

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-15, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
  - .2 CAN/CSA-C22.3 No. 7-15, Underground Systems.
  - .3 CAN3-C235-83(R2015), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
  - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
    - .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
  - .2 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.
    - .5 Installation to be in accordance with National Building Code of Canada (NBCC) and Local Regulations.

### **1.2 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.

### **1.3 DESIGN REQUIREMENTS**

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

### **1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00- Submittal Procedures.
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- .2 Shop drawings:
  - .1 Submit drawings.
  - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels.
  - .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.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control.
  - .1 Provide CSA certified equipment and material.
  - .2 Where CSA certified equipment and material is not available, submit such equipment and material to inspection authorities for special approval before delivery to site.
  - .3 Permits and fees:
    - .1 Submit to local inspection authority the necessary number of drawings and specifications for examination and approval prior to commencement of Work.
    - .2 Pay all associated fees.
    - .3 Notify Departmental Representative of changes required by local Electrical Inspection Authority prior to making changes
  - .4 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
- .4 Manufacturer's Field Reports: submit to Departmental Representative 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.

## **1.5 QUALITY ASSURANCE**

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
  - .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Territorial Act respecting manpower vocational training and qualification.
    - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
    - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
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## **1.6 SYSTEM STARTUP**

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

## **1.7 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 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS AND EQUIPMENT**

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having
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jurisdiction inspection authorities before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.

- .3 Factory assemble control panels and component assemblies. Full assembly shall be certified by a recognized certification agency, component certification only will not be accepted.

## **2.2 WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of inspection authorities and Departmental Representative.
- .2 Porcelain enamel signs, minimum size 175 x 250 mm.
- .3 Arc Flash.

## **2.3 WIRING TERMINATIONS**

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

## **2.4 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates and labels as follows:
  - .1 Nameplates: lamicoïd 3 mm thick plastic engraving sheet matt white finish face, black core, lettering accurately aligned and engraved into core mechanically attached with double face tape
  - .2 Sizes as follows:

<u>NAMEPLATE</u>	<u>SIZES</u>		
Size 1	10 X 50mm	1 line	3mm high letters
Size 2	12 X 70mm	1 line	5mm high letters
Size 3	12 X 70mm	2 lines	3mm high letters
Size 4	20 X 90mm	1 line	8mm high letters
Size 5	20 X 90 mm	2 lines	5mm high letters
Size 6	25 X 100mm	1 line	12m high letters
Size 7	25 X 100mm	2 lines	6mm high letters

- .2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.
  - .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.
  - .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
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- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. XX" as directed by Departmental Representative.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Pull Boxes: Indicate system and voltage characteristics.
- .9 MCC's: Indicate designated name of equipment, system and voltage characteristics.

## **2.5 WIRING IDENTIFICATION**

- .1 Identify all wiring with permanent indelible identifying markings, numbered coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .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 15m intervals.
- .3 Colours: 25mm wide prime colour and 20mm wide auxiliary colour.

	<u>Prime</u>	<u>Auxiliary</u>
up to 250V	Yellow	
up to 600V	Yellow	Green

## **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 indoor switchgear and distribution enclosures light gray.
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### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Complete underground systems installation in accordance with CSA C22.3 No.1 and No. 7 except where specified otherwise.

#### **3.2 NAMEPLATES AND LABELS**

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

#### **3.3 CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50mm.
- .2 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

#### **3.4 FIELD QUALITY CONTROL**

- .1 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
    - .1 Power distribution system including phasing, voltage, grounding and load balancing.
    - .2 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
    - .3 Insulation resistance testing:
      - .1 Megger circuits, feeders and equipment up to 350V with a 500V instrument.
      - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
      - .3 Check resistance to ground before energizing.
  - .2 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
  - .3 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 -
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**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.

**3.5 CLEANING**

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

**3.6 SINGLE LINE DIAGRAM**

- .1 Provide and install a single line diagram under plexyglass in glazed frame, locate in Main Electrical Room.

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 26 05 21 - Wires and Cables (0-1000 V).

