

**PART 1 GENERAL**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 General requirements that are common to Sections of Division 26 - Electrical, Division 27 - Communications, Division 28 - Electronic Safety and Security.

**1.2 RELATED SECTIONS**

- .1 Division 01 - General Requirements.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International):
  - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (Latest Edition), Safety Standard for Electrical Installations.
  - .2 CSA C22.2 No. 0-M91 (R2006), General Requirements.
  - .3 CAN3-C235-83 (R2006) Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
  - .4 Barrier-Free access: CAN/CSA-B651.
- .2 National Building Code of Canada, (2015)

**1.4 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.

**1.5 SCOPE OF WORK**

- .1 The work shall include all labour, materials and equipment necessary for the complete installation of the electrical, communications and electronic safety and security systems shown on the drawings and described in these specifications.
- .2 It is the requirement of this work to provide all systems completely functioning in intended system operation, notwithstanding that every item necessarily required may not be specifically mentioned.

**1.6 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 Overhead and Underground Electrical Services: CSA C22.3 No. 1 and CAN/CSA-C22.3 No. 3.
- .4 Barrier-Free access: design equipment and components in accordance with CAN/CSA-B651.

#### **1.7 SUBMITTALS**

- .1 Submittals: in accordance with Division 01 - General Requirements.
- .2 Shop drawings:
  - .1 Refer to individual specification sections for shop drawing requirements.
  - .2 Submit shop drawings in accordance with Division 01 - General Requirements.
  - .3 Identify applicable specification section and paragraph number on each shop drawing.
  - .4 Submit installation details of proposed location, layout and arrangement of conduit and boxes, and other items that must be shown to ensure co-ordinated installation.
  - .5 Faxes are not acceptable for shop drawings. If sent by fax, they will not be reviewed.
  - .6 Do not begin fabrication until shop drawings have been reviewed by Department Representative. Allow ten (10) working days for Department Representative review.
  - .7 Department Representative review of shop drawings does not relieve the contractor of the responsibility for co-ordination of field measurements required to complete the work.
  - .8 Contractor shall approve all shop drawings by signing and dating them prior to submitting to Department Representative.
- .3 Quality Control: in accordance with Division 01 - General Requirements.
  - .1 Provide CSA or other certification agency certified material, recognized by the Authority Having Jurisdiction.

- .2 Where certified material is not available, submit such equipment and material to authority having jurisdiction for approval before delivery to site.
- .3 Perform pull testing of the following conduit systems:
  - .1 Underground.
  - .2 Concrete encased.
  - .3 41mm and larger.
- .4 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Department Representative.
- .5 Submit, upon completion of Work, load balance report as described in PART 3 - FIELD QUALITY CONTROL.
- .4 Submit test results for installed electrical systems.
- .5 Manufacturer's Field Reports: submit to Department Representative written report, within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.
- .6 Submit for review fire alarm passive graphic at fire alarm control panel and annunciator(s).

#### **1.8 AS-BUILT DRAWINGS**

- .1 On a set of opaque drawings, record all changes as work progresses. Incorporate all information issued in Addenda, Site Instructions and Change Orders and all changes in actual installation as a result of site conditions and coordination. All changes shall be recorded neatly and legibility in red ink.
- .2 Identify each drawing in lower right hand corner in letters at least 13 mm high as follows: AS-BUILT DRAWING (This drawing has been revised to show electrical systems as installed), (Name of Contractor), (Signature of Contractor) and (Date).
- .3 Submit to the General Contractor for approval and make all corrections as directed.

#### **1.9 ALTERNATE PRODUCTS**

- .1 Requests for alternate product approval shall be in accordance with Division 01 - General Requirements.

- .2 It is the intent of these specifications to establish the required quality of materials. Where manufacturer's name and catalogue number are used, it is done in order to establish the required quality, style, size or function. The decision as to suitability shall rest with the Department Representative.
- .3 All materials not meeting the standards as set down by these specifications shall not be allowed on the job site.
- .4 Substitutions affecting the design will not be permitted.
- .5 Additional costs to any other trade as a result of a change or substitution by this Contractor shall be borne by this Contractor.
- .6 The listing of a manufacturer as acceptable does not imply acceptance of all products of that manufacturer and only products of that manufacturer meeting the standards as set out in the specifications will be accepted.
- .7 All requests for alternates must be submitted no later than five (5) working days prior to tender close.
- .8 Faxes are not acceptable for request for alternates. If sent by fax, they will not be reviewed.

**1.10 SAMPLES**

- .1 Submit samples in accordance with Division 01 - General Requirements.
- .2 After review and acceptance, samples will be returned for incorporation into work.

**1.11 TEST REPORTS**

- .1 Submit certified test reports and certificates to Department Representative from approved independent testing laboratories.
- .2 Indicate compliance with specifications for specified performance characteristics and physical properties.
- .3 Manufacturer's Field Services: submit copies of manufacturer's field inspection reports.

**1.12 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for incorporation into operation and maintenance manual as per Division 01 - General Requirements.
- .2 Include in Operation and Maintenance Data:
  - .1 Table of Contents.
  - .2 Name and address of Electrical Contractor.
  - .3 Names, addresses and telephone numbers of local suppliers for items included in Operation and Maintenance Manuals.
  - .4 Letter of Warranty.
  - .5 Product related warranties.
  - .6 Copy of reviewed Shop Drawings.
  - .7 Copy of all test certificates.
  - .8 Copy of all final panelboard schedules.
  - .9 Copy of signed transmittal verifying all maintenance materials turned over to the Department Representative/user.
  - .10 One (1) paper copy of As Built drawings and specifications including all addenda and change orders.
  - .11 Include details of design elements, component function and maintenance requirements to effectively operate, maintain or repair.
  - .12 Include technical data, product data, component illustrations, technical descriptions and parts list, wiring and schematic diagrams not considered proprietary, test and verification reports. Advertising or sales literature is not acceptable.

**1.13 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with Division 01 - General Requirements and as indicated in respective specification sections.

**1.14 EXISTING CONDITIONS**

- .1 Tie into existing systems at times coordinated with Department Representative.
- .2 Submit written request for approval 5 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing construction by this work.

- .4 Ensure daily clean-up of existing areas.

**1.15 FIRESTOPPING**

- .1 All firestopping work is to be performed by the General Contractor.
- .2 Electrical contractor shall coordinate all fire rated assembly penetrations with General Contractor.
- .3 Electrical Contractor shall provide required clearances between outside surface of conduits and inside surface of sleeves, core drilled holes or listed fire rated systems.

**1.16 ACCESS DOORS**

- .1 All access doors related to Electrical work shall be provided by Electrical Contractor, where required, and turned over to General Contractor for installation. See Section 08 31 13 - Access Doors and Frames.

**1.17 INTERPRETATION OF PLANS AND SPECIFICATIONS**

- .1 These specifications are to be considered as an integral part of the plans which accompany them and neither the plans nor the specifications shall be used alone. Any item which is omitted in one but which is reasonably implied in the other shall be considered properly and sufficiently specified and must, therefore, be provided by this Contractor.
- .2 Drawings are diagrammatic. Building dimensions shall not be scaled from the Electrical plans.
- .3 Any discrepancy between the drawings and the building shall be questioned before proceeding with any installation.

**1.18 CO-OPERATION OF CONTRACTORS**

- .1 This Contractor shall become familiar with the work of other contractors and in laying out and installing the work shall co-operate with the other Contractors, so as to facilitate the progress of the work as a whole and avoid interference or delays. Where interference exists, this Contractor shall notify the General Contractor and/or project manager and the Department Representative before installing the work. Any changes in the work or alterations of the Electrical Contractor's schedule required for such co-operation will not be considered as a claim for extra compensation.

- .2 Due to the complexities of many sub-trades, and the restrictive space available in this project, it is required that all trades co-operate closely so as to install all systems in their allotted locations as indicated on the drawings, or as coordinated on site.

**1.19 ERRORS AND OMISSIONS**

- .1 The drawings are not intended to show every item of accessory equipment, but the Contractor shall tender on and install all essential details to provide for efficiency of operation and ease of maintenance.
- .2 Should this Contractor discover errors or discrepancies in the plans or specification, he shall refer the matter to the Department Representative for change or clarification and shall not proceed with that portion of the work until advised by the Department Representative to do so.

**1.20 DELIVERY, STORAGE, AND HANDLING**

- .1 Material Delivery Schedule: Provide Department Representative with schedule within 14 days after award of contract.
- .2 Construction/Demolition Waste Management and Disposal: in accordance with Division 01 - General Requirements.
- .3 Store and handle materials in accordance with Division 01 - General Requirements and manufacturer's written instructions.

**1.21 SYSTEM START-UP**

- .1 Instruct operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacture's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

**1.22 PERMITS, FEES AND INSPECTION**

- .1 Submit to Electrical Inspection Department necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2 Obtain an electrical work permit and pay associated fees.

- .3 Notify Department Representative of changes required by the Electrical Inspection Department.

### **1.23 WARRANTY**

- .1 Warranty duration: 12 calendar months following Substantial Completion.
- .2 Coverage: warrant against failure to perform to characteristics as specified.
- .3 Manufacturer's warranty: submit manufacturer's warranty, for Department Representative's acceptance.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS AND EQUIPMENT**

- .1 Provide material and equipment in accordance with Division 01- General Requirements.
- .2 Material and equipment to be CSA or ULC certified. Where CSA or ULC certified material and equipment are not available, obtain special approval from authority having jurisdiction, before delivery to site.
- .3 Ensure labels are visible and readable after equipment is installed.
- .4 Factory assemble electrical panels and component assemblies.

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

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Division 26 responsibility is as follows:
  - .1 Supply and installation of breakers and/or switches.
  - .2 Supply and installation of power feeder (conduit and wire) from panel to starter, from starter to disconnect switch and from disconnect switch to motor.
  - .3 Supply and installation of starters complete with motor protection unless noted otherwise.
  - .4 Supply and installation of disconnect switches at motors unless noted otherwise.
  - .5 Supply and installation of 120V branch wiring to mechanical equipment as indicated on drawings.



- .3 Control wiring and conduit is by Division 25 unless noted otherwise on electrical drawings.

## **2.3 WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction, inspection authorities and Department Representative.
- .2 Signs, minimum size 178 x 254 mm.

