

## **1 GENERAL**

### **1.01 RELATED SECTIONS**

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .2 Section 01 78 00 - Closeout Submittals
- .3 Section 07 84 00 - Fire Stopping
- .4 Section 08 31 00 - Mechanical Access Doors
- .5 Section 26 05 01 - Electrical Identification

### **1.02 GENERAL**

- .1 This Section covers items common to all Sections of Division 26 and 27.
- .2 The General Conditions of the contract as well as provisions of Division 01 are part of and to be read in conjunction with this Section.
- .3 Refer to Division 01 for commissioning requirements.

### **1.03 FUNCTIONAL PERFORMANCE TESTING (FPT)**

- .1 Refer to Division 01 91 13 - Commissioning General Requirements.
- .2 Prior to Functional Performance Testing, submit the following documentation:
  - .1 Record drawings.
  - .2 Operations and maintenance manuals.
  - .3 Documentations listed in Section 01 78 00 - Closeout Submittals.
  - .4 Written confirmation of System Demonstration and Operating and Maintenance Instructions have been performed in accordance with Section 01 78 00 - Closeout Submittals.
- .3 Immediately rectify deficiencies or discrepancies discovered during the FPT process.
- .4 Return copies of deficiency lists to the Departmental Representative with all corrected items signed off.

#### **1.04 CODES AND STANDARDS**

- .1 Do complete installation in accordance with CSA C22.1 and local regulations, except where specified otherwise.
- .2 Comply with relevant CSA standards and all current Inspection Department bulletins.

#### **1.05 REFERENCES**

- .1 CSA C22.1-2018, Canadian Electrical Code.
- .2 CAN3 C235-83(R2015), Preferred Voltage Levels for AC Systems
- .3 CSA Z462-2018, Workplace Electrical Safety.
- .4 CSA O80 Series-2017, Wood Preservation.

#### **1.06 CARE, OPERATION AND START-UP**

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

#### **1.07 VOLTAGE RATINGS**

- .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. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

#### **1.08 INTERFERENCE DRAWINGS**

- .1 Refer to Division 01 for the requirement to provide interference drawings. Coordinate and cooperate with the production of these interference drawings and note that the installation of electrical systems must not commence until these interference drawings have been reviewed by the Departmental Representative.

### **1.09 PERMITS, FEES, AND INSPECTION**

- .1 Submit to the Electrical Inspection Department, Municipal Authority, and supply authority the necessary number of drawings and specifications for examination and approval prior to commencement of work. Submit this information within twenty (20) working days of the award of Tender and provide the Departmental Representative with written notice at the time this has been submitted.
- .2 Provide the Departmental Representative with a copy of the electrical inspection department and supply authority plans review report immediately upon receipt. No shop drawings will be reviewed prior to receipt of the plans review report from the Contractor.
- .3 Obtain all necessary permits including an Electrical Wiring Permit for electrical work and Communications Cabling Permit for communications cabling work from the authority having jurisdiction prior to commencement of work. Provide a copy of each permit to the Departmental Representative upon receipt. Properly display the permits on the work site.
- .4 Arrange for all required inspections to be conducted by the authority having jurisdiction. Provide a copy of all inspection reports to the Departmental Representative immediately upon receipt. Notify the Departmental Representative immediately of changes required by the authority having jurisdiction.
- .5 Furnish Certificates of Acceptance from authorities having jurisdiction upon completion of work. Include a copy in the Operation and Maintenance Manual.
- .6 Pay all associated fees.
- .7 Maintain up-to-date red-lined set of construction design drawings on Site at all times for reference of Inspection Authorities as well as construction purposes.

### **1.10 MATERIALS AND EQUIPMENT**

- .1 Provide materials and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment that is not CSA certified, obtain special approval from the authority having jurisdiction. Pay all fees associated with special approval and/or field certification.
- .3 Factory assemble control panels and component assemblies.

- .4 All equipment and materials which serve a similar function must be from a single manufacturer and a single product line.
- .5 The equipment listed on the project equipment schedules and shown on the drawings is the "basis of design equipment". The Contractor may utilize the alternates listed in the project documents or submit alternates for approval to this equipment that meet the technical and quality requirements of the project specifications. If there are necessary changes to any building system to accommodate these alternates, coordinate the changes and provide at no additional cost to the Contract.

#### **1.11 FINISHES**

- .1 Unless indicated otherwise, 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 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.

#### **1.12 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment in accordance with Section 26 05 01.

#### **1.13 WARNING SIGNS**

- .1 Provide warning signs, as specified and/or to meet requirements of the Inspection Department.
- .2 Confirm electrical equipment is field marked to warn persons of the potential electric shock and arc flash hazards, as per CSA C22.1, Rule 2-306. Provide hazard labels in accordance with CSA Z462.

#### **1.14 SINGLE LINE ELECTRICAL RISER DIAGRAMS**

- .1 Provide riser diagrams, framed under Plexiglass as follows:
  - .1 Power distribution riser.
- .2 Full drawing size.

- .3 Locate power distribution riser at each electrical service entrance room and generator room.

#### **1.15 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centre line of equipment unless specified or indicated otherwise.
- .2 Verify mounting height of equipment before proceeding with rough in.
- .3 Coordinate with architectural elevations prior to mounting exterior electrical devices.
- .4 Install electrical equipment at the following heights unless indicated otherwise. Refer to device mounting height details on drawings.
  - .1 Local switches: 1200mm A.F.F. unless otherwise indicated
  - .2 Wall receptacles:
    - .1 General: 460 mm A.F.F. unless otherwise indicated
    - .2 Above top of counters or backsplash: 152 mm.
    - .3 In mechanical/boiler rooms: 1370 mm A.F.F.
  - .3 Panelboards: 1980 mm A.F.F. to top of panel.
  - .4 Communications system outlets:
    - .1 General: 460mm A.F.F. unless otherwise indicated
    - .2 Above top of counters or backsplash: 152 mm.
    - .3 In mechanical/boiler rooms: 1370 mm A.F.F.
  - .5 Exit signs: 2286 mm A.F.F. or 152 mm above door frame.
  - .6 Emergency lights and remote heads: 2286 mm A.F.F.
  - .7 Fire alarm manual stations: 1200mm A.F.F.
  - .8 Fire alarm signaling devices: 305 mm below finished ceiling.