### **1.2 REFERENCES**

- .1 CSA International
  - .1 CAN/CSA-C22.2 No. 18.4-15, Hardware For The Support Of Conduit, Tubing and Cable.
  - .2 CAN/CSA-C22.2 No.65-13, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .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)

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

### **1.4 CLOSEOUT SUBMITTALS**

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

### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Materials and Equipment and with manufacturer's written instructions.
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- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

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

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wire and box connectors installation in accordance with manufacturer's written instructions.
    - .1 Visually inspect substrate in presence of Departmental Representative.
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- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 INSTALLATION**

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

### **3.3 CLEANING**

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

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

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

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA C22.2 No. 0.3-09(R2014), Test Methods For Electrical Wires and Cables.
  - .2 CAN/CSA C22.2 No. 131-14, Type TECK 90 Cable.

### **1.3 PRODUCT DATA**

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

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

- .1 Packaging Waste Management: remove for reuse packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 BUILDING WIRES**

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

### **2.2 TECK 90 CABLE**

- .1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical and to CAN/CSA C22.2 No. 131.
  - .2 Conductors:
    - .1 Grounding conductor: copper.
    - .2 Circuit conductors: copper, size as indicated.
  - .3 Insulation:
    - .1 Cross-linked polyethylene XLPE.
    - .2 Rating: 1000 V.
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- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking aluminum.
- .6 Overall jacket: thermoplastic polyvinyl chloride, low flame spread/low gas emission (LFS/LGE), fire retardant to CSA C22.2 No. 0.3.
- .7 Fastenings:
  - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables at 1200 mm centers, unless noted otherwise, and as required by Local Authority.
  - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .8 Connectors:
  - .1 Watertight, approved for TECK cable.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL CABLE INSTALLATION**

- .1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .2 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .3 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

#### **3.2 INSTALLATION OF BUILDING WIRES**

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

#### **3.3 INSTALLATION OF TECK90 CABLE (0-1000 V)**

- .1 Group cables wherever possible on channels.
  - .2 Group cables, on surface mounted channels where possible.
  - .3 Do not secure cable to equipment pertinent to other trade.
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- .4 Terminate cables and provide suitable connectors, as specified herein, where required.
- .5 Install cable, securely supported by cable clamps.

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

- .1 American National Standards Institute /Institute of Electrical and Electronics Engineers ( ANSI/IEEE )
  - .1 ANSI/IEEE 837-2014, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.
- .2 CSA International
  - .1 CSAZ462-15, Workplace Electrical Safety.

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

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

### **1.3 CLOSEOUT SUBMITTALS**

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

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Materials and Equipment and with manufacturer's written instructions.
  - .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
  - .3 Storage and Handling Requirements:
    - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
    - .2 Store and protect grounding equipment from nicks, scratches, and blemishes.
    - .3 Replace defective or damaged materials with new.
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- .4 Packaging Waste Management: remove for reuse packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT**

- .1 Grounding conductors: bare stranded copper, soft annealed, size as indicated.
- .2 Insulated grounding/bonding: green, copper conductors, RW90, size as indicated. Minimum size #12 AWG.
- .3 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .4 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bolted type conductor connectors.
  - .4 Bonding jumpers, straps.
  - .5 Pressure wire connectors.
  - .6 Compression connectors.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION GENERAL**

- .1 Install complete conductors, connectors, accessories. Run insulated bond wire in each conduit.
  - .2 Install connectors in accordance with manufacturer's instructions.
  - .3 Protect exposed grounding/bonding conductors from mechanical injury.
  - .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
  - .5 Soldered joints not permitted.
  - .6 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.
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- .7 Install flexible ground straps as required.
- .8 Install separate ground conductor to outdoor lighting standards.
- .9 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

### **3.2 EQUIPMENT GROUNDING**

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list: Service equipment, frames of motors, motor control centres, starters, control panels, distribution panels.