## **2.4 WIRING TERMINATIONS**

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

## **2.5 FINISHES**

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two (2) coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment" green finish to EEMAC Y1-1.
  - .2 Paint indoor switchgear and distribution enclosures light grey to EEMAC 2Y-1.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

## **2.6 EQUIPMENT IDENTIFICATION**

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

### **NAMEPLATE SIZES**

<b>Size 1</b>	<b>10 x 50 mm</b>	<b>1 line</b>	<b>3 mm high letters</b>
<b>Size 2</b>	<b>12 x 70 mm</b>	<b>1 line</b>	<b>5 mm high letters</b>
<b>Size 3</b>	<b>12 x 70 mm</b>	<b>2 lines</b>	<b>3 mm high letters</b>
<b>Size 4</b>	<b>20 x 90 mm</b>	<b>1 line</b>	<b>8 mm high letters</b>
<b>Size 5</b>	<b>20 x 90 mm</b>	<b>2 lines</b>	<b>5 mm high letters</b>

**NAMEPLATE SIZES**

<b>Size 6</b>	<b>25 x 100</b>	<b>1 line</b>	<b>12 mm high letters</b>
	<b>mm</b>		
<b>Size 7</b>	<b>25 x 100</b>	<b>2 lines</b>	<b>6 mm high letters</b>
	<b>mm</b>		

.3 Labels:

**.1 Embossed plastic labels with 6 mm high letters unless specified otherwise.**

.4 Wording on nameplates to be approved by Department Representative prior to manufacture.

.5 Allow for minimum of twenty-five (25) letters per nameplate.

.6 Identification to be in English.

.7 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics. **Label both box and cover.**

.8 Disconnects, starters and contactors: indicate equipment being controlled and voltage. Terminal cabinets and pull boxes: indicate system and voltage.

.9 Panelboards and switchboards: name and electrical characteristics (voltage, phase, wire, bus capacity, interrupting capacity, circuit number and designation).

Example:

Panel A - 225 A 120/240 V - 1 PH - 3 W Fed from panel DA Circuit #2, 4, 6	Minimum interrupting capacity of breakers installed in this panel is to be not less than 10 KAIC
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.10 Switch board and panels: indicate panel designation, amperage, voltage and interrupting rating.

.11 Transformers: indicate transformer designation, capacity, primary and secondary voltages.

.12 All power, switches, data and telephone outlets shall have a transparent identification permanently installed on coverplate.

**2.7 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 C22.1-18.
- .4 Use colour coded wires in communication cables, matched throughout system.

**2.8 CONDUIT AND CABLE IDENTIFICATION**

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide primary colour and **20 mm** wide auxiliary colour.
- .4 All electrical and communications conduits shall be color coded as per the following:

	<u>Prime</u>	<u>Auxiliary</u>
240/120 V Normal	Black	
Fire Alarm	Red	
Telephone	Blue	

	<u>Prime</u>	<u>Auxiliary</u>
Data	Yellow	Black
Intercom	Green	
Television	Turquoise	Blue
Switch Returns	Yellow	
Low Voltage	White	

- .5 Provide identification of equipment, components, and assemblies specified, using materials suitable to withstand anticipated operating environment.
- .6 Confirm colour code requirements with Departmental Representative prior to start of work.

**2.9 HOUSE KEEPING PADS**

- .1 Co-ordinate with the General Contractor for the provision of Housekeeping Pads under floor mounted equipment.
- .2 Provide concrete housekeeping pads for all switchboards, transformers and all other free-standing electrical equipment. Pads to be a minimum of 153 mm larger than the outside dimensions of the equipment they support, and not less than 102 mm thick.

**PART 3 EXECUTION**

**3.1 FIELD QUALITY CONTROL**

- .1 Confirm other related work is complete to receive work of this and related electrical sections.
- .2 Commission electrical systems.
- .3 Qualifications:
  - .1 Electricians: qualified, licensed electricians or apprentices in accordance with Provincial Act respecting manpower vocational training and qualifications.
  - .2 Apprentices: employees registered in provincial apprentices program permitted, under direct supervision of qualified licensed electrician, to perform specific tasks. Permitted activities determined based on level of training attained and demonstration of ability to perform specific duties.
- .4 Contractor holding valid Master Electrical contractor licensed as issued by Province that work is being constructed.

**3.2 INSTALLATION**

- .1 Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, MSDS, and product datasheets.
- .2 Protect electrical equipment from dust and dirt. Plug or cap openings in conduit, fixtures and equipment during construction with Department Representative approved materials.

- .3 Conceal conduit in finished areas, unless otherwise authorized. Run exposed conduit parallel to building lines, and maintain maximum headroom.
- .4 Install outlets, plates and other visible items parallel to building lines. Line up exposed raceways, parallel and at right angles to building walls, partitions, and ceilings.
- .5 Set equipment and components plumb and level, accurate to position intended, and position hanger rods plumb.

### **3.3 LOCATION OF OUTLET BOXES**

- .1 Do not install outlet boxes back to back in same wall or partition.
  - .1 Provide minimum **150 mm** horizontal separation between boxes.
  - .2 Prior to completion of rough-in, relocate outlets up to 3 m at no change in Contract cost.
  - .3 Locate disconnect devices on latch side of door.
- .2 Attach electrical equipment, components and devices directly to structure and structural supporting elements.

### **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 51 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

### **3.6 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Toggle switches: 1200 mm.
  - .2 Wall receptacles:
    - .1 General: 400 mm.
    - .2 In mechanical rooms: 1200 mm.
  - .3 Panel boards: as required by Code.
  - .4 Telephone and data outlets: 400 mm.
  - .5 Fire alarm manual pull stations: 1200 mm.
  - .6 Fire alarm horn/strobes: 2300 mm.

### **3.7 FIELD QUALITY CONTROL**

- .1 Conduct and pay for following tests in accordance with Division 01 - General Requirements:
  - .1 Circuits originating from branch and distribution panels.
  - .2 Lighting and its control.
  - .3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .4 Systems: fire alarm system, telephone, data, security, Intercom/PA, CCTV and emergency lighting.
  - .5 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.
    - .4 Replace conductors as required.
- .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 certificates from manufacturers verifying compliance of Work, in handling, installing, applying, protecting and cleaning of products for inclusion in operation and maintenance manuals.

- .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 as indicated in respective specification sections.

### **3.8 VERIFICATION**

- .1 Measure phase current to panelboards with normal loads 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 Submit report, at completion of measurements, listing phase and neutral currents on panelboards, dry-type transformers and motor control centres, operating under normal load. Include hour and date on which load was measured, and voltage at time of test.

### **3.9 FIELD TESTS**

- .1 Provide advance notice Department Representative of proposed testing schedule.
- .2 Perform tests at time of acceptance of work.
- .3 Conduct and pay for field tests:
  - .1 Power distribution, including phase voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Motors, including sequenced operation.
  - .4 Lighting and lighting control.
- .4 Perform tests in presence of Department Representative:
  - .1 Provide instruments, meters, equipment and personnel required to conduct required tests.
  - .2 Test systems to verify operation as specified.
- .5 Conduct di-electric tests, hi-pot tests, insulation resistance tests and ground continuity tests as required by nature of various systems and equipment.
- .6 Perform following tests on completed power systems:
  - .1 Control and switching: test circuits for correct operation of devices, switches and controls.

- .2 Polarity tests: test circuits for correct operation of devices, switches and controls.
- .3 Voltage tests: test voltage at last outlet of each circuit; maximum potential drop 2% on 120 V, and 208 V branch circuits, 2% on feeder circuits. Correct deficiencies.
- .4 Phase balance: measure load on each phase at switchboards, splitter, distribution panel board and lighting and power panel board:
  - .1 Submit results to Department Representative in writing.
  - .2 Re-arrange phase connections as necessary to balance load on each phase as instructed by Department Representative.
  - .3 After marking such changes, submit revised drawings showing modified connections to Department Representative.
- .5 Supply voltage: measure line voltage of each phase at load terminals of main breakers and report results in writing to Department Representative. Perform test with majority of electrical equipment in use.
- .6 Motor loading: measure line current of each phase of motors with motor operating under load, and report results in writing to Department Representative:
  - .1 Upon indications of imbalances or overloads, thoroughly examine electrical connections and rectify defective parts or wiring.
  - .2 If electrical connections are correct, report overloads due to defects in driven machines in writing to Department Representative.
- .7 Insulation resistance tests:
  - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument. Minimum insulation resistance shall be 0.5m $\Omega$ .
  - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument. Minimum insulation resistance shall be 1.0m $\Omega$ .
  - .3 Check resistance to ground before energizing.
- .8 Co-ordinate and carry out motor testing at same time as driven equipment is being tested. In addition to motor loading tests, provide labour and instruments to read and record motor load readings required to supplement tests on driven equipment through various load sequences, as required by driven equipment tests.



- .7 General operations: energize and operate electrical circuit and item. Repair, alter, replace, test and adjust as necessary for a complete and operating electrical system.
- .8 Provide labour, instruments, apparatus and pay expenses required for testing. Department Representative reserves right to demand proof of accuracy of instruments used.
- .9 Immediately prior to occupancy, test entire electrical system by performing loss and return of utility power test. Demonstrate operation of:
  - .1 High and low voltage service equipment and metering.
  - .2 Emergency lighting.
  - .3 Fire alarm, Public Address, Security Alarm / Door Access Control System, Video Surveillance System operation during power outage, including remote monitoring system.
  - .4 EMCS system shut down and auto restart, including re-stabilization of systems after power return. Attach report printouts as evidence of expected operation on systems.
  - .5 User equipment shut-down and auto-restart.

### **3.10 TEST RESULTS**

- .1 Submit test results to Department Representative for review.
- .2 Testing methods and test results: to CSA, CEC and authorities having jurisdiction.
- .3 Remove and replace conductors found damaged, with new materials.
- .4 Provide required labour and tools, if during testing Department Representative requests equipment be opened and removed from their housings to examine equipment, terminations and connections.

### **3.11 TRAINING**

- .1 Train operating personnel in operation, care and maintenance of electrical equipment.
- .2 Arrange and pay for manufacturer's factory service engineer to provide training. Ensure operating personnel are conversant with its care and operation.

- .3 Obtain and submit written confirmation from operating personnel that satisfactory training has been received.

**3.12 CLEANING**

- .1 Perform final cleaning of electrical equipment, systems and components.

**3.13 DEMONSTRATION**

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .3 Department's Representative may record these demonstrations on video tape for future reference.

**3.14 PROTECTION**

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

**3.15 CONTROL OF HAZARDOUS ENERGY**

- .1 Lock out and tag out all electrical and other equipment before performing work as per CAN/CSA-Z460-13.

