - .1 Altitude: 1000 m.
 - .2 Ambient temperature: 40 degrees C.
 - .3 Relative humidity: 95 %.
 - .2 Engine overload capability 110% of continuous output for 1 hour within 12 hours period of continuous operation.
 - .2 Cooling System:
 - .1 Liquid cooled: heavy duty industrial radiator mounted on generating set base with engine driven pusher type fan to direct air through radiator from engine side, with anti-freeze non-sludging above minus 46 degrees C.
 - .2 To maintain manufacturer's recommended engine temperature range at 10% continuous overload in ambient temperature of 40 degrees C.
 - .3 Block heater: thermostatically controlled lube oil or liquid coolant heater connected to line side of automatic transfer switch to allow engine to start in room ambient 0 degrees C.

- .1 Switch and fuse in heater circuit, mounted in engine-alternator control cubicle and fed from line side of automatic transfer switch.
- .5 Fuel:
 - .1 Natural gas
- .6 Fuel system:
 - .1 Natural Gas train to CSA B149.1-00 Natural Gas and Propane Installation Code.
- .7 Inlet system: Air cleaner housing with cartridge type air filter(s).
- .8 Governor:
 - .1 Electronic type, electric actuator, speed droop externally adjustable from isochronous to 5%, temperature compensated with steady state speed maintenance capability of plus or minus 0.25%.
- .9 Lubrication system:
 - .1 Pressure lubricated by engine driven pump.
 - .2 Lube oil filter: replaceable, full flow type, removable without disconnecting piping.
 - .3 Lube oil cooler.
 - .4 Engine sump drain valve.
 - .5 Oil level dip-stick.
- .10 Starting system:
 - .1 Positive shift, gear engaging starter 24V dc.
 - .2 Cranking limiter to provide 3 cranking periods of 10s duration, each separated by 5 s rest.
 - .3 Lead acid, 24V storage battery with sufficient capacity to crank engine for 1min at 0 degrees C without using more than 25% of ampere hour capacity.
 - .4 Battery charger : constant voltage, solid state, two stage from trickle charge at standby to boost charge after use. Regulation: plus or minus 1% output for plus or minus 10% input variation. Automatic boost for 6h every 30 days. Equipped with dc voltmeter, dc ammeter and on-off switch. Minimum charger capacity: 10 A.
 - .5 Batteries to be housed in rack or cabinet complete with cover to guard against accidental contact.
- .11 Vibration isolated engine instrument panel with:
 - .1 Lube oil pressure gauge.
 - .2 Lube oil temperature gauge.
 - .3 Lube oil level gauge.
 - .4 Coolant temperature gauge.
 - .5 Coolant level gauge.
 - .6 Running time meter: non-tamper type.
- .12 Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.

- .13 Drip tray.

2.2 ALTERNATOR

- .1 Alternator: to ANSI/NEMA MG1.
- .2 Rating: 3phase, 600 V, 3 wire, 150 kW, 60Hz, at 0.8PF.
- .3 Output at 40 degrees C ambient:
 - .1 100% full load continuously.
 - .2 110% full load for 1h.
 - .3 150% full load for 1 min.
- .4 Revolving field, brushless, single bearing.
- .5 Drip proof.
- .6 Amortisseur windings.
- .7 Synchronous type.
- .8 Dynamically balanced rotor permanently aligned to engine by flexible disc coupling.
- .9 Exciter:permanent magnet.
- .10 EEMAC H insulation on windings.
- .11 Thermistors or platinum resistance temperature transducers embedded in stator winding and connected to alternator control circuitry.
- .12 Voltage regulator: thyristor controlled rectifiers with phase controlled sensing circuit:
 - .1 Stability: 1% maximum voltage variation at any constant load from no load to full load.
 - .2 Regulation: 2% maximum voltage deviation between no-load steady state and full-load steady state.
 - .3 Transient: 15% maximum voltage dip on one-step application of 0.8PF full load.
 - .4 Transient: 10% maximum voltage rise on one-step removal of 0.8PF full load.
 - .5 Transient: 5 s maximum voltage recovery time with application or removal of 0.8PF full load.
- .13 Alternator: capable of sustaining 300% rated current for period not less than 10s permitting selective tripping of down line protective devices when short circuit occurs.