#### **1.16 PROTECTION**

- .1 Protect exposed live equipment during construction for personnel safety.
- .2 Shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage.
- .3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of an electrician.

#### **1.17 CONDUIT AND CABLE INSTALLATION**

- .1 Install cables, conduits, and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

- .2 Conceal all wiring and conduit unless noted otherwise. Where this is not possible due to existing construction, use metal surface mounted raceways. Refer to the contract documents for more detail.
- .3 Where conduits cross building expansion joints, provide conduit expansion joints with telescoping sleeve and insulated bushings.

#### **1.18 FIRESTOPPING**

- .1 Where conduits, cables, and cable troughs pass through fire-rated assemblies, provide firestopping in accordance with Section 07 84 00 - Firestopping.
- .2 Refer to architectural drawings for location of fire-rated assemblies.

#### **1.19 CUTTING AND PATCHING**

- .1 Obtain the Departmental Representative's approval before cutting, boring or sleeving load-bearing members.
- .2 Cut and patch as required to make work fit.
- .3 Make cuts with clean, true, smooth edges.
- .4 Where new work connects with existing and where existing work is altered, cut, patch and make good to match existing work.
- .5 Make good materials, and prepare surfaces and refinish all finished surfaces damaged, marred, replaced, or otherwise remedied in the existing building.
- .6 Finish new surfaces flush with existing surfaces. Make junctions between existing and new work, or at replaced or remedial work undetectable under conditions of normal vision. Make surfaces adjacent to one another of the same material, unit sizes, colour, and texture. If this is impossible, make a proposal of intended method of making good for approval, before installation.
- .7 Conceal all wiring and conduit unless noted otherwise. Where this is not possible due to existing construction, use metal surface mounted raceways. Refer to the contract documents for more detail.

#### **1.20 FIELD QUALITY CONTROL**

- .1 Have all electrical work carried out by qualified, licensed electricians or apprentices as per the conditions of the Provincial Act respecting manpower vocational training and

qualification. Employees registered in a provincial apprentice program will be permitted, under the direct supervision of a qualified licensed electrician, to perform specific tasks, the activities permitted will be determined based on the level of training attained and the demonstration of ability to perform specific duties.

- .2 Conduct and pay for tests of the following:
  - .1 Fire alarm system.
  - .2 Communication system.
  - .3 Intrusion alarm system.
- .3 Furnish manufacturers' certificates or letters confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .4 Provide instruments, meters, equipment, and personnel required to conduct tests during and at conclusion of project.
- .5 Submit test results for Departmental Representative's review.

#### **1.21 SHORT-CIRCUIT AND COORDINATION STUDY**

- .1 At a minimum, provide the following:
  - .1 Manufacturer's trip curves for all breakers and fuses.
  - .2 Available trip settings for all breakers with adjustable settings.
  - .3 Conductor and conduit sizes for all feeders, including branch panel and relay panel feeders.
  - .4 Length of all feeders, including branch panel and relay panel feeders, to the nearest metre.
  - .5 Transformer impedances.
- .2 Provide Arc-Flash warning labels for all electrical equipment in accordance with CSA Z462. Obtain arc-flash ratings for each piece of equipment from the Departmental Representative prior to ordering labels.

#### **1.22 DRAWINGS**

- .1 Electrical drawings are not intended to show structural details or architectural features.
- .2 The electrical drawings are not to be scaled.
- .3 Electrical drawings, except where dimensioned, indicate general layouts only. Investigate structural and finish conditions and the work of all other trades affecting this work and arrange work accordingly.

- .4 Coordinate the elevation of all outlet boxes with architectural drawings and report any conflicts to the Departmental Representative prior to installation.
- .5 All electrical junction boxes must be accessible at the completion of the project. Coordinate the location of each junction box with the proposed location of mechanical services prior to installation.
- .6 Layouts on the electrical drawings are based on the specified equipment including electrical power connections, number of conductors and conduit sizes, and physical dimensions. Alternate equipment and systems proposed for use on this project which necessitate changes in service connections, numbers of conductors and conduit sizes to perform the specified functions may be considered by the Departmental Representative, however, any required modifications or additions to the electrical contract or the work of other trade contractors must be done at no additional cost to the Contract. Furthermore, if it is found that the provisions made regarding space conditions and code required clearances are not met, the right is reserved by the Departmental Representative to require installation of the equipment specified.

#### **1.23 ACCESS DOORS**

- .1 Where junction boxes, pull boxes, and miscellaneous electrical equipment are concealed, provide access doors for operating, inspecting, adjusting, and servicing. Provide access doors which meet or exceed the fire resistance rating of the partition or ceiling in which they are being installed.
- .2 Provide access doors in accordance with Section 08 31 00 - Mechanical Access Doors.

#### **1.24 CONNECTION OF EQUIPMENT**

- .1 Provide all connections required by the equipment supplied by this Division.
- .2 Provide all connections required by equipment supplied by the Departmental Representative or by other Divisions. Examine all drawings and specifications and identify all requirements.
- .3 Provide all necessary accessories to make connections, including flexible connectors, etc.

#### **1.25 SPRINKLER-PROOF HOODS**

- .1 Protect all distribution equipment within ventilated enclosures located in the building from the direct spray of sprinkler heads to the satisfaction of the Inspection Authority by the use of non-combustible hoods.
- .2 Install distribution conduits exiting or entering equipment enclosures equipped with sprinkler hoods with rain-tight EMT connectors equipped with rubber O-rings.

#### **1.26 INSTALLATION REQUIREMENTS**

- .1 Install all products and services to follow building planes. Installation must permit free use of space and maximum headroom to the satisfaction of the Departmental Representative.
- .2 Confirm the exact location of fixtures, outlets and connections.
- .3 Install all equipment and appurtenances to allow free access for adjustment, maintenance and/or replacement.
- .4 Provide all hangers, supports and fasteners such that no undue stresses are imposed on the structure and systems. Confirm the load onto structures does not exceed the maximum loading. Equipment supports not supplied by equipment manufacturer are to be fabricated using structural grade steel.
- .5 Exterior supports are to be galvanized, unless noted otherwise.
- .6 Install all products and services in accordance with the respective manufacturer's recommendations.
- .7 Do not use high-velocity explosive-activated tools. Low-velocity system types are permitted.
- .8 Provide caps and seal all open ends of installed conduits to prevent the entrance of foreign substances.
- .9 Install all services capped for future possible use such that easy access is provided for future connections.