**END OF SECTION**

**PART 1 GENERAL****1.1 SECTION INCLUDES**

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

**1.2 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results - Electrical.
- .3 Section 26 05 21 - Wires and Cables 0-1000V.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International) Latest Edition of the following:
  - .1 CAN/CSA-C22.2, No.18 (R2009), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
  - .2 CSA C22.2 No.65 (R2008) Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC) Latest Edition of the following:
  - .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

**PART 2 PRODUCTS****2.1 MATERIALS**

- .1 Pressure type wire connectors to: *CSA C22.2 No. 65-03*, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: *CSA C22.2 No. 65-03*, 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 stranded copper conductors.
  - .3 Stud clamp bolts.
  - .4 Bolts for copper conductors.
  - .5 Bolts for aluminum conductors.
  - .6 Sized for conductors as indicated.

- .4 Clamps or connectors for armoured cable, flexible conduit, as required to: CAN/CSA-22.2 No. 18.1.

### **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 datasheet.

#### **3.2 INSTALLATION**

- .1 Remove insulation carefully from ends of conductors and:
  - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
  - .2 Install fixture type connectors and tighten. Replace insulating cap.
  - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2.
- .2 Joints required in connecting all wiring up to and including # 8 are to be made using twist-on connectors.
- .3 Joints for all other wiring shall be made using colour-keyed compression type connectors followed by a layer of CSA approved vinyl plastic tape.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results - Electrical.
- .3 Section 26 05 20 - Wire and Box Connectors - 0-1000 V.
- .4 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

**1.2 REFERENCES**

- .1 CSA C22.2 No .0.3-09 (R2005), Test Methods for Electrical Wires and Cables Latest Edition.
- .2 CAN/CSA-C22.2 No. 131-M89 (R2004), Type TECK 90 Cable Latest Edition.

**PART 2 PRODUCTS**

**2.1 BUILDING WIRES**

- .1 Conductors: solid for #10 AWG and smaller; stranded for #8 AWG and larger. Minimum size: #12 AWG.
- .2 Conductors: size as indicated, with 600V insulation of chemically cross-linked thermosetting polyethylene material rated RW90, RWU90 for wiring installed underground in conduit.
- .3 Conductors: all wiring shall be copper.
- .4 Neutral conductor insulated for 600V shall be continuous with no fuses, switches, or breaks of any kind.
- .5 Wiring requirements for specialized systems such as fire alarm, public address, etc. are indicated in the respective specification sections or on drawings.
- .6 The voltage drop shall in no case exceed **3%** of the line volts for branch circuits.
- .7 Voltage drop shall be calculated based on 80% of the circuit breaker current rating for all branch circuits unless noted otherwise.

- .8 Voltage drop for motor branch circuits shall be calculated based on current equal to 80% of the ampacity of the branch circuit conductors.
- .9 Branch circuit conductor sizes specified on drawings are the minimum required. Upsize branch circuit conductor sizes as required so that the voltage drop is less than the maximum value permitted.

## **2.2 TECK CABLE**

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
  - .1 Type: ethylene propylene rubber.
  - .2 Chemically cross-linked thermosetting polyethylene rated type RW90, 600V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking.
- .6 Overall covering: thermoplastic polyvinyl chloride material.
- .7 Fastenings:
  - .1 Channel type supports for two or more cables at 1.5 m centers.
  - .2 Threaded rods: 13 mm dia. to support suspended channels.
- .8 Connectors:
  - .1 Watertight, approved for TECK cable.

## **2.3 ARMoured CABLES**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from galvanized steel strip.
- .4 Connectors: Steel set screw.

- .5 AC-90 cables may only be used:
  - .1 As individual cable drops from junction boxes to devices and fixtures provided the horizontal components are not longer than 1.5 m, do not run from room to room, are adequately supported and are run concealed.
  - .2 For wiring of outlets or devices in cabinetry where it is impractical to install conduit.
- .6 AC-90 shall not be permitted in masonry walls.

## **2.4 MINERAL - INSULATED CABLE**

- .1 Not Applicable.

## **2.5 CONTROL CABLES**

- .1 Low energy 300 V control cable: stranded annealed copper conductors sized as indicated, with PVC insulation type, TW wire braid over each group and overall covering of PVC jackets.

## **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 datasheet.

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

- .1 Fire rated cables shall be used for all 600 V, and 208 V essential power feeder as well as fire alarm system wiring as required by NBCC (latest edition).
- .2 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34.
- .3 The voltage drop shall in no case exceed **3%** of the line volts for branch circuits.
- .4 Voltage drop shall be calculated based on 80% of the circuit breaker current rating for all branch circuits unless noted otherwise.
- .5 Voltage drop for motor branch circuits shall be calculated based on current equal to 80% of the ampacity of the branch circuit conductors.

- .6 Branch circuit conductor sizes specified on drawings are the minimum required. Upsize branch circuit conductor sizes as required so that the voltage drop is less than the maximum value permitted.

**3.3 INSTALLATION OF TECK CABLE 0-1000 V**

- .1 Group cables wherever possible on channels.
- .2 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0 - 1000 V.
- .3 Use only for portions of feeders located outdoors, unless indicated otherwise.

**3.4 INSTALLATION OF ARMOURED CABLES**

- .1 Group cables wherever possible.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.
- .3 Fixture drops are to run from the junction box in the respective room and not to fixtures in other rooms. Fixture drops shall be from the side of the outlet boxes and not through the cover plate. Maximum of four fixture drops from any single junction box. AC 90 cables shall be secured within 300mm of the junction boxes.
- .4 Support and securing of AC 90 cables shall not be derived from suspended ceiling support wires or by lying on top of the ceiling.

**3.5 INSTALLATION OF CONTROL CABLES**

- .1 Install control cables in conduit or underground ducts as directed.
- .2 Ground control cable shield.

**3.6 INSTALLATION OF MINERAL - INSULATED CABLES**

- .1 Not Applicable.

**END OF SECTION**



**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International):
  - .1 CSA C22.2 No.41-07, Grounding and Bonding Equipment.

**PART 2 PRODUCTS**

**2.1 CONNECTORS AND TERMINATIONS**

- .1 Copper compression connectors to CSA C22.2 as required sized for conductors.

**PART 3 EXECUTION**

**3.1 INSTALLATION**

- .1 Install, terminations, and splices in accordance with manufacturer's instructions.
- .2 Bond and ground as required to CSA C22.2 No.41.
- .3 Do not install more than three (3) connections per junction box unless specifically permitted by Department Representative (in writing).

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 Canadian Standards Association, CSA C22.1-18, Canadian Electrical Code, Part 1.

**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 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .5 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.

**2.2 MANUFACTURERS**

- .1 Not Applicable.

**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 datasheet.

**3.2 INSTALLATION GENERAL**

- .1 Install complete permanent, continuous grounding system including electrodes, conductors, connectors, accessories. Where EMT 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 and grounding 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 separate ground conductor to outdoor lighting standards.
- .9 Connect building structural steel and metal siding to ground by welding copper to steel.
- .10 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .11 Bond single conductor metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

- .12 Install grounding conductors in conduit except where run in cable tray. Bond to EMT conduit.
- .13 Ground secondary enclosures.

### **3.3 ELECTRODES**

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter.
- .2 Install water meter shunt.
- .3 Install rod electrodes and make grounding connections.
- .4 Bond separate, multiple electrodes together.
- .5 Use size 2/0 AWG copper conductors for connections to electrodes.
- .6 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

### **3.4 EQUIPMENT GROUNDING**

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list: Service equipment, transformers, duct systems, frames of motors, starters, control panels, building steel work, elevators, distribution panels, outdoor lighting.
- .2 Where feeders over 100 A capacity pass through junction or pull boxes the ground continuity through the box shall be ensured by the use of grounding bushings and conductors sized in accordance with table 18 of CSA 22.1.
- .3 Run continuous bond wire the entire length of cable tray. Bond to cable tray at each section.

### **3.5 GROUNDING BUS**

- .1 Install copper grounding bus mounted on insulated supports, on walls of electrical rooms as indicated on drawings.
- .2 Use Thermit weld connections for all connections to perimeter ground bus.

**3.6 FIELD QUALITY CONTROL**

- .1 Verifications requirements in accordance with Division 01 - General Requirements.
- .2 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.

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

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results - Electrical.

**PART 2 PRODUCTS**

**2.1 SUPPORT CHANNELS**

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

**2.2 CABLE SUPPORTS**

- .1 J-Hook secured to wall or structural member for support of communications cabling.

**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 datasheet.

**3.2 INSTALLATION**

- .1 Secure equipment to hollow or solid masonry, tile and plaster surfaces with nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps:

- .1 One-hole steel straps to secure surface conduits and cables 51mm and smaller.
- .2 Two-hole steel straps for conduits and cables larger than 51mm.
- .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems:
  - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 10 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Department Representative.
- .13 Install fastenings and supports as required for each type of equipment, cable and conduit, and in accordance with manufacturer's installation recommendations.
- .14 **Do not support conduit from other conduit.**

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results - Electrical.

**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 and connection bars 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.

**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 datasheet.

**3.2 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.

**3.3 JUNCTION AND PULL BOXES INSTALLATION**

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



- .2 Install pull boxes so as not to exceed 30 m of conduit run or 2-90° bends between pull boxes.
- .3 Mount cabinets with top not higher than 1800 mm above finished floor.

#### **3.4 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 RELATED SECTIONS**

- .1 Division 01- General Requirements.
- .2 Section 26 05 00 - Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 CSA C22.1-18, Canadian Electrical Code, Part 1.
- .2 CAN/CSA-C22.2 No. 18-98 (R2003) Outlet Boxes, Fittings and Associated Hardware.

**PART 2 PRODUCTS**

**2.1 OUTLET AND CONDUIT BOXES GENERAL**

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.

**2.2 SHEET STEEL OUTLET BOXES**

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 51 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 voice and data outlets.

**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-galvanized sheet steel concrete type boxes for flush mounted devices in concrete with matching extension and plaster rings as required.

**2.5 CONDUIT BOXES**

- .1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

**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.
- .5 EMT fittings to be steel set screw type.

**2.7 IDENTIFICATION**

- .1 All boxes installed above finished ceilings and in interstitial levels shall have their covers color coded, as described in these specifications, and shall be labelled as to room number they serve.

**2.8 FLOOR BOXES**

- .1 Not Applicable.

**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 datasheet.

### **3.2        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, and armored cable connections. Reducing washers are not allowed.
- .5    All boxes shall be installed recessed/flush unless indicated otherwise.
- .6    Install all outlet boxes in exterior walls with flexible vapour barrier and seal with caulking.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA) Latest Edition of the following:
  - .1 CAN/CSA C22.2 No. 18.1-04 (R2009), Metallic Outlet Boxes.
  - .2 CAN/CSA C22.2 No. 18.3-04 (R2009), Hardware for the Support of Conduit, Tubing and Cable Fittings.
  - .3 CAN/CSA C22.2 No. 18.5-02 (R2007), Positioning Devices.
  - .4 CSA C22.2 No. 45.1-07, Electrical Rigid Metal Conduit - Steel.
  - .5 CSA C22.2 No. 45.2-07, Electrical Rigid Metal Conduit - Aluminum, Red Brass and Stainless Steel.
  - .6 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .7 CSA C22.2 No. 83.1-07, Electrical Metallic Tubing - Steel.
  - .8 CSA C22.2 No. 211.2-06, Rigid PVC (Un-plasticized) Conduit.
  - .9 CAN/CSA C22.2 No.227.3-05, Non-Metallic Mechanical Protection Tubing (NMPT), National Standard of Canada (February 2006).