### **3.3 FIELD QUALITY CONTROL**

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

### **3.4 CLEANING**

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

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 26 05 21 - Wires and Cables (0-1000 V).
- .2 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### **1.2 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

## **PART 2 - PRODUCTS**

### **2.1 SUPPORT CHANNELS**

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.
- .2 Stainless steel material for installation in wet areas.
- .3 Galvanized steel material for installation in dry areas.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- .1 Secure equipment to masonry, tile and plaster surfaces with lead anchors or nylon shields.
  - .2 Secure equipment to poured concrete with expandable inserts.
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- .3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .4 Fasten exposed conduit or cables to building construction or support system using straps.
  - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .5 Suspended support systems.
  - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .6 For surface mounting of two or more conduits use channels at spacing in accordance with CSA C22.1 - latest edition.
- .7 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .8 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .9 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .10 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trades and approval of Departmental Representative.
- .11 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-15, Canadian Electrical Code, Part 1.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

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

- .1 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 JUNCTION AND PULL BOXES**

- .1 Construction: welded steel enclosure. Enclosure to provide a degree of environmental protection equal to or higher than CSA Type 3R for indoor.
  - .2 Covers Flush Mounted: 25 mm minimum extension all around.
  - .3 Covers Surface Mounted: screw-on turned edge covers.
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### **PART 3 - EXECUTION**

#### **3.1 JUNCTION AND PULL BOXES INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations.

#### **3.2 IDENTIFICATION**

- .1 Equipment Identification: to Section 26 05 00- Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name, voltage and phase or as indicated.
- .3 All junction boxes: indicate panel and circuit number.

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-15, Canadian Electrical Code, Part 1.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Materials and Equipment.
- .2 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 OUTLET AND CONDUIT BOXES GENERAL**

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.

### **2.2 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 35mm and pull boxes for larger conduits.
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- .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 Provide correct size of openings in boxes for conduit. Do not install reducing washers.
- .4 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .5 Identify systems for outlet boxes as required.
- .6 Conduit fittings (condulets) shall be accessible (not concealed).

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Section 26 05 29 - Hangers and Supports for Electrical Systems.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .2 CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.
  - .3 CSA C22.2 No. 211.2-06(R2011), Rigid PVC (Unplasticized) Conduit.
  - .4 CAN/CSA No. 18.3-12, Conduit, Tubing and Cable Fittings.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
  - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
  - .1 Test reports: submit certified test reports.
  - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .3 Instructions: submit manufacturer's installation instructions.

### **1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .2 Place materials defined as hazardous or toxic waste in designated containers.
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- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

## **PART 2 - PRODUCTS**

### **2.1 CONDUITS**

- .1 Rigid PVC conduit: to CSA C22.2 No. 211.2. PVC conduits that are not concrete encased shall be Schedule 40.
- .2 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with coupling.

### **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 in accordance with Section 26 05 29 - Hangers and Supports For Electrical Systems.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.
- .5 All conduit fastenings and supports in pump pit area to be stainless steel.

### **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" (condulets) where 90 degrees bends for 27 mm and larger conduits.
  - .3 Steel watertight connectors and couplings with insulated throat for EMT.
    - .1 Set-screws are not acceptable.
-

## **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 Use electrical metallic tubing (EMT) indoors except where indicated otherwise.
  - .3 Use rigid pvc conduit in pump pit.
  - .4 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment.
  - .5 Minimum conduit size for lighting and power circuits: 21 mm.
  - .6 Bend conduit cold:
    - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
  - .7 Mechanically bend steel conduit over 19 mm diameter.
  - .8 Remove and replace blocked conduit sections.
    - .1 Do not use liquids to clean out conduits.
  - .9 Install fish cord in empty conduits.
  - .10 Dry conduits out before installing wire.
  - .11 Remove and replace blocked conduit sections.
    - .1 Do not use liquids to clean out conduits.
  - .12 Do not secure conduits to mechanical systems piping or ducts, suspended ceiling, etc.
  - .13 Provide minimum #12 AWG insulated "green" bonding conductor in all conduits. Provide suitable means to bond ends of metallic conduit.
-

### **3.3 SURFACE CONDUITS**

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

### **3.4 CLEANING**

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

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 26 28 16.02 - Moulded Case Circuit Breakers.