2.3 CONTROL PANEL

- .1 Totally enclosed, wall mounted.
- .2 Instruments:
 - .1 Digital 100% solid state circuitry indicating type 2 % accuracy, rectangular face, flush panel mounting:

- .1 Voltmeter: ac, scale 0 to 1000 V, 3 Phase (L-L & L-N).
- .2 Ammeter: ac, scale 0 to 200 A, (3 Phase & total).
- .3 Wattmeter scale 0 to 200 kW, 3 Phase & total.
- .4 Frequency meter: scale 55 to 65Hz.
- .5 kVA, Total.
- .6 kVAR, Total.
- .7 kW.h, Total.
- .8 kVAR.h, Total.
- .9 PF, average total & per phase.
- .10 DC voltage.
- .11 Coolant temperature.
- .12 Oil pressure.
- .13 RPM.
- .14 Hours run.
- .15 System diagnostic
- .2 All functions to be selected by keypad.
- .3 Instrument Transformers
 - .1 Potential-dry type for indoor use:
 - .1 Ratio: 600 to 120.
 - .2 Rating: 600 V, 60Hz, BIL 10 kV.
 - .2 Current-dry type for indoor use:
 - .1 Ratio: as required.
 - .2 Rating: 600 V, 60Hz, BIL 10 kV.
 - .3 Positive action automatic short-circuiting device in secondary terminals.
- .3 Controls:
 - .1 Engine start button.
 - .2 Selector switch: Off-Auto-Manual - Test (at full load or test at no load).
 - .3 Engine emergency stop button and provision for remote emergency stop button.
 - .1 Alternator output breaker:
 - .1 Circuit breaker: bolt-on, moulded case, temperature compensated for 40 degrees C ambient, dual thermal-magnetic trip.
 - .2 Voltage control rheostat: mounted on inside of control panel.
 - .3 Operating lights, panel mounted:
 - .1 "Normal power" pilot light.
 - .2 "Emergency power" pilot light.
 - .3 Green pilot lights for breaker on and red pilot lights for breaker off.
 - .4 Solid state indicator lights for alarm, according to CSA-C282, with 1 set manually reset NO/NC contacts wired to terminal block for remote annunciation on:
 - .1 Low engine temperature.

- .2 Low battery voltage.
- .3 Ventilation failure.
- .4 Low coolant level.
- .5 Automatic transfer switch in bypass mode.
- .5 Solid state controller for automatic shutdown and alarms, according to CSA-C282, with 1 set manually reset NO/NC contacts wired to terminal block for remote annunciation on:
 - .1 Engine overcrank.
 - .2 Engine overspeed.
 - .3 Engine high temperature.
 - .4 Engine low lube oil pressure.
 - .5 Short circuit.
 - .6 AC over voltage.
 - .7 Control switch not in auto.
- .6 Lamp test button.
- .7 Provision for remote monitoring.

2.4 AUTOMATIC TRANSFER SWITCH

- .1 Automatic transfer switch to meet Section 26 36 23 – Automatic Load Transfer Equipment.

2.5 STEEL MOUNTING BASE

- .1 Complete generating set mounted on structural steel base of sufficient strength and rigidity to protect assembly from stress or strain during transportation, installation and under operating conditions on suitable level surface.
- .2 Assembly fitted with vibration isolators.
 - .1 Spring type isolators with adjustable side snubbers and adjustable for levelling.
- .3 Sound insulation pads for installation between isolators and concrete base.