**PART 2 PRODUCTS**

**2.1 CONDUITS**

- .1 Rigid metal conduit: to CSA C22.2 No.5, Hot Dipped Galvanized Steel Threated.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83 - M 1985 (R003), with couplings.
- .3 Rigid PVC conduit: to CSA C22.2 No.211.2.
- .4 Flexible metal conduit and liquid-tight flexible conduit complete with anti-short bushings: to CSA C22.2 No. 56-04, steel and liquid-tight flexible metal.

- .5 Flexible PVC conduit: to CAN/CSA-C22.2 No.227.3.

## **2.2 CONDUIT FASTENINGS**

- .1 One-hole steel straps to secure surface conduits 51 mm and smaller. Two hole steel straps for conduits larger than 51 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1.5 m oc.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

## **2.3 CONDUIT FITTINGS**

- .1 Rain tight EMT connectors shall be used on "vertical" sections of conduit runs where terminating into tops of electrical equipment incorporating drip shields or hoods.
- .2 Fittings: Use set screw connectors and fittings for EMT. Coating: same as conduit.
- .3 Factory "ells" where 90 degree bends are required for 25 mm and larger conduits.
- .4 Connectors for flexible conduit shall be set screw galvanized steel.
- .5 Connectors for liquid tight flexible conduit shall be watertight, compression type galvanized steel.
- .6 Threaded plastic or metal bushings to be installed on all EMT connectors sizes 35 mm and larger.
- .7 Fittings: manufactured for use with conduit specified. Coating: same as conduit

## **2.4 EXPANSION FITTINGS FOR RIGID CONDUIT**

- .1 Not Applicable.

## **2.5 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 datasheet.

**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 EMT shall be installed as a complete system.
- .4 Support of electrical systems raceway shall be independent of any type of suspended ceiling support rods, wires, etc. and mechanical piping or duct systems.
- .5 Use electrical metallic tubing (EMT) for all work, unless otherwise indicated, for panelboard feeders, branch circuit wiring, fire alarm and communications, etc., where not installed underground unless specifically indicated otherwise. Provide a separate green ground for all conduit systems, including E.M.T.
- .6 Use rigid PVC conduit underground (direct buried) or embedded in concrete walls or ceiling slabs for panels and equipment.
- .7 Flexible Metal Conduit:
  - .1 Use flexible metal conduit for connection to surface or recessed luminaires.
  - .2 Flexible metal conduit permitted above T-bar ceilings, for drops to various fire alarm devices mounted on flush outlet boxes in finished ceiling. Minimum size of flexible conduit: 22 mm, Maximum length of drop: 1.5 m.
- .8 Use flexible PVC conduit embedded in concrete walls or ceiling for light/power branch circuit wiring and switch legs.

- .9 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment, furniture and transformers. Include a separate ground wire.
- .10 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .11 Minimum conduit size for lighting and power circuits: 21 mm.
- .12 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .13 Mechanically bend steel conduit over 22 mm dia.
- .14 Install rigid galvanized steel threaded conduit for service cables for electrical vault to service entrance boards.
- .15 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .16 Install fish cord in empty conduits.
- .17 Run 2 - 25 mm spare conduits up to accessible ceiling space for each flush panel. Terminate these conduits in 153 x 153 x 102 mm junction boxes in ceiling space.
- .18 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .19 Dry conduits out before installing wire.
- .20 Securely fasten in place within 83 mm of each outlet box, junction box, cabinet, coupling or fitting, maximum spacing between supports as follows:
  - .1 1.5 m for 21 mm trade size conduit and smaller.
  - .2 2 m for 27 mm to 35 mm trade size conduit.
  - .3 3 m for 41 mm trade size and larger.
- .21 Ground Wires:
  - .1 Provide a separate green ground wire in all conduit, including EMT.

### 3.3 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Run conduits in flanged portion of structural steel.



- .3 Group conduits wherever possible on suspended or surface channels.
- .4 Do not pass conduits through structural members except as indicated.
- .5 Do not locate conduits less than 76 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- .6 Unless approved in writing by Department Representative, surface conduits are acceptable only in electrical, communications and mechanical rooms.

### **3.4 CONCEALED CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not run conduits horizontally in walls and do not run conduit on inside of metal studs.
- .4 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 1" concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.

2021-02-18

Project No. R.110935.001

SECTION 26 05 34

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

Page 6 of 6

**3.6 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE**

- .1 Run conduits 1" (minimum) and larger below slab and encase in 3" concrete envelope:
  - .1 Provide 2" of sand over concrete envelope below floor slab.

**3.7 CONDUITS UNDERGROUND**

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

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials, components, cabinets, instruments and installation for metering and switchboard Instruments.
  - .2 Electrical Meter products.

**1.2 RELATED SECTIONS**

- .1 Sections 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition, Waste Management and Disposal.
- .3 Section 26 05 00 - Common Work Results - Electrical.

**1.3 REFERENCES**

- .1 Markings:
  - .1 The Electrical Meter shall be marked and comply with CE directives.
  - .2 The Electrical Meter shall be marked and comply with the CSA.
  - .3 The Electrical Meter shall be marked with UL.
- .2 The Electrical Meter shall comply with the following safety/construction standards:
  - .1 IEC61010-1 (EN61010-1): Safety requirements for electrical equipment for measurement, control and laboratory use.
  - .2 CSA C22.2 No 1010-1: Canadian Standards Association. Certified by Canadian Standards Association (CSA).
  - .3 UL61010B-1 Measuring, Testing and Signal Generation Equipment
  - .4 IEC62052-11: Electricity metering equipment (AC) - general requirements, tests and test conditions.
- .3 The Electrical Meter shall comply with the following electromagnetic immunity standards:
  - .1 IEEE C.37-90.1: IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems (ANSI). All inputs tested, except for the network communications port.
  - .2 IEC1000-4-2 (EN61000-4-2/IEC801-2): Electrostatic Discharge (B).

- .3 IEC1000-4-3 (EN61000-4-3/IEC801-3): Radiated EM Field Immunity (A).
- .4 IEC1000-4-4 (EN61000-4-4/IEC801-4): Electric Fast Transient (B).
- .5 IEC1000-4-5 (EN61000-4-5/IEC801-5): Surge Immunity (B).
- .6 IEC1000-4-6 (EN61000-4-6/IEC801-6): Conducted Immunity.
- .7 IEC1000-4-12 (EN61000-4-12/IEC801-12): Immunity to damped oscillatory waves.
- .8 IEC1000-3-2 (EN61000-3-2): Limits for harmonic currents emissions (equipment input current < 16 amps per phase).
- .9 IEC1000-3-3 (EN61000-3-3): Limitation of voltage fluctuations and flicker in low voltage supply systems for equipment with rated current < 16 amps.
- .4 The Electrical Meter shall have a 3rd party certification proving compliance to the following electromagnetic emission standards:
  - .1 FCC Part 15 Subpart B, Class A: Class A Digital Device, Radiated Emissions.
  - .2 ICES-003, Industry Canada, Interference Causing Equipment Standard (ICES) Class A Digital Device, Radiated/Conducted Emissions.
  - .3 EN55011 (CISPR 11): Radiated/Conducted Emissions (Group 1, Class A).
  - .4 EN55022 (CISPR 22): Radiated/Conducted Emissions (Class A).
- .5 The Electrical Meter shall comply to the following measurement standards with 3rd party compliance certification:
  - .1 IEC61000-4-30 Class A Edition 2.
  - .2 IEC61000-4-7 interharmonics.
  - .3 IEC61000-4-15 flicker (accurate to PST of 20).
- .6 The Electrical Meter shall have a 3rd party compliance certification to the following communications standards:
  - .1 IEC 61850-8-1 edition 1.

#### 1.4 PRODUCT DATA

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

- .2 Indicate meter, instrument, outline dimensions, panel drilling dimensions and include cut-out template.

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

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - 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 paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused wiring materials from landfill to metal recycling facility as approved by ESCo Construction Manager.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

#### **1.6 SPECIFIC PRODUCT WARRANTY**

- .1 Meters shall be warranted by the vendor against manufacturing defects for a period of three (3) years. No maintenance shall be required for the meters.

#### **1.7 SITE CONDITIONS**

- .1 Provide acceptable operations and performance under to following conditions:
  - .1 Temperature: 0°C to 50°C.
  - .2 Humidity: 5% to 95% non-condensing.

#### **1.8 SUBMITTALS**

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Submit product data sheets for each product item proposed for this project.
  - .2 Submit product data sheets for auxiliary devices, cabinets, UPS and other supporting components. Provide enclosure shop fabrication drawings.
  - .3 Indicate devices, outline dimensions, panel drilling dimensions and cut-out template.

- .4 Contractor to field verify mounting locations and space restrictions prior to preparing cabinet details and shop drawing submissions. Adjustment of the cabinet sizes will be reviewed with the ESCo Construction Manager prior to completing preparation of submittals.

## **1.9 DEMONSTRATION AND TRAINING**

- .1 Submit demonstration and training plan to ESCo Construction Manager for approval.

## **1.10 COMMISSIONING**

- .1 Manufacturer's Representative shall conform to Cx Requirements and Support Commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Manufacturer's Representative to be present during all site commissioning.

## **Part 2 Products**

### **2.1 ELECTRICAL METERS**

- .1 Approved Products: Not applicable.
- .2 Mounting Configuration:
  - .1 The Electrical Meter shall be available as a combined front panel and base unit that can be mounted in the enclosures cabinet door or as a separate base unit and remote display unit. The remote display unit is panel mountable in the enclosures cabinet door or similar mounting surfaces.
- .3 Factory Assembled Enclosure:
  - .1 Reference Part 2.3 for enclosure specification.
- .4 Current/Voltage Inputs:
  - .1 The Electrical Meter shall:
    - .1 Have no less than 4 voltage inputs and 4 current inputs
    - .2 In its standard configuration be able to accept 600VAC LL / 347VAC LN without using potential transformers.
    - .3 Be able to withstand 1500 VAC RMS continuously without damaging the device.