### **1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.29-2015, Panelboards and Enclosed Panelboards.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

### **1.4 CLOSEOUT SUBMITTALS**

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

### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Materials and Equipment and with manufacturer's written instructions.
  - .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
  - .3 Storage and Handling Requirements:
    - .1 Store materials off ground indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
    - .2 Store and protect panelboards from nicks, scratches, and blemishes.
-

- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/ Demolition Waste Management and Disposal.

## **PART 2 - PRODUCTS**

### **2.1 PANELBOARDS**

- .1 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
    - .1 Install circuit breakers in panelboards before shipment.
    - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
  - .2 250 and 600 V panelboards: bus and breakers rated for 10,000 A (symmetrical) interrupting capacity unless indicated otherwise on drawings.
  - .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
  - .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
  - .5 Minimum of 2 flush locks for each panel board.
  - .6 Two keys for each panelboard and key panelboards alike.
  - .7 Copper bus with neutral of same ampere rating of mains.
  - .8 Mains: suitable for bolt-on breakers.
  - .9 Trim with concealed front bolts and hinges.
  - .10 Trim and door finish: baked enamel as per colour schedule.
  - .11 Enclosure to provide a degree of environmental protection equal to or higher than CSA Type 3R.
-

## **2.2 BREAKERS**

- .1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

## **2.3 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Nameplate for each panelboard size 4 engraved as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.

## **2.4 WARNING SIGNS**

- .1 Provide potential electric shock and arc flash hazard warning sign in accordance with Section 26 05 00 - Common Work Results for Electrical.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for panelboards installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 INSTALLATION**

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
-

- .2 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.
- .3 Connect loads to circuits.
- .4 Connect neutral conductors to common neutral bus with respective neutral identified.

### **3.3 CLEANING**

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

### **3.4 PROTECTION**

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

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 26 05 00 - Common Work Results - Electrical.
- .2 Section 26 29 10 - Motor Starters to 600 V.
- .3 Section 26 29 30 - Soft Start Starters.

### **1.2 REFERENCES**

- .1 C22.2 No. 14-05, Industrial Control Equipment.
- .2 Canadian Standards Association (CSA)
  - .1 CSA-QS-9000, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

### **1.3 PRODUCT DATA**

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 33 00 - Submittal Procedures. WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .3 Submit product data sheets for sills, busbars and compartments. Include product characteristics, physical size and finish.
- .4 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence and cleaning procedures.

### **1.4 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Indicate:
    - .1 Outline dimensions
    - .2 Configuration of identified compartments.
    - .3 Floor anchoring method and dimensioned foundation template.
    - .4 Conduit entry and exit locations.
    - .5 Dimensioned position and size of busbars and details of provision for future extension.
-

- .6 Schematic and wiring diagrams.

### **1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal, and with Waste Reduction Workplan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .4 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .5 Fold up metal banding, flatten and place in designated area for recycling.
- .6 Collect, package and store existing busbars, wireways, sills, copper ground straps and other associated components for recycling and reuse.

### **1.6 CLOSEOUT SUBMITTALS**

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

### **1.7 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, 3 phase, 3 wire, 60 hz, grounded.

### **2.2 GENERAL DESCRIPTION**

- .1 Compartmentalized vertical sections with common power busbars.
  - .2 Floor mounting, free standing, enclosed dead front.
-

- .3 Indoor CSA 2 gasketed enclosure with sprinkler hood, front mounting (only).
- .4 EEMAC Class I, Type C wiring.

### **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 coverplates, in side of vertical sections for horizontal wiring between sections.
- .7 Incoming conduit to enter at top as indicated.
- .8 Provision for outgoing conduits to exit via top or bottom 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.
  - .2 Branch vertical busbars: 300 A (minimum).
- .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 25 kA rms symmetrical (minimum).
- .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 Provide in accordance with Section 26 29 10 - Motor Starters to 600 V and Section 26 29 30 - Soft Start Starters.
- .2 Provide in conformance with Equipment Schedule, MCC Elevation and Motor Schematics drawings.