#### **1.27 FIELD REVIEW**

- .1 The Departmental Representative must have access to the site at all times for review of the work.
- .2 Correct any deficiencies as they are reported during the performance of the Work.

#### **1.28 TORQUE FOR WIRE TERMINATION**

- .1 For proper termination of conductors, field connections must be made properly tight.
- .2 Where possible, obtain and comply with Manufacturer's instructions for proper termination torque values for the equipment.
- .3 In the absence of Manufacturer's instructions, make terminations in conformance with the values given in Tables D6 and D7 of the Canadian Electrical Code.

#### **1.29 CABLE TIES AND TYE WRAPS**

- .1 Cable ties and tye wraps are only permitted to be used to provide limited support for bundling purposes only. These devices are not intended to provide the primary support for conduits or cables as required by the Canadian Electrical Code.

#### **1.30 WORKING SPACE ABOUT ELECTRICAL EQUIPMENT**

- .1 Arrange installation as required to maintain minimum working space around electrical equipment in conformance with the CEC.

#### **1.31 LOW V. O. C. MATERIALS**

- .1 All site applied coatings, adhesives & sealants must be low volatile organic compound (VOC) content.
- .2 Provide Material Safety Data Sheets for all products and materials of these types incorporated into the work.

#### **1.32 PLYWOOD BACKBOARDS**

- .1 Provide plywood backboards for mounting of all wall-mounted electrical and communications equipment located inside electrical rooms, communications rooms, and other services rooms, including but not limited to panelboards, control panels, contactors, etc.
- .2 Plywood used for backboards must be marked indicating that it is Fire Retardant Treated Wood (FRTW) in accordance with the CAN/CSA-080 standard, and meets Underwriters Laboratories FR-S rating, or equivalent. Materials must be free of formaldehyde and VOCs.

### **1.33 NETWORK CONNECTIONS**

- .1 All required network connections must be registered with the facilities management information technology (FMIT) department. Complete the registration form for each and every device supplied under this contract which may require connection to the existing IT network. This includes, but is not limited to: access control, intrusion alarm, Ethernet ports, building automation system, lighting control etc.

**END OF SECTION**

## **1 GENERAL**

### **1.01 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 61 00 - Common Product Requirements.
- .3 Section 01 74 21 - Construction Waste Management Disposal

### **1.02 PRODUCT DATA**

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data to include paint colour chips, other products specified in this section.

### **1.03 SAMPLES**

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Samples to include nameplates, labels, tags, lists of proposed legends.

## **2 PRODUCTS**

### **2.01 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates and labels as specified herein.
- .2 Identification:
  - .1 Provide all switchboards, panels, disconnect switches, receptacles, voice/data/CATV/Multimedia outlets, MCCs, transformers, control panels, fire alarm devices, magnetic starters, TOLs, etc. with lamicoid nameplates as further described herein. Affix plates true, level, and plumb in all instances.
  - .2 Affix nameplates to all metal surfaces with steel type pop-rivets unless penetration would void enclosure rating.
  - .3 Affix nameplates to building exterior surfaces with nylon inserts and self-tapping screws unless specifically indicated otherwise.

- .4 Affix nameplates to other types of surfaces with contact-type cement.
- .5 Apply contact type cement to complete rear side of plate, as opposed to several locations or areas on same.
- .6 Lamicoid nameplates installed on distribution panelboards, motor control centres, splitter troughs and transformers to indicate the following:
  - .1 Designated name of equipment.
  - .2 Amperage of overcurrent protection device.
  - .3 Voltages, number of phases and wires.
  - .4 Designation of power source.

Example

PANEL H - 150 AMPS  
120/208V - 3PH - 4W  
FED FROM MAIN SWITCHBOARD #QMS-1

- .7 Lamicoid nameplates installed on combination starters, magnetic starters, manual starter and all various systems controls, control panels, disconnect switches, etc., to contain the following information:
  - .1 Designated name of equipment.
  - .2 Designated name of power source.
  - .3 Branch circuit breaker number(s) where possible.
  - .4 Voltage(s).

EXHAUST FAN NO. 5	SUPPLY FAN NO. 3
PANEL H - CCT. NO. 17	M.C.C. NO. 1
120V - 1 PH	600V - 3 PH

- .8 Lamicoid nameplates installed on fusible-type disconnect switches to also indicate maximum designated/designed fuse size.
- .9 Install lamicoid nameplates on all junction and/or pull boxes sized 150 mm x 150 mm and larger indicating name of system, designated panel name and electrical characteristics where applicable.
- .10 Install lamicoid nameplates adjacent to each overcurrent devices located in switchboards, MCCs, CDP panels, etc. They need only indicate designated name and/or number of equipment they feed. Identify unused O.C. devices as spare(s).
- .11 Lamicoid nameplates installed on main service entrance switches, or main entrance switchboards to indicate the following information on minimum size 150 mm x 50 mm plate complete with two (2) lines of 13 mm high lettering (Size #8 nameplate)

Example:

Example:

MAIN BREAKER 800 AMPS	MAIN SWITCH 200 AMPS
346/600V, 3PH, 4W	120/208V, 3PH, 4W

- .12 Install an additional lamicaid nameplate on all, or any piece of electrical equipment, or apparatus (i.e., Main Switchboard, CDP panels, panelboards, Motor Control Centres. etc.), that may contain overcurrent devices (i.e., circuit breakers and/or fuses), that have been designed for, and incorporate interrupting capacity sized larger than 10 kAIC.

Example:

Min. interrupting capacity of breakers installed in this panel to be not less than 22 kAIC

Example:

Min. interrupting capacity of fuses installed in this MCC to be not less than 100 kAIC

- .13 Install lamicaid nameplates above all types of receptacles and abutted directly to tops of their respective device plates. Identification is to indicate respective panel source complete with associated circuit breaker number(s) as per the following:

- .1 1.5mm x 13mm high complete with 6 mm black letters on white core, directly above all receptacles. Plate to be identical width as finish device plate.