- .4 Support nominal current ratings of 1A, 2A, 5A, 10A, and/or 20A and an overcurrent rating of 500A for 1s (5A nominal model) or 200A for 1s (1A nominal model).
- .5 Measured Values:
  - .1 The Electrical Meter shall provide at minimum the following voltage values:
    - .1 Voltage L-L Per-Phase.
    - .2 Voltage L-L 3-Phase Avg.
    - .3 Voltage L-N Per-Phase.
    - .4 Voltage 3-Phase Avg.
    - .5 Voltage % unbalanced.
  - .2 The Electrical Meter shall provide at minimum the following current values:
    - .1 Current Per-Phase.
    - .2 Current, Neutral (measured).
    - .3 Current % Unbalanced.
  - .3 The Electrical Meter shall provide at minimum the following power values:
    - .1 Real Power (Per-Phase, 3-Phase Total).
    - .2 Reactive Power (Per-Phase, 3-Phase Total).
    - .3 Apparent Power (Per-Phase, 3-Phase Total).
    - .4 Power Factor - True (Per-Phase, 3-Phase Total).
    - .5 Power Factor - Displacement (Per-Phase, 3-Phase Total).
  - .4 The Electrical Meter shall provide at minimum the following energy values:
    - .1 Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute).
    - .2 Incremental Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute).
    - .3 Conditional Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute).
    - .4 Reactive Energy by Quadrant.
  - .5 The Electrical Meter can provide a minimum/maximum value for any measured parameter.
  - .6 The Electrical Meter shall be capable of deriving values for any combination of measured or calculated parameter, using the following arithmetic, trigonometric, and logic functions (or equivalent PLC capabilities):

- .1 Arithmetic functions: division, multiplication, addition, subtraction, power, absolute value, square root, average, max, min, RMS, sum, sum-of-squares, unary minus, integer ceiling, integer floor, modulus, exponent, PI.
  - .2 Trigonometric functions: COS, SIN, TAN, ARCCOS, ARCSIN, ARCTAN, LN, LOG10.
  - .3 Logic functions: =, =>, <=, <>, <, >, AND, OR, NOT, IF.
- .6 Demand:
- .1 The Electrical Meter shall be able to provide min/max demand, present demand interval, running average demand, and predicted demand on multiple demand channels.
  - .2 The Electrical Meter shall be able to perform multiple accepted demand calculation methods including block, rolling block, and thermal demand with user-programmable demand period lengths.
- .7 Accuracy:
- .1 The Electrical Meter shall meet ANSI C12.20 accuracy class 0.2.
  - .2 The Electrical Meter shall meet IEC62053-22: Electricity metering equipment (AC) - particular requirements -part 22: static meters for active energy, accuracy class 0.2S.
  - .3 The Electrical Meter shall meet IEC62053-23: Electricity metering equipment (AC) - particular requirements -part 23: static meters for reactive energy, accuracy class 1.
  - .4 The Electrical Meter shall provide 4-quadrant metering.
- .8 Sampling:
- .1 The Electrical Meter shall sample at 1024 or 512 samples/cycle.
  - .2 The Electrical Meter shall be able to perform high speed sag/swell detection of voltage disturbances on a cycle-by-cycle basis, providing the duration of the disturbance, the minimum, maximum, and average value of the voltage for each phase during the disturbance. Disturbances less than one cycle in duration can be detected.



.9 Logging:

- .1 The Electrical Meter shall have at least 5MB of user programmable onboard data logging.
- .2 The Electrical Meter will store all critical internal and revenue data upon sudden power loss.
- .3 The Electrical Meter shall have non-volatile memory.
- .4 The Electrical Meter shall have a time-stamped event log with the following features:
  - .1 Supports at least 500 events.
  - .2 The number of records in the log is programmable.
  - .3 Each event is recorded with the date and time of the event, the cause and effect of the event, and the priority of the event.
  - .4 All events relating to setpoint activity, relay operation and self-diagnostics is recorded in the event log.
  - .5 Time stamps have a resolution of 1 millisecond.
  - .6 Time stamps can be synchronized to within 100 ms between devices on the same serial communications medium.
  - .7 Minimum event recording response time is  $\frac{1}{2}$  cycle (8.3ms 60Hz, 10ms 50Hz) for high-speed events and 1 second for other events.
  - .8 The priority of setpoint events is programmable.
- .5 The Electrical Meter shall be able to log any parameter in the meter including min/max and waveforms.

.10 Alarming:

- .1 The Electrical Meter shall be able to generate a push notification via Ethernet connection on an alarm condition.
- .2 The Electrical Meter shall have millisecond timestamp resolution on alarm entries.
- .3 The Electrical Meter shall be able to readjust alarm setpoints based on the alarm quantity (Alarm Setpoint Learning):
  - .1 The user can enable the Electrical Meter to learn the characteristics of normal operation of metered values and select alarm setpoints based on this data.

- .2 The quantities to be learned shall be user selectable, including standard-speed and high-speed analog alarms, disturbance alarms, and voltage transient alarms.
- .3 The user can configure this feature using one of two modes:
  - .1 Manual: Once the learning is completed, the recommended values are stored for review and manual installation.
  - .2 Automatic: Once the learning is completed, the recommended values are automatically installed and operational.
- .4 The learning period shall be user configurable from 1 to 365 days to insure system stability prior to determining the recommended setpoints.
- .4 The Electrical Meter shall support consecutive high-speed alarm conditions which trigger on a cycle-by-cycle basis with no "dead" time between events (i.e. no need for a rearming delay time between events).
- .5 The Electrical Meter shall be able to operate relays on alarm conditions.
- .6 The Electrical Meter shall be able to initiate datalog captures on alarm conditions.
- .7 The Electrical Meter shall be able to control digital output relays in an AND or an OR configuration, using pulse mode or latch mode operation, for control and alarm purposes.
- .8 The Electrical Meter shall be able to combine any logical combination of any number of available setpoint conditions to control any internal or external function or event.
- .11 Communications:
  - .1 The Electrical Meter shall be capable of the following communications methods simultaneously and independently:
    - .1 Ethernet over Fiber or copper media.
    - .2 Serial RS-485.
  - .2 The Electrical Meter shall support the following communications protocols on any one port at any one time:
    - .1 Modbus:
      - .1 Modbus RTU.
      - .2 Modbus TCP.

- .3 Modbus Mastering of serial RS485 slaves.
- .2 XML compatibility.
- .3 HTTP (web pages).
- .3 The Electrical Meter shall support GPS time synchronization.
- .4 The Electrical Meter shall support at least 32 concurrent Modbus TCP connections.
- .5 The Electrical Meter shall have a Modbus TCP gateway for reading Modbus serial devices connected to a serial port on the instrument.
- .6 The Electrical Meter shall be equipped with an Ethernet port, internet enabled and support the following functions:
  - .1 Automatically send alarm notifications or scheduled system status updates via push notifications. Push notification sent by the Electrical Meter can be received via any web based messaging platform (i.e. Email, SMS etc.). Data logs can also be sent on an event-driven or scheduled basis.
  - .2 Built in web pages in the Electrical Meter enables access to real-time values and basic power quality information using a standard web browser.
  - .3 Basic configuration of the Electrical Meter can also be performed through the browser. Integration with custom reporting, spreadsheet, database and other applications with XML compatible data.
  - .4 IEC 61850 compliance with the following features:
    - .1 4 concurrent client connections.
    - .2 File based setup via FTP.
    - .3 Network time sync via SNTP.
    - .4 Configurable reports including selectable dataset member and configurable deadband values.
    - .5 Support buffered (4) and un-buffered (20) reports (1 buffered and 5 un-buffered per client).
    - .6 Map up to 16 analog and/or 16 digital calculated value for reporting in 61850.
    - .7 Fault capture data for 3-phase voltage and current channels in COMTRADE format including:

- .1 At least 1Mb of storage for fault capture files.
  - .2 The files shall be downloadable via standard ftp client.
- .12 I/O Options:
  - .1 The Electrical Meter shall be capable of having 16 digital inputs capable of  $\frac{1}{2}$  cycle timing resolution.
  - .2 The Electrical Meter shall have digital outputs that support pulse output relay operation for kWh total, kWh imported, kWh exported, kVARh total, kVARh imported, kVARh exported, and kVAh values.
  - .3 The Electrical Meter shall have 3 Form C relays which are isolated for up to 5000 VAC for 1 minute and 10A continuous for 30VDC and up to 240VAC.
  - .4 The Electrical Meter shall have 4 Form A analog inputs which are optically isolated.
  - .5 The Electrical Meter shall have 4 analog outputs with a 0-20mA range.
- .13 Display:
  - .1 The Electrical Meter shall have an integral display or a remote mounted display.
  - .2 The Electrical Meter shall support direct display of all parameters on the front panel.
  - .3 The Electrical Meter shall provide a trend display of any parameter internally recorded at regular intervals.
  - .4 The Electrical Meter shall have a user programmable custom display.
  - .5 The Electrical Meter shall be able to display advanced graphical representations of metering information including at minimum spectral components, phasor diagrams, and trending charts.
  - .6 The Electrical Meter shall be able to display measurements in either IEC or IEEE formats.
  - .7 The Electrical Meter display shall be support English language.
  - .8 The Electrical Meter shall be able to display the following front panel screens:
    - .1 Event Log: Display recent events written to the Electrical Meter's event log, including diagnostic events.

- .2 Nameplate: Display information in a tabular format (default nameplates show owner, meter and power system details).
  - .3 Trend Bar: Display up to 4 real time numeric parameters along with their upper and lower extremes.
  - .4 Histogram: Display harmonics content in histogram format, including 2nd to 63rd harmonic, THD (total, even, odd); current harmonics histogram screens display K Factor and Crest Factor.
  - .5 Phasor: Display phase information in phasor diagram format, including phase, voltage and current magnitudes; phasors that are too small in magnitude are shown as table entries only.
- .14 Field Programmability:
- .1 The Electrical Meter is field programmable as follows:
    - .1 Basic parameters: Voltage input scale, voltage mode (Wye, Delta, single phase), current input scale, auxiliary input and output scales, and communications setup parameters are programmable from the front panel.
    - .2 All basic parameters described above, plus additional setpoint/relay and data log setup parameters may be programmed via the communications port using a portable or remotely located computer terminal.
    - .3 Custom configuration of all operating parameters is possible through a graphical, flexible programming language.
    - .4 The configuration of the device will be done using programmable modules. The modules can be linked together in an arbitrary manner to create arbitrary functionality. Some example module types include min, max, setpoint, digital input, and digital output.
    - .5 Programming through a computer can be secured by user ID and password.
    - .6 Programming through the front panel is secured by password.
    - .7 Programmability shall be sectioned such that when the meter is sealed, the meter shall still be configurable to an extent that does not affect the accumulation of revenue metering related data.