## **2.8 STARTER UNIT COMPARTMENTS**

- .1 Units EEMAC size 5 and smaller, circuit breaker units 225 A 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.
  
  - .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, selector switches 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.
  
  - .9 Accessories:
    - .1 Hand-Off-Auto selector switch.
    - .2 LED type indicating lights, color as indicated.
    - .3 2-N/O and 2-N/C spare auxiliary contacts unless otherwise indicated.
    - .4 AC current sensor:
      - .1 Ranges:
        - .1 0-5 VDC.
        - .2 LOW: 1 to 10A.
        - .3 MID: 5 to 50A.
        - .4 HIGH: 20 to 200A.
      - .2 Accuracy: +/- 2% of full scale.
      - .3 Repeatability: within +/- 2% of full scale over time, temperature and unit to unit.
      - .4 Loading error: 0.25% error when loaded with 1 megohm (0.025% with 10 megohms, etc.).
      - .5 Frequency: 60 Hz.
      - .6 Operating Temperature: -30°C to + 70°C.
      - .7 Case: CYCOLAC (ABS) meets UL flammability rating 94V-0.
      - .8 Response time: 100 m Sec (10% to 90%).
      - .9 Ripple: Less than 10 mV.
    - .5 Single phase, dry type, control transformer with primary voltage as indicated and 120V secondary, 100VA, complete with secondary fuse, installed in starter.
-

## **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 detailed.
  - .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 Departmental Representative 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-QS-9000.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- .1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.
  - .2 Make field power and control connections as indicated.
  - .3 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.

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 26 24 16.01 – Distribution Panelboards Breaker Type.

### **1.2 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.5-13, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2013).

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Product Data:
    - .1 Submit manufacturer's instructions, printed product literature and data sheets for circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.
  - .3 Include time-current characteristic curves for provided breakers.
  - .4 Certificates:
    - .1 Prior to installation of circuit breakers in either new or existing installation, Contractor must submit 3 copies of a production certificate of origin from the manufacturer. Production certificate of origin must be duly signed by factory and local manufacturer's representative certifying that circuit breakers come from this manufacturer and are new and meet standards and regulations.
      - .1 Production certificate of origin must be submitted to Departmental Representative for approval.
    - .2 Delay in submitting production of certificate of origin will not justify any extension of contract and additional compensation.
    - .3 Any work of manufacturing, assembly or installation to begin only after acceptance of production certificate of origin by Departmental Representative. Unless complying with this requirement, Departmental Representative reserves the right to mandate manufacturer listed on circuit breakers to authenticate new circuit breakers under the contract, and to Contractor's expense.
    - .4 Production certificate of origin must contain:
      - .1 Manufacturer's name and address and person responsible for authentication. Person responsible must sign and date certificate.
-

- .2 Licensed dealer's name and address and person of distributor responsible for Contractor's account.
- .3 Contractor's name and address and person responsible for project.
- .4 Local manufacturer's representative name and address. Local manufacturer's representative must sign and date certificate.
- .5 Name and address of building where circuit breakers will be installed:
  - .1 Project title.
  - .2 End user's reference number.
  - .3 List of circuit breakers.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Materials and Equipment and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store circuit breakers off ground indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect circuit breakers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/ Demolition Waste Management and Disposal.

### **PART 2 - PRODUCTS**

#### **2.1 BREAKERS GENERAL**

- .1 Moulded-case circuit breakers and ground-fault circuit-interrupters to CSA C22.2 No. 5.
  - .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
  - .3 Common-trip breakers: with single handle for multi-pole applications.
-

- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum symmetrical rms interrupting capacity rating same as associated board. Series rating for breakers is not acceptable.