Example: PANEL H - 20

- .14 Identify receptacles intended for computer, electronic or other sensitive types of electronic equipment etc., as per following:

- .1 1.5mm thick x 19mm wide complete with 6 mm black letters on white core above all receptacles. Identical width as finish device plate.

Example: For computer use only  
PANEL H - 24

- .15 Identify lamicaid nameplates above 120V receptacles protected by GFCI circuit breakers, or GFCI type receptacles as per the following:

- .1 1.5mm thick x 19mm wide complete with 6 mm black letters on white core above all receptacles. Identical width as finish device plate (EXAMPLE: GFCI Protected Panel H-26).

- .16 Apply lamicoid nameplate(s) for power/voice/data/multimedia outlets above face of finish plate, complete with information as specified in Section 27 05 28.
  - .1 1.5mm thick x 19mm wide complete with 6mm black letters on white cove above all receptacles. Identical width as finish device plate.
- .17 All addressable fire alarm devices are to be lamicoid identified.
  - .1 Lamicoid identification is to be chain hung on mechanical items (pressure switches, supervisory switches, etc.).
  - .2 Manual pull station lamicoid plate to be similar to typical receptacle lamicoid plate.
  - .3 Lamicoid wording to match physical location and annunciator display address.
- .18 Lamicoid 3mm thick plastic engraving sheet, white face, black core, for all electrical systems except fire alarm and emergency power which shall have red face with white core.
  - .1 1.5mm thick nameplates above receptacles as previously indicated, with top left and right corners to be rounded off.
  - .2 Lettering on lamicoid nameplates must not start, nor end nearer than 13mm from either, or both ends of said plates. Size of lettering, including overall lengths of various plates to be as indicated in the following chart:

NAMEPLATE SIZES

Size 1 10mm x 50mm	1 line 5mm high letters
Size 2 13mm x 70mm	1 line 6mm high letters
Size 3 16mm x 75mm	2 lines 5mm high letters
Size 4 19mm x 90mm	1 line 9mm high letters
Size 5 38mm x 90mm	2 lines 13mm high letters
Size 6 25mm x 100mm	1 line 13mm high letters
Size 7 25mm x 100mm	2 lines 6mm high letters
Size 8 50mm x 150mm	2 lines 13mm high letters
Size 9 75mm x 150mm	3 lines 13mm high letters

- .3 Have wording on nameplates and labels approved by the Departmental Representative prior to manufacture.
- .4 Allow for average of fifty (50) letters per nameplate and label.
- .5 Identification to be English.
- .6 Provide lamicoid nameplates and install on, or adjacent to, all various systems' control panels and/or cabinets complete with information as indicated. Nameplates to reflect individual system's assigned name, and where applicable, also indicate

- both designated panel name and associated branch circuit breaker number(s).
- .1 Fire alarm panels
  - .2 Security (intrusion) panels
  - .3 Energy management panels
  - .4 Television panels
  - .5 Communication panels
  - .6 Lockdown system panels
  - .7 Low voltage lighting relay panels (EXAMPLE: LIGHTING RELAY PANEL #1 - LPA - 36).
- .7 Control Transformers:
- .1 Concealed control transformers located within ceiling spaces are to have lamicoid nameplates installed adjacent to same indicating their identified system, primary power source including designated panel name, complete with associated branch circuit breaker number(s).
  - .2 A second plate with identical information is to be installed on underside of room grid system or access opening frame directly below control transformer, so as to identify its concealed location directly above same.
  - .3 All control transformers installed in either control cabinets or on walls adjacent to same, are to be identified with lamicoid nameplates containing information as previously indicated.
- .8 Junction and pull boxes: indicate system and voltage.
- .9 Co-ordinate names of equipment and systems with other trades to ensure that equipment identification is consistent.
- .10 In addition to required nameplates and colour coding, junction boxes and pull boxes to have the panel and circuit numbers of all wiring contained within listed on the cover plate. Write circuit list neatly using a black indelible marker.
- .11 Colour code electrical junction boxes, pull boxes, and conduit fittings as follows:
- .1 Apply colour coding prior to installation of boxes/equipment.
  - .2 Where primary colour only is indicated:
    - .1 Colour inside and outside of box.
    - .2 Colour all cover plates.
  - .3 Where primary and secondary colours are indicated:
    - .1 Paint inside and outside of box with the primary colour.
    - .2 Diagonally apply to each half of the cover plate the primary and secondary colours.
- .12 Where a lamicoid identified item is installed above an accessible ceiling, provide two (2) lamicoid plates,

one (1) at the item location and one (1) directly below on the underside of the ceiling.

- .13 Paint boxes and conduits outside of the building in an area that will not cause vapours to enter the building ventilation system.

## 2.02 WIRING IDENTIFICATION

- .1 Identify wiring with self-laminating, permanently mechanically imprinted labels on both ends of each conductor and cable utilized. Identify conductors and cables in each junction or pull box through which they pass. Install labels in a flagged manner around individual conductors.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Identify all conductors with insulation colours as follows:
  - .1 Phase A - Red
  - .2 Phase B - Black
  - .3 Phase C - Blue
  - .4 Neutral - White
  - .5 Bond - Green
  - .6 Ground - Green
  - .7 Isolated Ground - Green c/w yellow strip
- .4 Color-coded conductor insulation as per the following:
  - .1 All sizes of phase conductors up to and including #2 AWG.
  - .2 All sizes of neutral, bond and/or ground conductors up to and including #3/0 AWG.
  - .3 Approved coloured tapes in lieu of insulation coloring may be used to identify conductors that exceed sizes as previously indicated. Labelling is to take place at both ends of all runs at a minimum of 300mm from terminations, in addition to within all boxes between both ends of the run.
- .5 Use colour coded wires in communication cables, matched throughout system.
- .6 Indicate panel and circuit number of all phase conductors i.e.: "Panel 'A' - cct 3". Identify all neutral and bonding conductors to indicate the phase conductor with which they are associated. Identify all ground conductors with the service, transformer, or generator with which they are associated.