2.6 EXHAUST SYSTEM

- .1 Refer also to Mechanical drawings.
- .2 Heavy duty residential grade horizontally mounted exhaust silencer with condensate drain, plug and flanged couplings. Minimum 20 dBA noise reduction at engine rated output.
- .3 Insulated, ULC listed wall thimble complete with rain guard.
- .4 Heavy duty flexible engine to exhaust system connector, bellows type with flanged couplings.
- .5 Fittings and accessories as required.
- .6 Mineral wool insulated exhaust system.

- .7 Expansion joints: stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion, flanged ends.

2.7 FUEL SYSTEM

- .1 To CSA B149.1-00 Natural Gas and Propane Installation Code.
- .2 Shut-off cock.
- .3 Renewable cartridge filter.
- .4 Dual valves.

2.8 COOLING AIR SYSTEM

- .1 Engine ventilating system:
 - .1 Recirculating damper assembly with modulating motor.
 - .2 Cold air inlet damper assembly with modulating motor.
 - .3 Air discharge and intake gooseneck weatherhoods.
 - .4 Modulating thermostat.
 - .5 Replaceable air intake filters.

2.9 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Control panel:
 - .1 Size 4 nameplates for controls including alternator breakers and program selector switch.
 - .2 Size 2 nameplates for meters, alarms, indicating lights and minor controls.

2.10 FABRICATION

- .1 Shop assemble generating unit including:
 - .1 Base.
 - .2 Engine and radiator.
 - .3 Alternator.
 - .4 Control panel.
 - .5 Battery and charger.
 - .6 Automatic transfer equipment.

2.11 FINISHES

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Alternator control cubicle: paint inside, exterior to match engine and alternator.
- .3 Exhaust and inlet air hoods international orange.

- .4 Other ducts and racks grey.
- .5 Supply 0.25L of grey touch-up enamel.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate generating unit and install as indicated.
- .2 Install fuel supply system as indicated.
- .3 Install ventilating air duct system as indicated.
- .4 Pipe muffler drains to nearest floor drain.
- .5 Complete wiring and interconnections as indicated.
- .6 Start generating set and test to ensure correct performance of components.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Notify Contract Administrator 10 working days in advance of test date.
- .3 Supply and connect load bank for on site testing.
- .4 Demonstrate:
 - .1 Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.
 - .2 Unit start and shut down on "Manual" control
 - .3 Unit start and transfer on "Test" control.
 - .4 Unit start on "Engine start" control.
 - .5 Operation of manual bypass switch.
 - .6 Operation of automatic alarms and shut down devices.
- .5 Run unit on load for minimum period of 6 hours to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling.
- .6 At end of test run, check battery voltage to demonstrate battery charger has returned battery to fully charged state.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for automatic load transfer equipment which can monitor voltage on all phases of normal power supply, initiate cranking of standby generator unit, transfer loads and shut down standby unit.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 78 00 - Closeout Submittals.
- .3 Section 26 05 00 - Common Work Results - Electrical.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN3-C13-M83(R1998), Instrument Transformers.
 - .2 CSA C22.2No.5-02, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).
 - .3 CSA C22.2No.178-1978(R2001), Automatic Transfer Switches.
- .2 American National Standards Institute (ANSI)/National Electrical Manufacturers Association (NEMA)
 - .1 ANSI/NEMA ICS 2-2000, Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.

1.4 SYSTEM DESCRIPTION

- .1 Automatic load transfer equipment with bypass isolation 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.

1.5 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Include:
 - .1 Make, model and type.
 - .2 Load classification:
 - .1 Tungsten lamp load: kW.
 - .2 Ballast lamp load: kW.
 - .3 Motor load: kW.
 - .4 Restricted use: resistance and general loads, 0.8pf or higher kW.
 - .3 Single line diagram showing controls and relays.
 - .4 Description of equipment operation including:
 - .1 Automatic starting and transfer to standby unit and back to normal power.
 - .2 Test control.
 - .3 Manual control.
 - .4 Automatic shutdown.

1.6 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Detailed instructions to permit effective operation, maintenance and repair.
- .3 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.