## **2.2 THERMAL MAGNETIC BREAKERS**

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

## **2.3 MOTOR CIRCUIT PROTECTORS (MCP)**

- .1 Moulded case circuit breaker to operate automatically by means of solid state tripping devices to provide instantaneous tripping for short circuit protection.
- .2 MCP tripping range to allow for starting motors direct-on-line. Adjustable range from 700% to 1700% of motor full load amps.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 INSTALLATION**

- .1 Install circuit breakers as indicated.
-

### **3.3 CLEANING**

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

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CAN/CSA C22.2 No.4-04(R2014), Enclosed and Dead-Front Switches (Tri-National Standard With ANCE NMX-J-162-2004 and UL 98).
  - .2 CSA C22.2 No.39-13, Fuseholder Assemblies.

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

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

### **1.3 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers waste in accordance with Waste Management Plan.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

## **PART 2 - PRODUCTS**

### **2.1 DISCONNECT SWITCHES**

- .1 Non-fusible, horsepower rated disconnect switch, to CAN/CSA C22.2 No.4, size as indicated.
  - .2 Provision for padlocking in "off" switch position by three pad-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 Disconnect switch in pump pit area is to be stainless steel, NEMA Type 4X.
-

## **2.2 EQUIPMENT IDENTIFICATION**

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

## **2.3 WARNING SIGNS**

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

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- .1 Install disconnect switches. where indicated on the drawings.

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

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

### **1.2 REFERENCES**

- .1 Standards:
  - .1 CSA C22.2 No. 14, Industrial Control Equipment.
  - .2 CSA C22.1-2015, Canadian Electrical Code Part 1.
- .2 In case of conflict, the most stringent standards shall be applied.
- .3 Apply all other standards, reference publications and amendments referred to in the standards listed above.

### **1.3 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 26 05 00 – Common Work Results for Electrical.
- .2 Include:
  - .1 Mounting method and dimensions.
  - .2 Starter size and type, pick-up voltage and time, drop-out voltage and time.
  - .3 Layout and description of identified internal and front panel components.
  - .4 Enclosure types.
  - .5 Wiring diagram for each type of starter.
  - .6 Interconnection diagrams.
  - .7 Certifications and approvals.

### **1.4 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 26 05 00 – Common Work Results for Electrical.
- .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 26 05 00 – Common Work Results for Electrical.
  - .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 transformer.
- .5 1 operating coil.
- .6 10% of indicating lamp used.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- .1 Starters NEMA rated, as indicated on drawings.

### **2.2 FULL VOLTAGE MAGNETIC STARTERS**

- .1 Combination magnetic starters of size, type, rating and enclosure type as indicted with components as follows: Combination magnetic starters of size, type, rating and enclosure type as indicted with components as follows:
  - .1 Contactor solenoid operated, rapid action type.
  - .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 Power and control terminals.
  - .6 Enclosure shall be sprinkler resistant.
- .2 Combination type starters to include motor circuit interrupter (starters in MCC) with operating lever on outside of enclosure to control disconnect of motor circuit interrupter or disconnect switch 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: heavy duty labeled as required.
  - .2 Indicating lights: heavy duty type.
  - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

### **2.3 CONTROL TRANSFORMER**

- .1 Single phase, dry type, control transformer with primary voltage and secondary as indicated, complete with primary and secondary fuses as indicated.
  - .2 Size control transformer for control circuit load plus 20% spare capacity.
-

## **2.4 FINISHES**

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

## **2.5 EQUIPMENT IDENTIFICATION**

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

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- .1 Install starters, connect power and control as indicated.
- .2 Install switches and indicating lights.
- .3 Ensure correct protective devices elements are installed.
- .4 Installation shall be in compliance with manufacturer's instructions, drawings and recommendations.
- .5 The soft start controller unit manufacturer shall provide a factory certified technical representative to supervise the testing and start-up of the soft start controller unit(s).

### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 – Common Work Results for Electrical and manufacturer's instructions.
  - .2 Operate switches, contactors to verify correct functioning.
  - .3 Perform starting and stopping sequences of contactors and relays.
-

### **3.3 TRAINING**

- .1 An on-site training session shall be provided by a representative of the starter manufacturer.
- .2 Training session to be scheduled with departmental representative.