## 2.03 CONDUIT AND BOX IDENTIFICATION

- .1 Colour code conduits and metallic sheathed cables as per the schedule as follows:

<u>SYSTEM</u>	<u>19mm DISCS</u>	<u>6mm DISCS</u>
0 to 50 Volts	Violet	
51 to 240 Volts	Yellow	
241 to 600 Volts	Orange	
Fire Alarm	Red	
Telephone (voice only)	Black	
Security	Brown	
Ground or Bond	Green	
Computer (data only)	Black	White
Voice & Data	Blue	White
Emergency Lighting (DC)	Yellow	Black
Other	Brown	White

- .2 Code with paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m intervals.
- .3 Colour code junction and/or pull boxes, conduit fittings (and respective covers), complete with their respective cover plates as per the following: Boxes are to be coloured both inside and outside where one colour only is required. Boxes are to be coloured on inside only where two colours are required. Metal cover plates are to have both colours applied diagonally where two colours are required. Complete plate is to be painted where one colour only is required. All junction boxes are to be colour identified prior to installation and not within the building.
- .4 All various systems concealed junction and/or pull boxes located within ceiling spaces are to have their locations identified on room side of T-Bar grid spline or access cover frames with appropriate colour coded, circular shaped, self-adhering discs. Discs are to be both 19mm and 6mm in diameter as indicated in the following legend, with 6mm discs always being centered in middle of 19mm discs:
- .5 Where boxes are not concealed, such as in an open ceiling concept, fasten discs directly to the outside of the box after architectural painting is complete. Cover plates for boxes containing branch circuits are to have each branch circuit number neatly identified on the inside of the cover plate. Felt marker-pen may be used for this purpose.
- .6 Provide a legend of colour coding mounted under plexiglass cover installed in main electrical room, minimum size: 610mm x 610mm.

## 2.04 TELECOMMUNICATIONS IDENTIFICATION

- .1 Horizontal Distribution System:
  - .1 Uniquely identify horizontal cabling with a wrap type self-laminating adhesive label with mechanically generated (not hand written) identifier.
  - .2 Horizontal cable identifiers must denote basic telecommunications system application and the originating telecommunications space termination equipment port:  
  
Example: D-024  
          where 'D' denotes 'data',  
          '024' denotes termination equipment port number
  - .3 For other telecommunications cabling system other than data, use the following abbreviations:
    - .1 V=Voice
    - .2 DB=Data Backbone
    - .3 VB=Voice Backbone
    - .4 DMR=Demarcation Backbone
    - .5 TV=Internal Multimedia Broadcast System
    - .6 CA=Video Surveillance
- .2 Work Area:
  - .1 For the purposes of system administration the work area includes the telecommunications outlet faceplate and all outlet termination hardware.
  - .2 All telecommunications outlet faceplates will be standard four port configuration with port assignments as shown on design drawings.
  - .3 All Telecommunications Outlet (TO) locations require a unique component identifier as part of the administration system by a lamicoid type etched vinyl nameplate, minimum 120mm H X 70mm L and secured to the wall-space centered and 12 mm minimum above the telecommunications outlet faceplate.
  - .4 Telecommunications work area outlet identifiers must denote basic telecommunications system application, originating telecommunications space and termination equipment port:  
  
Example: TR-118 D-012  
Where: TR denotes telecommunications room  
         118 denotes architectural room number  
         D denotes data  
         012 denotes termination equipment port number

### **3 EXECUTION**

#### **3.01 PAINTING OF BOXES**

- .1 Do not paint junction boxes, pull boxes, cabinets, etc. inside the building at any time during construction.

#### **3.02 TIMING**

- .1 Provide identification only after all painting specified in Section 09 91 00 has been completed.

#### **3.03 NAMEPLATES**

- .1 Locations:
  - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Protection:
  - .1 Do not paint, insulate or cover in any way.

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 CSA C22.2 No. 65-2018, Wire Connectors.

## **2 PRODUCTS**

### **2.01 MATERIALS**

- .1 Spring-type pressure wire connectors: with current carrying parts of copper and copper alloy sized to fit copper conductors 10 AWG or less. Connectors to be complete with appropriate size insulating cap.
- .2 Clamps or connectors for armoured cable, liquid tight flexible metal conduit.
- .3 Bushing stud connectors are not acceptable.

## **3 EXECUTION**

### **3.01 INSTALLATION**

- .1 Make connections and terminations electrically and mechanically secure. Sizes of connectors to be as per manufacturer's recommendations for various sizes and combinations of wire sizes.
- .2 Make joints required in branch wiring #10 and smaller utilizing spring-type pressure wire connectors. Plier tighten wire connectors. Cap to completely fit or cover all enclosed conductors as required.
- .3 Make joints for all other wiring utilizing colour keyed compression type connectors complete with compression tools. Apply an initial layer of compound type tape followed by an additional layer of vinyl tape.

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 CSA C22.2 No. 0.3-09(R2019), Test Methods for Electrical Wires and Cables.
- .2 CSA C22.2 No. 208-18, Fire Alarm and Signal Cable.

### **1.02 RELATED WORK**

- .1 Section 26 05 00 - Common Work Results for Electrical.
- .2 Section 26 05 29 - Hangers and Supports For Electrical Systems
- .3 Section 26 05 32 - Outlet Boxes, Conduit Boxes And Fittings
- .4 Section 27 05 28 - Grounding - Secondary 1.03 Product Data

### **1.03 SUBMITTALS**

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

### **1.04 OPERATION AND MAINTENANCE DATA**

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

## **2 PRODUCTS**

### **2.01 BUILDING WIRES**

- .1 Conductors: soft drawn copper of 98% conductivity; stranded for #12 AWG and larger. Minimum size: #12 AWG.
- .2 Copper conductors sized as indicated or as required by C.E.C., with 600 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90-XLPE.
- .3 Grounding and bonding conductors sized up to and including #10 AWG are to have green coloured RW90 cross linked insulation. Type TW75 green coloured insulation is acceptable for sizes #8 AWG and larger.