.15 Power Quality:

- .1 Without the use of separate software, the Electrical Meter shall be able to evaluate power quality statistically in accordance with IEC 61000-4-30 Class A Edition 2.
- .2 The Electrical Meter shall be certified by a third party as compliant with IEC 61000-4-30 class A, Edition 2.
- .3 Without using separate software, the Electrical Meter shall determine statistical indicators of power quality parameters that include but are not limited to flicker, dips and swells, harmonics and inter-harmonics, in accordance with the EN50160 standards, "Voltage characteristics of electricity supplied by public distribution systems".
- .4 Without the use of separate software, the Electrical Meter shall make available the statistical indicators of power quality on the front panel display or via communications over any supported protocol or via an analog transducer interface.
- .5 Without the use of separate software, the Electrical Meter shall monitor the value of any statistical indicator of power quality (present, predicted, average or otherwise manipulated value) with an absolute or relative setpoint. When such setpoint is exceeded, issue an alert via push notification, or enable control via a local interface to mitigation equipment or control systems through relays and analog or digital outputs.
- .6 The Electrical Meter supports symmetrical components.

.16 Transients:

- .1 The Electrical Meter shall provide sub-cycle transient detection at 1024 or 512 samples/cycle
- .2 The Electrical Meter shall be able to perform 17microsecond transient captures (at 60Hz) or 20microsecond transient captures at 50Hz.

.17 Waveform Capture:

- .1 The Electrical Meter shall be able to perform 1024 or 512 samples/cycle waveform capture recording.
- .2 The Electrical Meter shall have nine programmable oscillographic waveform recorders. Each waveform recorder has the following features:

- .1 Able to record a digitized representation of any phase voltage or current signal with no dead time between such recordings, and the ability to trigger multiple such recordings in continuous succession, and at different resolutions simultaneously.
  - .2 Enabled and triggered manually or through internal operating conditions, including periodic timer or setpoint activity.
  - .3 High speed triggering is supported.
  - .4 The number of records (depth) of each data recorder, and the overflow conditions (stop-when-full or circular) is programmable.
- .3 The Electrical Meter shall be able to record continuously to capture long duration waveforms. The duration of the waveform capture shall be limited by memory alone.
- .18 Advanced Features:
  - .1 The Electrical Meter firmware shall be field upgradeable.
  - .2 Onboard meter clock can be paced by a choice of sources including GPS, power line, or internal clock.
  - .3 The Electrical Meter shall have security capabilities including but not limited to the following:
    - .1 Password protected, no hardware lock, or
    - .2 Password protected and hardware locked, or
    - .3 The following data is protected from alteration when locked:
      - .1 kWh and kVARh (import, export, net and total).
      - .2 kVAh (total).
      - .3 kW, kVAR, kVA demand (thermal and sliding window).
      - .4 kWh, kVARh, kVAh pulse outputs.
  - .4 The Electrical Meter shall have provisions for conformal coating of its internal circuitry for installations exposed to high degrees of humidity. (Tropicalization treatment)
  - .5 The Electrical Meter shall have provisions for creating periodic or non-periodic schedules for up to two (2) years. These schedules may be used to perform the following functions:

- .1 Time of Use (TOU).
- .2 Demand Control.
- .3 Load Scheduling.
- .4 Logging.
- .5 Periodic Resetting.
- .6 Alarm Gating.
- .6 The Electrical Meter shall have multiple tariffs and Time-of-Use (TOU) functionality to store and monitor up to 20 years of seasonal rate schedules. The TOU feature allows four seasons, four day types (each one capable of at least eight switch times, with a resolution of one minute). The TOU feature supports four rate tariffs, and at least twelve holidays per year, and allows periodic self-read capability.
- .7 The Electrical Meter shall be able to determine (with a level of confidence) whether a disturbance event occurred upstream or downstream of the meter. (Disturbance Direction Detection).
- .8 The Electrical Meter shall support trending and forecasting of logged data values feature both on the meter display and via the webpages.

## **2.2 FACTORY ASSEMBLED ENCLOSURE**

- .1 Application: Installation of new factory assembled enclosure to be supplied in identified instances of new meter installation and existing meter replacement.
- .2 NEMA Type 4 enclosure with one integrated display meter installed and wired.
- .3 Concealed hinge industrial enclosure that is UL listed.
- .4 Assembly to include factory mounted meters and devices wired to terminal blocks, voltage disconnects and current transformer (CT) shorting blocks.
- .5 Wall mountable and easy to install using concealed holes in the back of the enclosure.
- .6 Carbon steel construction, with industry standard ANSI 61 gray power-coat finish.
- .7 Custom engraved nameplates on all enclosures.
- .8 Provide wing knob lock.
- .9 Equip with hazard and safety labels.



- .10 Reference electrical drawings for meter enclosure layout requirements.
- .11 Factory testing certificate and pre-wiring guide to be provided for each meter.

### **2.3 CURRENT TRANSFORMERS (CT)**

- .1 Brass terminals.
- .2 CSA and UL approved.
- .3 Flexible leads are UL 1015 105°C, CSA approved, #16 AWG, 600 mm long.
- .4 Non-standard lead length to be available and ordered where required.
- .5 Mounting bracket kit - confirm with site specific requirements.
- .6 Order bus bar mounting kit as required. Confirm with site specific requirements.
- .7 5 amp with frequency 50-400 Hz.
- .8 Insulation Level: 600V, 10kV BIL full wave.
- .9 Approved for revenue metering by Measurements Canada.
- .10 Model and diameter to be confirmed on-site.

### **2.4 POTENTIAL TRANSFORMERS (PT)**

- .1 Thermal Rating: 200 VA (55°C rise above 30°C ambient).
- .2 Insulation Level: 600 V, BIL 10 kV full wave.
- .3 Frequency: 60 Hz.
- .4 Tin plated brass terminals.
- .5 CSA and UL approved.
- .6 Approved for revenue metering by Measurements Canada.
- .7 PT Ratio: as indicated on drawings.

**Part 3 Execution****3.1 ACCEPTABLE INSTALLERS**

- .1 Meter must be installed by a qualified contractor acceptable to the manufacturer's agent.

**3.2 INSTALLATION**

- .1 All power supply and communications wiring connections shall be performed in accordance with the guidelines set out in the meter product documentation.
- .2 All current and voltage sensing connections to the meter must be made using appropriately rated CT shorting blocks and PT's.
- .3 Installation of meter and ancillary equipment, and wiring connections to all electrical circuits, other meters and terminal strips for external devices must comply with all Provincial and National Electrical Codes.
- .4 All voltage sensing connections to metering instrumentation shall be made with appropriately sized fuses.
- .5 Provide new CT's and PT's for all new meter installations.
- .6 Where new is required, CTs shall be appropriately sized for the service and shall be Measurement Canada revenue metering approved. Measurement Canada certification is not required.
- .7 All meters must be powered from an auxiliary 120V power supply or dedicated, fused control power transformer. Meters cannot be powered from metering PTs.
- .8 Mount new meter, except where noted, in new externally mounted enclosure.
- .9 Install meter in location free from vibration and shock.

**3.3 FIELD QUALITY CONTROL**

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results - Electrical and in accordance with manufacturer's recommendations.

- .2 Conduct commissioning in accordance with Section 01 91 13 - General Commissioning (CX) Requirements and other relevant sections.
- .3 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.
- .4 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.
- .5 Perform test to obtain correct calibration.
- .6 Do not dismantle meters, auxiliaries in enclosures and instruments.

#### **3.4 CURRENT TRANSFORMERS (CT)**

- .1 Contractor to determine CT requirements through on-site measurement and inspection.

#### **3.5 TRAINING**

- .1 Manufacturer's Representative will be required to provide Demonstration and Training, reference Section 01 79 00.

**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 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results for Electrical.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C9-M1981(R2001), Dry-Type Transformers.
  - .2 CAN/CSA - C802.2-18, Test Method and Minimum Efficiency Values for Dry-type Transformers.

**1.4 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Shop drawings shall include the following:
  - .1 Dimensioned drawing showing enclosure, mounting devices, terminals, taps, internal and external component layout.
  - .2 Technical data:
    - .1 KVA rating.
    - .2 Primary and secondary voltages.
    - .3 Frequency.
    - .4 Three phase.
    - .5 Polarity or angular displacement.
    - .6 Full load efficiency.
    - .7 Regulation at unity power factor.
    - .8 BIL.
    - .9 Insulation type.
    - .10 Sound rating.

**1.5 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for dry type transformers for incorporation into Operation and Maintenance Manual specified in Division 01 - General Requirements.

- .2 Operation and maintenance instructions to include:
  - .1 Tap changing.
  - .2 Recommended environmental conditions.
  - .3 Recommended periodic inspection and maintenance.
  - .4 Bushing replacement.

## **PART 2 PRODUCTS**

### **2.1 HARMONIC MITIGATING TRANSFORMERS**

- .1 Not Applicable.

### **2.2 TRANSFORMERS**

- .1 Use transformers of one manufacturer throughout project.
- .2 Type: ANN, copper wound, 3 core.
- .3 3-phase, 60 Hz, 600V input, 120/208V output, 4 wire, 60 Hz isolation transformers.
- .4 Copper windings.
- .5 Size: As indicated on drawings.
- .6 Voltage taps: standard, located at front of coils for accessibility.
- .7 Insulation Class: 220 °C.
- .8 Insulation Temperature rise: 130 °C.
- .9 Efficiency: meets or exceeds CSA - C802.2-18.
- .10 Basic Impulse Level (BIL): standard.
- .11 Hipot: standard.
- .12 Average sound level: max 50dB at 5feet.
- .13 Single electrostatic shield: 60dB attenuation.
- .14 Impedance at 170°C: Standard.
- .15 Tap Changer: bolted-link type.
- .16 Mechanical lugs on primary, secondary and neutral.
- .17 Ground bar kit.

- .18 Vibration Isolator Pads.
- .19 Enclosure:
  - .1 Fabricated from sheet steel.
  - .2 Bolted removable panels for access to tap connections.
  - .3 Conduit entry: Knockouts.
  - .4 Designed for floor or wall mounting as indicated.
  - .5 Ventilated, NEMA-2 (Sprinkler Proof).
- .20 K-rated where indicated on drawings. **(Minimum K=13)**
- .21 Mitigating type where indicated on drawings (45 kVA and larger).

## **2.3 ACCEPTABLE MANUFACTURERS**

- .1 Acceptable Manufacturers:
  - .1 Not Applicable

## **2.4 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Label size: 7.

# **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 Mount dry type transformers up to 75 kVA as indicated.
- .2 Mount dry type transformers above 75 kVA on floor.
- .3 Floor mounted transformers shall be mounted on concrete house keeping pads as per Section 26 05 00.
- .4 Ensure adequate clearance around transformer for ventilation.
- .5 Install transformers in level upright position.