Part 2 Products

2.1 MATERIALS

- .1 Instrument transformers: to CAN3-C13.
- .2 Contactors: to ANSI/NEMA ICS2.

2.2 CIRCUIT BREAKER TYPE TRANSFER EQUIPMENT

- .1 Circuit Breaker Type Transfer Equipment: to CSA C22.2No.5.
- .2 Rated: 600 V, 60Hz, 200 A, 3 wire, solid neutral.
 - .1 Fault withstand rating: 22 kA symmetrical for 3 cycles with maximum peak value of 22 kA.
 - .2 One normal- three phase molded-case circuit breaker with thermal magnetic, mounted on common base, designed for double throw action, motor operated, mechanically held and interlocked, floor mounted CSA 1 enclosure.

- .3 One emergency – three phase moulded-case circuit breaker with thermal magnetic trip, motor operated, and interlocked.
- .4 Circuit breakers:
 - .1 Trip free in closed position.
 - .2 Interrupting rating: 22 kA symmetrical.
- .5 Dead front construction with access to relays and controls for inspection and maintenance, and manual operating lever for transfer switch.
- .6 Auxiliary contact: to initiate emergency generator start-up on failure of normal power.
- .7 Solid neutral bar, rated: 200 A.
- .8 Overlapping neutral contacts on contractor type transfer equipment.
- .9 Switchable neutral pole on circuit breaker type equipment.
- .10 Bypass breakers for normal and emergency.

2.3 CONTROLS

- .1 Selector switch -position "Test", "Auto", "Manual", "Engine start".
 - .1 Test position - Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.
 - .2 Auto position - Normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.
 - .3 Manual position - Transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.
 - .4 Engine start position - Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.
- .2 Control transformers: dry type with 120V 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, 2V minimum undervoltage and over voltage protection.
 - .2 Time delay: normal power to standby, adjustable solid state, 0 to 60s.
 - .3 Time delay on engine starting to override momentary power outages or dips, adjustable solid state, 0 to 60s delay.
 - .4 Time delay on retransfer from standby to normal power, adjustable 20s to 10 min.
 - .5 Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable solid state, 20s intervals to 10 min.
 - .6 Time delay during transfer to stop transfer action in neutral position to prevent fast transfer, adjustable, 5s intervals to 180s.
 - .7 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.

2.4 ACCESSORIES

- .1 Pilot lights to indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel.
- .2 Auxiliary relay to provide 2 N.O. 2 N.C. contacts for remote alarms.
- .3 Manual bypass: bypass of both normal and emergency supplies.

2.5 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Control panel:
 - .1 For selector switch and manual switch: size 4 nameplates.
 - .2 For meters, indicating lights, minor controls: size 2 nameplates.

2.6 SOURCE QUALITY CONTROL

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Contract Administrator.
- .2 Notify Contract Administrator 5 days 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.
 - .4 In-phase monitor operation.

Part 3 Execution

3.1 INSTALLATION

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

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - 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 min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .7 Repeat, at 1h intervals, 4 times, complete test with selector switch in each position, for each test.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for emergency lighting systems.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 26 05 21 - Wires and Cables (0-1000 V).
- .3 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

1.3 REFERENCES

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

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Data to indicate system components, mounting method, source of power and special attachments.

1.5 WARRANTY

- .1 For batteries, the 12 months warranty period prescribed in subsection GC32.1 of General Conditions "C" is extended to 120 months, with no-charge replacement during the first 5 years and pro-rate charge on the second 5 years.

Part 2 Products

2.1 EQUIPMENT

- .1 Emergency lighting equipment: to CSA C22.2 No.141.
- .2 Supply voltage: 120 V, ac.
- .3 Output voltage: 12 V dc.
- .4 Operating time: 30 min.
- .5 Battery: sealed, maintenance free.
- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations.