- .4 Provide phase colour-coding of conductors as per CEC rule 4-036, unless noted otherwise.
- .5 Color code phase conductor sizes up to and including #2 AWG as follows:

Phase A	Red
Phase B	Black
Phase C	Blue
Neutral	White or Grey
Bond	Green
Ground	Green
Isolated Ground	Green c/w Yellow Strip
- .6 Insulation Colour Coding as per following:
  - .1 Phase conductors up to and including #2 AWG.
  - .2 Neutrals, bonds and ground conductors up to and including #3/0 AWG.
  - .3 Approved coloured tapes in lieu of insulation colouring may be used to identify conductors that "exceed" sizes as noted on both ends of runs.

## 2.02 ARMOURED CABLES

- .1 Conductors: insulated, copper, size as indicated, minimum #12 AWG.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Termination of AC90 cable is to utilize steel connections with accompanying lock nuts similar to or equal to T&B 3301 series.
- .5 Supports to be as per Section 26 05 29 - Hangers and Supports for Electrical Systems.

## 2.03 CONTROL CABLES

- .1 Type LVT: two (2) soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.
- .2 Control circuit wiring 50V and less: Cat 6A with yellow jacket.
- .3 Cables to be FT6 rated.

## **2.04 FIRE ALARM CABLES**

- .1 Type FAS 105 to CSA C22.2 No. 208, PVC insulation, size and quantity of conductors as indicated, Red PVC outer jacket.

## **2.05 SECURITY SYSTEM CABLING**

- .1 Minimum FT4 rated.
- .2 Insulated copper conductors, size as indicated or required by manufacturer.
- .3 White coloured PVC outer jacket.

# **3 EXECUTION**

## **3.01 INSTALLATION OF BUILDING WIRES**

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

## **3.02 INSTALLATION OF FIRE ALARM CABLES**

- .1 Install fire alarm cables in E.M.T.
- .2 Fire alarm cabling will be permitted to be installed in flexible metal conduit for final connection to various fire alarm devices installed upon flush mounted outlet boxes in finished ceiling tiles and to sprinkler devices. Flexible metal conduit is not exceed 5m in total length. Minimum size: 16mm.

## **3.03 INSTALLATION OF ARMOURED CABLES**

- .1 AC-90 will only be permitted for branch circuit wiring drops from ceiling junction boxes to light fixtures within the same room. The installation of AC-90 cable for branch circuit wiring home runs or runs between rooms is not acceptable.
- .2 A home run is defined as that portion of the branch circuit wiring that runs between the applicable panelboard and the area or room in which it either:
  - .1 Terminates at the applicable branch circuit device, or
  - .2 Makes a splice for final connection to the applicable branch circuit device.
- .3 The grouping together of AC-90 cables to form a bundle for securing purposes is acceptable provided:

- .1 In addition to securing AC-90 cables at 1.5m intervals to structure, multiple or bundled groups of armoured cables shall be tye-wrapped together at mid-point between each structural support and are to be secured to structure at 1.5m intervals, and also secured together between each structure support at 1.5m intervals.
- .2 Limit the grouping of AC-90 cables to a maximum of eight (8) current carrying conductors, including associated oversized neutrals, where phase sharing occurs.
- .4 Install concealed, parallel and perpendicular to building lines and adequately secure to the building structure at not less than 1.5m intervals in such a manner as to ensure they are protected from potential types of mechanical damage occurring. Install independent supports for cabling in ceiling spaces, and do not use those of other trades. Do not secure cables to mechanical piping systems, ducts, or suspended ceiling support wires. The laying of unsupported cables directly upon the ceiling grid system is strictly prohibited.
- .5 Always install and secure surface cables directly to the underside of ceiling slabs or metal decking where located in concealed ceiling spaces.
- .6 The following examples incorporate uses of both common and dedicate branch circuit neutral conductors.
  - .1 Maximum of two (2) runs of #12/4 conductor cables including common (oversized) branch circuit neutrals in each.
  - .2 Maximum of two (2) runs of #12/3 conductor cables, including oversized branch circuit neutrals (if not 3 phase 3 wire) plus one (1) run of #12/2 cable.
  - .3 Maximum of four (4) runs of #12/2 conductor cables, each including a separate, dedicated branch circuit neutral conductor.
- .7 Where dedicated or separate branch circuit neutral conductors are non-phase sharing they need not be sized larger than phase conductors they are accompanying unless specifically indicated otherwise.
- .8 AC-90 fixture feeds to originate from the sides of outlet boxes and not from the box cover. Where three (3) and/or four (4) fixture drops extend from any one outlet box, do not use a box smaller than 119 mm square.
- .9 Fixture drop is defined as that portion of AC-90 cable or flexible conduit being used to make final connection between accessible type junction or outlet box located in ceiling space and its respective light fixture.
  - .1 Fixture drops are not to exceed 3 m in total length unless specifically indicated otherwise.

- .2 There must not be more than four (4) drops permitted to be fed from any one box regardless of its size. Secure AC-90 cables used for fixture drops within 300 mm of the junction box. Provide each light fixture complete with its own separate fixture drop originating from junction box located in the same room as the fixture. An exception will be made for recessed down lights that may be wired from one fixture to another if they have integral junction boxes and the luminaire access opening is 150 mm or greater in diameter.
- .3 Wire each light fixture with a separate whip emanating from an overhead junction box.
- .4 Minimum size 119mm square box will be used when extending three (3) or four (4) drops.
- .5 Both #12 AWG and #14 AWG type AC-90 armoured cables may be used where the total fixture drop loads do not exceed the following:
  - .1 5000W at 347V, #12AWG
  - .2 3500W at 347V, #14AWG
  - .3 1800W at 120V, #12AWG
  - .4 1300W at 120V, #14AWG
- .10 Provide separate pig-tail type leads in each light fixture junction/outlet box for final connection to fixture drops. Only connect these pig-tails to light fixture returns and associated neutral conductors.
- .11 Support and securing of type AC90 cables, low voltage wiring etc., will not be derived from either suspended ceiling support wires and/or by directly laying atop of the ceiling grid system.
- .12 Where application of AC90 cables, other types of pliable cables, open low voltage or communication wiring, etc. are to be used; install neatly and parallel or perpendicular to the building lines unless otherwise noted.