- .6 Remove shipping supports only after transformer is installed and just before putting into service.
- .7 Install vibration isolation pads between transformer enclosure and the mounting surface.
- .8 Loosen isolation pad bolts until no compression is visible.
- .9 Make primary and secondary connections in accordance with wiring diagram. All connections to transformers shall be with flexible metal conduits. Liquid-tight flexible connections shall not be permitted.
- .10 Energize transformers after installation is complete.
- .11 Install ground wire and connect to building ground in accordance with Section 26 05 08 - Grounding Secondary.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- .1 Materials and installation for breaker type panelboards.

**1.2 RELATED SECTIONS**

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

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International)  
Latest Edition of the following:
  - .1 CSA C22.2 No.29-M 1989 (R2004), Panelboards and Enclosed Panelboards.

**1.4 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Drawings include electrical detail of panelboard, branch breaker type, quantity, and ampacity and enclosure dimension, shown in the same layout as on panelboard schedules.

**PART 2 PRODUCTS**

**2.1 PANELBOARDS**

- .1 Panelboards: to CSA C22.2 No.29-M 1989 (R2004) 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.
  - .3 All provisional space shall be fully bussed and breaker ready.
- .2 250V panelboards: bus and breakers rated for 10 kA rms (symmetrical) interrupting capacity minimum or as indicated. 600V panelboard bus and breakers rated for 35000A (symmetrical) interrupting capacity or as indicated.



- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Two keys for each panelboard and key panelboards alike. Turn over keys to building Departmental Representative.
- .6 Copper bus with neutral of same ampere rating as mains, unless noted otherwise.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Trim and door finish: baked grey enamel.
- .10 Copper ground bus.
- .11 Surface mounted panelboard shall be sprinkler proof.

## **2.2 SURGE SUPPRESSION PANELBOARD**

- .1 Panelboards complete with integrated transient voltage surge suppression.
- .2 Surge current per phase: 100 kA.
- .3 Surge current modes: three (3) L-N, three (3) L-G, three (3) L-L, one (1) N-G.
- .4 Surge current per mode: 50 kA.
- .5 Surge withstand capabilities: 8000 surges.
- .6 Individual fused MOV's.
- .7 Monitoring display system.
- .8 Direct bus connection.
- .9 TVSS filter and monitoring display at top of panelboard.
- .10 Ten (10) year warranty.

- .11 Factory installed by manufacturer.

### **2.3 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.
- .4 Lock on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock on devices to Departmental Representative.
- .5 Lock on devices for fire alarm, door supervisory, intercom, stairway, exit, and night light circuits. Provide copy of receptacles of used breakers locked in operation and maintenance manuals.
- .6 Breakers shall be installed in panelboards as per schedule on drawings so as to conform to load balancing. Shop drawings shall indicate above positioning.

### **2.4 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - 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 Provide typewritten circuit directory, indicating location and load for each circuit. Circuit directories shall be written in English.

### **2.5 ACCEPTABLE MANUFACTURERS:**

- .1 Acceptable Manufacturers:
  - .1 Not Applicable

**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 Locate panelboards as indicated and mount securely, plumb, true, and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards or either fire retardant type or painted on all sides with fire retardant paint.
- .3 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.
- .6 Each flush mounted panel shall have 2 - 1" empty conduits studded to accessible ceiling space for future connections.

**3.3 TESTS**

- .1 Test each branch breaker to verify that it controls the load indicated on the drawing and panel directory.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results for Electrical.

**1.2 SECTION INCLUDES**

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

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International) Latest Edition of the following:
  - .1 CSA-C22.2 No.42-99 (R2004), General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2 CSA-C22.2 No.42.1-00 (R2004), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  - .3 CSA-C22.2 No.55-M 1986 (R2003), Special Use Switches.
  - .4 CSA-C22.2 No.111-00, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

**1.4 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 26 05 00 - Common Work Results for Electrical.

**PART 2 PRODUCTS**

**2.1 SWITCHES**

- .1 15A, 120V and 347V single pole, 3-way and 4-way switches, commercial specification grade to: CSA-C22.2 No.55 and CSA-C22.2 No.111.
- .2 Manually-operated commercial specification grade ac switches with following features:
  - .1 Terminal holes approved for No. 10 AWG wire.
  - .2 Silver Alloy contacts.
  - .3 High strength thermoplastic polycarbonate toggle.

- .4 Urea or melamine moulding for parts subject to carbon tracking.
- .5 Suitable for back and side wiring.
- .6 Toggle colour: white.
- .3 Toggle operated locking fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 Acceptable products:
  - .1 Toggle switch:
    - .1 15A, 120V, single pole, and 3-way, specification grade, white color, toggle switch.
    - .2 15A, 347V, Single and 3-way, specification grade, white color toggle switch.
    - .3 15A, 120V, specification grade, white color key switch.
    - .4 15A, 347V, specification grade, Brown color key switch.
    - .5 Switches of one manufacturer throughout project.
  - .2 Each light switch shown on plans shall have the circuit number and supplying panelboard identified. This identification shall be a mechanically attached label and shall be visible when the coverplate is in place, and shall be in a position not likely to be painted over.

## 2.2 RECEPTACLES

- .1 Duplex commercial specification grade receptacles, CSA types 5-15R and 5-20R 125V, U ground, specification grade, to: CSA-C22.2 No.42 with following features:
  - .1 Impact resistant nylon face.
  - .2 Thermoplastic back body.
  - .3 White urea moulded housing.
  - .4 Suitable for No. 10 AWG for back and side wiring.
  - .5 Break-off links for use as split receptacles.
  - .6 Triple wipe contacts and riveted grounding contacts.
  - .7 Plated steel mounting strap with integral ground contacts.
  - .8 Color: as indicated.

- .2 Acceptable materials:
  - .1 Duplex receptacles (NEMA 5-15R) shall be rated for 15 amp, 125 volt, Receptacles shall be specification grade.
  - .2 Duplex receptacles (NEMA 5-20RA) shall be rated for 20 amp, 125 volt, with a T-slot. Receptacles shall be specification grade.
  - .3 White housing for receptacles connected to non-essential power.
  - .4 Devices shall be tamper proof where indicated on plans.
  - .5 Receptacles of one manufacturer throughout project.

## **2.3 COVER PLATES**

- .1 Cover plates for wiring devices to: CSA-C22.2 No.42.1.
- .2 Cover plates from one manufacturer throughout project.
- .3 Cover plates for all flush-mounted switches and receptacles shall be as indicated on drawings.
- .4 FS-type cover plates for wiring devices installed in surface-mounted FS-type outlet boxes.
- .5 Recess weather protective covers as indicated on drawings.
- .6 Sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.
- .7 Nylon coverplates, thickness 2.5 mm for wiring devices mounted in flush mounted outlet box (unless indicated otherwise, white cover plates for receptacles and switches connected to non-essential power).
- .8 Sheet metal cover plates for wiring devices mounted in surface mounted FS or FD type conduit boxes.
- .9 All receptacles installed in vehicle storage open area shall be heavy duty type complete with steel cover plates.

## **2.4 SPECIAL WIRING DEVICES**

- .1 Other receptacles with ampacity and voltage as indicated on drawings.

**2.5 DIMMING CONTROL STATION**

- .1 Not Applicable.

**2.6 ACCEPTABLE MANUFACTURERS**

- .1 Not Applicable.

**2.7 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Label size: 1.
- .3 Provide one label for each wiring device indicating circuit number that the wiring device is connected to. Example: "A-23".

**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 Switches and dimmers:
  - .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 specified in Section 26 05 00 - Common Work Results - Electrical or as indicated.
  - .4 Install 3-way switches such that load is "OFF" when both toggles are down.
- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Where 2 receptacles are fed from different panelboards and installed in a common 2-gang outlet box, install voltage barrier between the receptacles.

- .3 Mount receptacles at height specified in Section 26 05 00 - Common Work Results - Electrical or as indicated.
- .4 All receptacles shall be installed with the "U" ground at the top.
- .5 All receptacles mounted horizontal shall be oriented with ground to the left.
- .3 Cover plates:
  - .1 Protect 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 General:
  - .1 All surface mounted wiring devices shall be installed in FS-type outlet boxes, c/w FS-type coverplates.

### **3.3 PROGRAMMING AND TRAINING**

- .1 Provide training to users for programming and operation of Dimmers.

### **3.4 TESTS**

- .1 Test and record each receptacle for polarity and retention of blades.

**END OF SECTION**



**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- .1 Materials for moulded-case circuit breakers.

**1.2 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results for Electrical.
- .3 Section 26 24 17 - Panelboards Breaker Type.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International) Latest Edition of the following:
  - .1 CSA-C22.2 No. 5-2 (R2007), Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).
  - .2 CAN/CSA-C22.2 No. 144-M91 (R2001), Ground Fault Circuit Interrupters.

**1.4 SUBMITTALS**

- .1 Submit Shop Drawings in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Include time-current characteristic curves for breakers with ampacity of 100 amp and over.

**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°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 to have minimum symmetrical rms interrupting capacity rating to match panel.

## **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 GFCI BREAKERS**

- .1 Ground fault circuit interrupter (GFCI) breakers to CAN/CSA-C22.2 No. 144, Class "A" type.
- .2 Single pole GFCI breakers, rated as noted c/w test and reset facilities.

## **2.4 ACCEPTABLE MATERIALS**

- .1 Breakers shall be compatible with existing panelboards and panelboards specified in Section 26 24 17 - Panelboards Breaker Type and shall meet the short circuit interrupting ratings as indicated.

# **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 circuit breakers as indicated.

## **3.3 TESTS**

- .1 Demonstrate simulated ground fault tests for all GFCI breakers.

**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 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results for Electrical.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International) Latest Edition of the following:
  - .1 CAN/CSA C22.2 No.4-04 **(R2009)**, Enclosed Switches.
  - .2 CSA C22.2 No.39-M 1987 (R2003), Fuse holder Assemblies.

**1.4 SUBMITTALS**

- .1 Submit Shop Drawings in accordance with Section 26 05 00 - Common Work Results for Electrical.

**PART 2 PRODUCTS**

**2.1 DISCONNECT SWITCHES**

- .1 Fusible and non-fusible, heavy-duty horsepower rated disconnect switches to CAN/CSA C22.2 No.4, sized to match circuit ampacity and voltage, or as indicated.
- .2 Provision for padlocking in off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle is in ON position.
- .4 Quick-make, quick-break action.
- .5 ON-OFF switch position indication on switch enclosure cover.
- .6 Enclosure: NEMA Type 4 or as indicated.