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

- .1 The electronic soft start starters (controllers) and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of CSA, IEC, ULC, and EEMAC.

### **1.2 RELATED SECTIONS**

- .1 Section 01 78 00 - Closeout Submittals.
- .2 Division 25 – EMCS Integrated Automation.

### **1.3 SUBMITTALS FOR REVIEW**

- .1 Submit shop drawings for review in accordance with Section 01 33 00 - Submittal Procedures. The following information shall be submitted.
  - .1 Dimensioned outline drawing.
  - .2 Schematic diagram.
  - .3 Component list.
  - .4 Power and control connection diagram(s)
  - .5 The shop drawings shall be cross referenced to every clause in the specifications.

### **1.4 SUBMITTALS FOR CLOSE-OUT**

- .1 The following information shall be submitted for record purposes prior to final payment.
  - .1 Installation information.

### **1.5 OPERATION AND MAINTENANCE MANUALS**

- .1 Operation and maintenance manuals shall include the following information:
    - .1 Instruction books
    - .2 Recommended renewal parts list.
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## **PART 2 - PRODUCTS**

### **2.1 SOLID-STATE REDUCED VOLTAGE MOTOR CONTROL**

- .1 Reduced Voltage Motor Starter:
    - .1 The solid-state reduced voltage starter shall be ULC, and CSA listed and bear the CE mark for compliance with applicable IEC and Euro Norm standards for solid state reduced voltage motor starters. The solid state reduced voltage starter shall be an integrated unit with power SCRs, heat sink, logic board, paralleling bypass contactor, and electronic overload relay enclosed in a single moulded housing.
    - .2 The SCR based power section shall consist of six (6) back- to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1600 volts PIV. The starter shall be three-phase, 60 Hz, and rated for the kW, current, and voltage as shown on the drawings.
    - .3 Units shall include an integrated fan controlled by thermal sensors on the heat sink. Fan shall automatically operate during the start ramp and if internal temperature on the heat sink exceeds 60 degree C.
    - .4 Units using triacs or SCR/diode combinations shall not be acceptable.
    - .5 Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt effects.
    - .6 The logic board shall be identical for all ampere ratings and voltage classes and shall be conformally coated to protect environmental concerns.
    - .7 The paralleling run bypass contactor shall energize when the motor reaches 90% of full speed and close/open under 1 times motor current.
    - .8 The paralleling run bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions.
    - .9 Starter shall be provided with electronic overload protection as standard and shall be based on an inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via a DIP switch setting on the device keypad.
    - .10 Overload protection shall be adjusted via the device keypad and shall have a motor, full-load amperage adjustment from 30 to 100% (3.2:1) of the max continuous ampere rating of the starter.
    - .11 Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting on the device keypad.
    - .12 Starter shall be capable of either an electronic or a mechanical reset after a fault.
    - .13 Units using bi-metal overload relays are not acceptable.
    - .14 Over temperature protection (on heat sink) shall be standard.
    - .15 Starters shall provide protection against improper line side phase rotations as standard. Starter will shut down if a line side phase rotation other than
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- A-B-C exists. This feature can be disabled via a DIP switch on the device keypad.
- .16 Starters shall provide protection against a phase loss as standard. Starter will shut down if a 50% current differential between any two phases is encountered. This feature can be disabled via a DIP switch on the device keypad.
  - .17 Start shall provide protection against a motor stall condition during the start ramp as standard. This feature can be disabled via a DIP switch on the device keypad.
  - .18 Starter shall provide protection against a motor jam condition during run as standard. This feature can be disabled via a DIP switch on the device keypad.