### **3.04 INSTALLATION OF CONTROL CABLES**

- .1 Install control cables in E.M.T. complete with bonding conductor, minimum 21mm conduit and #14 AWG bonding conductor.
- .2 Bond control cable shield where required.
- .3 Building management system controls wiring methods to be installed in accordance with Section 27 05 28 - Pathways for Communications Systems (per voice and data structured cabling).

### **3.05 INSTALLATION OF CABLES: GENERAL**

- .1 Support cables independently of supports used for equipment of other trades. Do not support from or secure cables to ductwork, piping and ceiling hanger wires.
- .2 Do not lay cables on top of suspended ceiling grids and tiles.
- .3 Install cables in a neat and professional manner so as to conserve headroom. Correct any unacceptable work at no additional cost to the Contract.
- .4 Install cables parallel and perpendicular to building lines.
- .5 Secure cables to underside of metal decking.
- .6 The tye-wrapping of the neutral conductor with its respective phase conductors is to be made at the closest point of entry within all panelboards, pull boxes, junction boxes and outlet boxes, etc.
- .7 All branch circuits which do not have neutral conductors are to have their respective phase conductors tye-wrapped together in accordance with Clause 3.5.6 above.
- .8 All stranded conductors are to be twisted together prior to any types of terminations taking place, but not necessarily limited to: receptacles, light switches, neutral terminal strips, bonding terminal strips, circuit breakers, disconnect switches, starters, contactors, relays, all types of termination lugs, panelboards, etc.
- .9 All CDPs panelboards, MCCs (pull boxes, junction boxes, etc.) will have their respective feeder phase and neutral conductors tye-wrapped together and with enough slack conductor length to enable the ability to clamp the ground detector around each set of feeders. This wiring method is such that ease of clamping the ground detector can be accomplished without excessive exposure to live bus.
- .10 After all electrical wiring has been completed by the Electrical Subcontractor, test the grounded electrical distribution system to confirm there are no grounds or shorts in the system.

### **3.06 VOLTAGE DROP**

- .1 Run all branch circuits so that the voltage drop in no instance exceeds 3% of the line voltage. The table in clause 3.06.2 is to include both vertical and horizontal lengths of conductor runs. Minimum size of branch circuit neutral where phase sharing occurs must be #10 AWG. Minimum size of branch circuit neutral

where dedicated to its own branch circuit phase conductor must be #12 AWG. Note that minimum size #10 AWG bond conductors to accompany #8 branch circuit conductors.

- .2 At a minimum, provide conductors sized in accordance with the following table:

<u>Branch Circuit Length of Run</u>	<u>Phase Wire Size</u>	<u>Dedicated Neutral</u>	<u>Shared Neutral</u>	<u>Bond Size</u>
Up to 24.3 m	#12	#12	#10	#12
Up to 38.1 m	#10	#10	#8	#12
Up to 56.3 m	#8	#8	#6	#10

- .3 Oversized #10 AWG branch circuit wiring conductors to be extended to outlet box of device they feed (including switch legs). Oversized #8 AWG branch circuit wiring conductors to be extended from panelboard to junction box located on wall or ceiling directly above wall light switches and/or receptacles. Reduce #8 AWG wire to #10 AWG for vertical portion of drop only.

### **3.07 INSTALLATION OF SECURITY CONTROL SYSTEM CABLING**

- .1 Install access control and security system wiring in conduit in its entirety unless noted otherwise.
- .2 The portion of wiring installed in door frames to feed electric strikes or electric latch retraction devices need not be installed in conduit provided that the door frames are suitable for such use. Install wiring in conduit once it exits the door frame.

**END OF SECTION**

## **1 GENERAL**

### **1.01 RELATED SECTIONS**

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

### **1.02 REFERENCES**

- .1 IEEE 837-2014, Qualifying Permanent Connections Used in Substation Grounding.
- .2 CSA C22.2 No. 41-13(R2017) Grounding and Bonding Equipment.

## **2 PRODUCTS**

### **2.01 MATERIALS**

- .1 Rod electrodes: copper clad steel, 19 mm dia by 3 m long.
- .2 Conductors: bare, stranded, soft annealed copper wire, size No 4/0 AWG and 2/0 AWG for ground bus, electrode interconnections, metal structures, transformers, ground connections.
- .3 Accessories: non-corroding, necessary for complete grounding system, type, size material as indicated, including:
  - .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.

## **3 EXECUTION**

### **3.01 GROUNDING INSTALLATION**

- .1 Install continuous grounding system including, electrodes, conductors, connectors and accessories in accordance with CSA C22.2 No. 41 and requirements of local authority having jurisdiction.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.

- .4 Make buried connections, and connections to electrodes, structural steel work, using copper welding by thermit process.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.

### **3.02 ELECTRODE INSTALLATION**

- .1 Install ground rod electrodes. Leave grounding connections to station equipment for utility.
- .2 Install ground rod electrodes at transformer and switchgear locations.
- .3 Make special provision for installing electrodes that will give acceptable resistance to ground value, where rock or sand terrain prevails.

### **3.03 NEUTRAL GROUNDING**

- .1 Connection of utility neutral tie conductor and grounding conductors at pad mounted transformers by utility.
- .2 Leave adequate conductor length above ground at transformer to facilitate connections.

### **3.04 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00- Electrical General Requirements.
- .2 Perform earth loop test and resistance tests using method appropriate to site conditions and to approval of Department Representative and local authority having jurisdiction.
- .3 Perform test before energizing electrical system.