**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 ACCEPTABLE MANUFACTURERS**

- .1 Not Applicable.

## **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 disconnect switches complete with fuses, if applicable, where indicated *on drawings*.
- .2 Disconnect switches for mechanical equipment shall be mounted on uni-strut frame work.

### **3.3 TESTS**

- .1 Operate each disconnect switch to verify that the loads are disconnected.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results for Electrical.

**1.2 SUBMITTALS**

- .1 Submit Shop Drawings in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Shop Drawings shall 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.

**1.3 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for motor starters for incorporation into Operation and Maintenance Manual specified in Division 01- General Requirements.
- .2 Include operation and maintenance data for each type and size of starter.

**1.4 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with Section 26 05 00.
- .2 Provide the following spare parts for each different size and type of starter:
  - .1 3 contacts, stationary.
  - .2 3 contacts, movable.
  - .3 1 contact, auxiliary.
  - .4 1 control transformer.
  - .5 1 operating coil.
  - .6 2 fuses.
  - .7 10% indicating lamp bulbs used.
- .3 Provide a copy of receipts of maintenance and materials in the maintenance and operation manuals.

## **Part 2      Products**

### **2.1            MATERIALS**

- .1    Starters:    NEMA Type.
- .2    Half size starters not acceptable.
- .3    I.E.C. rated starters not acceptable.

### **2.2            MANUAL MOTOR STARTERS**

- .1    Single and Three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
  - .1    Switching mechanism, quick make and break.
  - .2    One or Three overload heater(s), manual reset, trip indicating handle.
- .2    Accessories:
  - .1    Toggle switch:    standard.
  - .2    Indicating light:    standard, red in color.
  - .3    Locking tab to permit padlocking in "ON" or "OFF" position.

### **2.3            MAGNETIC MOTOR STARTERS**

- .1    Magnetic and combination magnetic starters 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    Hand-off-auto selector switch.
  - .6    Full voltage non-reversing NEMA contactors in EEMAC 1 enclosure.
  - .7    Size per motor rating.
  - .8    Power and control terminals.
- .2    Combination type starters to include non-fused disconnect switch with operating lever on outside of enclosure 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 Selector switches: standard.
- .2 Indicating lights: standard type and colour red.
- .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.
- .4 Control transformer: 24 V.
- .5 Locking in "ON" position.
- .6 All starters for motors 5HP and larger shall have phase loss, phase reversal and low line voltage protection.

**2.4 CONTROL TRANSFORMERS**

- .1 Single phase, dry type, control transformer with primary voltage as indicated and secondary voltage to match control signal voltage, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.
- .3 Magnetic starter designation label, white face, black core (normal), red face, yellow core (essential), size 2 engraved as indicated.

**2.5 MANUAL MOTOR SWITCHES**

- .1 Manual motor switches as indicated on drawings.

**2.6 FINISHES**

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

**2.7 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Manual starter designation label, white face, black core (normal), size 1, engraved as indicated.
- .3 Magnetic starter designation label, white face, black core (normal), size 2 engraved as indicated.
- .4 Combination magnetic starter, designation label, white face, black core (normal), size 4, engraved as indicated.

**2.8 ACCEPTABLE MANUFACTURERS**

- .1 Not applicable.

**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 starters, connect power and control as indicated.
- .2 Ensure correct fuses and overload device elements installed.
- .3 Install manual starters recessed where possible.

**3.3 TESTS**

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

**END OF SECTION**



**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results for Electrical.

**1.2 REFERENCES**

- .1 American National Standards Institute (ANSI).

**1.3 SUBMITTALS**

- .1 Submit shop drawings for each of the following:
  - .1 Luminaires.
  - .2 Driver.
- .2 Luminaire shop drawings shall indicate: housing construction, driver type, reflector type, lens type and photo metrics.
- .3 Driver shop drawings shall indicate: input power.

**1.4 QUALITY ASSURANCE**

- .1 Luminaires shall be provided with a five (5) year warranty covering LED's, drivers, parts and mechanical components.

**1.5 EXTRA MATERIALS**

- .1 Provide maintenance materials in accordance with Division 01.
- .2 Provide listed spare parts for each different luminaire type:
  - .1 Not Applicable.
- .3 Provide copy of receipts of maintenance materials in maintenance and operation manuals.

**1.6 WARRANTY**

- .1 Provide warranty as specified in luminaire schedule on drawings.

**PART 2 PRODUCTS**

**2.1 LED DRIVERS**

- .1 Refer to luminaire schedule on drawings.

- .2 Photometry must be compliant with IESNA LM-79-08.
- .3 Technical Requirements for LED luminaires:
  - .1 Electrical:
    - .1 Power Factor: The Luminaire shall have a power factor of 0.90 or greater.
    - .2 THD: Total harmonic distortion (current and voltage) induced into an AC power line by a Luminaire shall not exceed 20 percent.
  - .2 Photometric Requirements:
    - .1 All photometric data will be measured by the IESNA LM-79-08 standard.
    - .2 Illuminance: The illuminance shall not decrease by more than 30% over the expected operating life.
    - .3 Light Color/Quality: The luminaire shall have a correlated color temperature (CCT) range of 3500K. The color rendition index (CRI) shall be 85 or greater.
  - .3 Thermal Management:
    - .1 The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the Luminaire over the expected useful life.
  - .4 Submit shop drawings and product data as specified, in accordance with Division 01.

## **2.2 LUMINAIRES**

- .1 Refer to Luminaire Schedule on drawings.

## **2.3 FINISHES**

- .1 Baked enamel finish:
  - .1 Conditioning of metal before painting:
    - .1 For paint base, conversion coating to ASTM F1137.
  - .2 Metal surfaces of luminaire housing and reflectors finished with high gloss to give smooth, uniform appearance, free from pinholes or defects.
  - .3 Reflector and other inside surfaces finished as follows:
    - .1 White, minimum reflection factor 85%.
    - .2 Colour fastness: yellowness factor not above 0.02 and after 250 hours exposure in Atlas fade-ometer not to exceed 0.05.

- .3 Film thickness, not less than 0.03 mm average and in no areas less than 0.025 mm.

## **2.4 ACCEPTABLE MANUFACTURERS**

- .1 Not Applicable.

## **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 datasheet.

### **3.2 INSTALLATION**

- .1 Locate and install luminaires as indicated.

### **3.3 WIRING**

- .1 Connect luminaires to lighting circuits as indicated.

### **3.4 LUMINAIRE SUPPORTS**

- .1 Provide all supports and brackets for mounting luminaries. Confirm mounting method for all luminaires with Department Representative prior to rough-in.

### **3.5 LUMINAIRE ALIGNMENT**

- .1 Align luminaries mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaries mounted individually parallel or perpendicular to building grid lines.
- .3 All flush trims on recessed pot lights to be flat/flush to finished ceiling.

**END OF SECTION**

**PART 1 GENERAL****1.1 RELATED SECTIONS**

- .1 Division 01- General Requirements.
- .2 Section 26 05 00 - Common Work Results for Electrical.

**1.2 SUBMITTALS**

- .1 Submit Shop Drawings in accordance with Section 26 05 00 - Common Work Results for Electrical.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International):
  - .1 CSA C22.2 No.141 (R2012), Unit Equipment for Emergency Lighting.

**1.4 GUARANTEE**

- .1 Provide a written guarantee stating that all batteries for emergency lighting are guaranteed against defects in material and workmanship for a period of ten years, with a no-charge replacement during the first five years and a pro-rated charge on the second five-year period, from the date of the Substantial Completion.

**1.5 DELIVERY**

- .1 Deliver batteries in dry state unless hermitically sealed.

**PART 2 PRODUCTS****2.1 BATTERY UNITS**

- .1 Supply voltage: 120 V.
- .2 Output voltage: 12 VDC.
- .3 Operating time: 60 minutes minimum.
- .4 Battery: sealed, maintenance free, 10 year life.
- .5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus input variations.
- .6 Solid state transfer circuit.

- .7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .8 Signal lights: solid state, life expectancy 100,000 hour minimum, for AC Power On and High Charge.
- .9 Lamp heads: as indicated.
- .10 Cabinet: complete with knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .11 Automatic self-diagnostic circuitry.
- .12 Auxiliary equipment:
  - .1 Lamp disconnect switch.
  - .2 Test switch.
  - .3 Battery disconnect device.
  - .4 AC input and DC output terminal blocks inside cabinet.
  - .5 *Bracket.*

## **2.2 REMOTE UNITS**

- .1 Refer to luminaire schedule on drawings.

## **2.3 WIRING OF REMOTE HEADS**

- .1 Conduit: to section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Conductors: Type *RW90* to section 26 05 21 - Wires and Cables 0-1000 V, and in accordance with manufacturer's recommendations. Voltage drop shall not exceed 3%.

## **2.4 ACCEPTABLE MANUFACTURERS**

- .1 Refer to luminaire schedule on drawings.

## **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 battery units and remote units as indicated.
- .2    Aim heads to illuminate path of egress in corridors and as indicated in open areas.
- .3    Mount directly to wall or ceiling as indicated.
- .4    Connect to lighting circuit of area served in accordance with CEC 46-304 (4). Provide relays as required.
- .5    **Feed unit equipment from line side of ambient lighting circuit serving the same area.**

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Division 01 - General Requirements.
- .2 Section 26 05 00 - Common Work Results for Electrical.

**1.2 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.

**1.3 SUBMITTALS**

- .1 Submit Shop Drawings in accordance with Section 26 05 00 - Common Work Results for Electrical.

**PART 2 PRODUCTS**

**2.1 EXIT LIGHTS**

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860 and NBC 2015 compliant.
- .2 Housing: 1.0 mm thick, steel, white finish.
- .3 Face and back plates: cast aluminum alloy.
- .4 Lamps: white LED, 25-year life, 5 watt max total consumption, solid-state board.
- .5 Pictogram type, green on white (or lightly tinted background) running man with arrow graphic viewable (where required), also two (2) signs required where bi-directional arrows are indicated.
- .6 Mounting as indicated.
- .7 Single and double face units, as indicated.
- .8 Supply voltage as per circuiting.
- .9 Face plate to remain captive for re-lamping.

**2.2 ACCEPTABLE MANUFACTURERS**

- .1 Refer to luminaire schedule on drawings.

**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 as indicated in accordance with National Building Code (NBC) 2010, local regulatory requirements, NFPA Standard and Listing Requirements.
- .2 Connect exit lights to circuits as indicated.
- .3 Ensure that exit light circuit breakers are locked in ON position. Provide lock-on devices.

**END OF SECTION**