  - .19 Starter shall be provided with a form C normally open (NO), normally closed (NC) contact that shall change state when a fault conditions exists. Contacts shall be rated 240V AC and 24V DC max, 3 amps as standard. In addition, an LED display on the device keypad shall indicate type of fault (Overtemp, Phase Loss, Jam, Stall, Phase Reversal, and Overload).
  - .20 The following control function adjustments on the device keypad and LCD screen are required:
    - .1 Selectable Torque Ramp Start or Current Limit Start
    - .2 Adjustable Kick Start Time, 0-2 seconds
    - .3 Adjustable Kick Start Torque, 0-85%
    - .4 Adjustable Ramp Start Time; 0.5-180 second
    - .5 Adjustable Initial Starting Ramp Torque; 0-85%
    - .6 Adjustable Smooth Stop Ramp Time; 0-60 seconds.
  - .21 Enclosed units shall include a thermal magnetic circuit breaker or HMCP for short circuit protection and quick disconnect means.
  - .22 Units enclosed in motor control centers shall be of the same manufacturer as that of the circuit breaker and motor control center for coordination and design issues.
  - .23 The manufacturer of the solid-state starter shall employ a field based factory service organization for the purpose of start up and repair of units. (Third party Service Contractors are not acceptable.)
  - .24 Maximum continuous operation shall be at 100% of continuous amp rating.
  - .25 Control power shall be 24V DC as standard for safety and reliability.
  - .26 Separate control terminals shall be provided for 24V DC power, logic level signals for permissive, start jog forward, ramp start overload override and electric reset.
  - .27 Control terminals shall be pull-apart for easy access and wiring.
  - .28 A removable Customer Interface Module (CIM) shall be provided that allows for full adjustment of control and protection functions through the use of potentiometers and DIP switches.
  - .29 Power terminations shall consist of pressure type terminals.
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- .2 Accessories:
  - .1 Hand-Off-Auto Switch.
  - .2 LED type red "ON" pilot light.
  - .3 2 N/O and 2 N/C spare auxiliary contacts.
  - .4 Control transformer: single phase dry type with secondary fuse, primary voltage: 600, secondary 120 V.
  - .5 AC Current Sensor:
    - .1 Ranges: For 0-5 VDC LOW: 1 to 10 Amps (Maximum Overload: 50 Amps) MID: 50 to 50 Amps (Maximum Overload: 130 Amps) HIGH: 20 to 200 Amps (Maximum Overload: 300 Amps)
  - .6 Accuracy:  $\pm 2\%$  of Full Scale
  - .7 Repeatability: Within  $\pm 2\%$  of Full Scale over time, temperature, and unit to unit.
  - .8 Loading Error: 0.25% error when loaded with 1 megohm (0.025% with 10 megohms, etc.)
  - .9 Frequency: 60 Hz
  - .10 Operating Temperature:  $-30^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$  ( $-22^{\circ}\text{F}$  to  $+158^{\circ}\text{F}$ )
  - .11 Case: CYCOLAC (ABS) meets UL flammability rating 94V-0
  - .12 Response Time: 100 mSec (10% to 90%)
  - .13 Ripple: Less than 10 mV

### **PART 3 - EXECUTION**

#### **3.1 FACTORY TESTING**

- .1 The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of CSA and EEMAC standards.
  - .1 All printed circuit boards shall be functionally tested via faultfinder bench equipment prior to unit installation.
  - .2 All final assemblies shall be load tested.

#### **3.2 INSTALLATION**

- .1 Install units in location indicated on the drawings.

#### **3.3 FIELD QUALITY CONTROL**

- .1 Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment,
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connections and adjustments, and testing of the assembly and components contained herein.

- .2 The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.
  - .1 Inspection and final adjustments.
  - .2 Operational and functional checks of controllers/starters and spare parts.
  - .3 The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

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**3.4 MANUFACTURER'S CERTIFICATION**

- .1 A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.
- .2 The Contractor shall provide three (3) copies of the manufacturer's representative's certification before final payment is made.

**3.5 TRAINING**

- .1 The Contractor shall provide a training session for up to 2 personnel for 1 normal workday at a job site location determined by the Departmental Representative.
- .2 The training representative shall be conducted by a manufacturer's qualified representative.
- .3 The training program shall consist of the following:
  - .1 Instructions on the proper maintenance and operation of the equipment.