- .7 Solid state transfer circuit.
- .8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for 'AC Power ON'.
- .10 Lamp heads: integral on unit and remote, 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: mini halogen MR16, 20 W.
- .11 Cabinet: suitable for direct to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 NEMA 4X enclosure.
- .13 Remote lamp heads in Class I Div I locations shall be rate for the area. Two (2) heads per unit.
- .14 Auxiliary equipment:
 - .1 Magnetic test switch.
 - .2 Time delay relay.
 - .3 Service required lamp.
 - .4 Diagnostic LEDs
 - .5 Battery disconnect device.
 - .6 AC input and DC output terminal blocks inside cabinet.
 - .7 Cord and single twist-lock plug connection for AC.
- .15 Acceptable Manufacturer:
 - .1 Emergi-Lite, Survive-All NXM series battery unit, Survive-All EF39 series remote head, EFXPR series hazardous location remote head.
 - .2 Lumacell, RG-NX series battery unit, MQM-NX series remote head, RS10XP series hazardous location remote head.

2.2 WIRING OF REMOTE HEADS

- .1 Conduit: rigid aluminum, in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Conductors: in accordance with Section 26 05 21 - Wires and Cables 0-1000 V, sized in accordance with manufacturer's recommendations.
- .3 Remote heads in Class I Div I areas shall be wire with hazardous location rated TECK cable and connectors. Conductors sized in accordance with manufacturer's recommendations.

Part 3 Execution

3.1 INSTALLATION

- .1 Install unit equipment and remote mounted fixtures.
- .2 Direct heads.
- .3 Connect exit lights to unit equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.141-02, Unit Equipment for Emergency Lighting.
 - .2 CSA C860-01(December 2002), Performance of Internally-Lighted Exit Signs.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 101-2006, Life Safety Code.

1.2 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, physical size, finish and limitations.
- .3 Quality Assurance Submittals:
 - .1 Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures and ____.

Part 2 Products

2.1 STANDARD UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2 Housing: NEMA 4X
- .3 Clear acrylic faceplate.
- .4 Lamps: One or two or multiple LED-12W, 120 V supply over 500,000 hours.
- .5 Operation: designed for over 100,000 hours of continuous operation without relamping.
- .6 Letters: 150 mm high x 19 mm, with 13 mm thick stroke, red letters reading EXIT.
- .7 Face plate to remain captive for relamping.

2.2 SELF-POWERED UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860.

- .2 Housing: NEMA 4X
- .3 Clear acrylic faceplate.
- .4 Lamps: One or two or multiple LED-12W, 120 V supply over 500,000 hours.
- .5 Operation: designed for over 100,000 hours of continuous operation without relamping.
- .6 Letters: 150 mm high x 19 mm, with 13 mm thick stroke, red letters reading EXIT.
- .7 Downlight: white glass translucent acrylic in bottom of unit.
- .8 Face plate to remain captive for relamping.
- .9 Supply voltage: 120 V, ac.
- .10 Output voltage: 12 V dc.
- .11 Operating time: 30 minimum.
- .12 Recharge time: 12 hours
- .13 Battery: sealed, maintenance free.
- .14 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.
- .15 Solid state transfer circuit.
- .16 Signal lights: solid state, for 'AC Power ON'condition.
- .17 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit.
 - .1 Removable or hinged front panel for easy access to batteries.
- .18 Right/left chevron designation as required.
- .19 Cabinet: NEMA 4X
- .20 Auxiliary equipment:
 - .1 Test switch.
 - .2 AC/DC output terminal blocks inside cabinet.
 - .3 Cord and single twist-lock plug connection for AC power supply.
- .21 Acceptable manufacturer: Emergi-Lite, Ready-Lite, Lumacell LER3000 Series

2.3 SELF-LUMINOUS SIGNS

- .1 Exit lights:
 - .1 No power source or wiring required, spark free.
 - .2 Constructed: metal and plastic.
 - .3 Source of energy: tritium gas emits constant low energy beta particles to excite phosphor coating on inside of tube.
 - .4 Viewing distance: in accordance with NFPA.

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 exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits.
- .3 Ensure that exit light circuit breaker is locked in on position.

END OF SECTION