**END OF SECTION**

## **1 GENERAL**

### **1.01 RELATED SECTIONS**

- .1 Common Work Results For Electrical: Section 26 05 00
- .2 Electrical Identification: Section 26 05 01
- .3 Wires and Cables 0-1000V: Section 26 05 21

### **1.02 REFERENCES**

- .1 IEEE 837-2014, Qualifying Permanent Connections Used in Substation Grounding.
- .2 CSA C22.2 No. 41-13(R2017), Grounding and Bonding Equipment

## **2 PRODUCTS**

### **2.01 EQUIPMENT**

- .1 Clamps for grounding of conductor: size as required and suitable for application.
- .2 Rod electrodes: copper clad steel 19mm diameter by 3m long.
- .3 Direct buried grounding conductors: bare stranded copper of 98% conductivity, soft annealed, size as indicated.
- .4 Insulated grounding and bonding conductors: soft drawn stranded copper of 98% conductivity, type RW90 (green coloured insulation as indicated in 26 05 01, item 10 - Wiring Identification).
- .5 Ground bus: copper, minimum size 6mm x 75mm x 600mm size and as indicated, complete with insulated supports, fastenings, connectors.
- .6 Ground connections to take place on the ground bus are to be as follows:
  - .1 For wire sizes 6 AWG and smaller: copper, one-hole, short barrel (single crimp) lugs.
  - .2 Wire larger than 6 AWG to be two-hole, long barrel (dual crimp) lugs.
- .7 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.
- .8 Copper compression type, long barrel, two hole type lugs unless specified otherwise.
- .9 Copper compression type connectors (cable to cable, cable to ground rod, etc.).

### **3 EXECUTION**

#### **3.01 INSTALLATION GENERAL**

- .1 Install complete permanent, continuous grounding system including electrodes, conductors, connectors, and accessories. Conform to the requirements of the Departmental Representative, applicable codes and the local electrical inspection authority having jurisdiction.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding and bonding conductors from mechanical injury.
- .4 Make buried connections, and connections to electrodes using copper welding by thermit process or inspectable copper crimp type compression connectors.
- .5 Use mechanical connectors for grounding and bonding connections to equipment provided with lugs except grounding terminations in 600V switchboards, 600V CDP panels, 600V MCCs to be copper, compression type, long barrel, two hole connectors.
- .6 Soldered joints not permitted.
- .7 Install insulated bonding conductor in all conduits.
- .8 Install separate insulated bonding conductor to outdoor lighting standards.
- .9 Connect building structural steel to ground as indicated on the drawings.
- .10 Make grounding connections in radial configuration only, with connections terminating at single grounding point on street side of water pipe. 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 Ground secondary service pedestals.
- .13 Secure the 'feed' bonding conductor (wrapped around unbroken) to the grounding screw of each outlet/device box, before connecting to the other grounding conductors and/or provide a "pig-tail" lead for device terminations.
- .14 Twist ground/bond wires together with a screw-on type wire connector, and place in the rear of the outlet box.
- .15 Bond EMT "wall stubs" or sleeves to ground as per CEC requirements.
- .16 All conduits containing insulated ground conductor(s) shall be bonded at both ends.
- .17 Bend radius of all grounding/bonding conductors must be a minimum of 200mm in diameter.

### **3.02 ELECTRODES**

- .1 Install rod electrodes and make grounding connections.
- .2 Bond separate, multiple electrodes together.
- .3 Use size #4/0 AWG copper conductors for connections to electrodes unless otherwise indicated.
- .4 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

### **3.03 SYSTEM AND CIRCUIT GROUNDING**

- .1 Install system and circuit grounding connections to neutral of secondary systems.
- .2 The main incoming grounding conductor is to run unbroken to the main electrical service entrance overcurrent device ground bus and then to the wall mounted ground bus, where applicable.

### **3.04 EQUIPMENT GROUNDING**

- .1 Install grounding/bonding connections to typical equipment included in, but not necessarily limited to following list: Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centers, starters, control panels, building steel work,

generators, cellular floor headers and cells and fittings, distribution panels, outdoor lighting, metallic waste water piping systems, metallic rain water leader systems, metallic gas fuel piping systems.

### **3.05 GROUNDING BUS**

- .1 Install copper grounding bus mounted on insulated supports on each wall of electrical and telecommunications rooms.
- .2 Ground items of electrical equipment to ground bus as indicated herein and on the Drawings.

### **3.06 COMMUNICATION SYSTEMS**

- .1 Telecommunications: provide grounding and bonding in accordance with BICSI Telecommunications Distribution Methods Manual (TDMM), 12th Edition.

### **3.07 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of the Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Where applicable, disconnect ground fault indicators during tests.

**END OF SECTION**

## **1 GENERAL**

### **1.01 RELATED SECTIONS**

- .1 Section 26 05 21 - WIRES AND CABLES (0 - 1000 V).

### **1.02 GENERAL**

- .1 Not applicable.

## **2 PRODUCTS**

### **2.01 SUPPORT CHANNELS**

- .1 U shape, size 40 mm x 40 mm, galvanized steel, surface mounted, suspended or set in poured concrete walls and ceilings unless otherwise indicated.
- .2 All threaded hanger rods will be minimum 10mm diameter, larger if required, made from galvanized steel.

### **2.02 CABLE TIES**

- .1 Use cable ties solely for the purpose of holding cables in place when installed in cable tray.
- .2 Nylon flame retardant, low smoke cable tie. Size as required.
- .3 Nylon flame retardant, low smoke cable tie mounting bracket. Mechanical fastening type only; adhesive mounts not acceptable.

## **3 EXECUTION**

### **3.01 INSTALLATION**

- .1 Secure equipment to hollow and solid masonry, tile and plaster surfaces with expanding anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Where outlet boxes are set in drywall construction, a piece of steel stud will be secured to either side of the outlet box or use caddy quick-mount box supports, or caddy J-1-A for side box supports.

- .4 Secure all equipment in a manner so as not to distort or cause undue stress on any components.
- .5 Secure equipment to masonry, tile or plaster surfaces with lead anchors or nylon shields.
- .6 The use of toggle bolts for securing equipment to hollow masonry walls, suspended ceilings, or drywall is strictly prohibited.
- .7 Support equipment, conduit or cables using clips, spring-loaded bolts, cable clamps designed as accessories to basic channel members.
- .8 Secure surface mounted equipment with twist clip fasteners to inverted T-bar ceilings.
- .9 Fasten exposed conduit or cables within 1m of each outlet box, junction box, pull box, cabinet or conduit fittings with spacing between supports as per CEC to building construction or support system using straps.
  - .1 One-hole zinc plated steel straps to secure surface conduits and cables smaller than 41mm.
  - .2 Two-hole zinc plated steel straps for conduits and cables 41mm and larger.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .10 Suspended support systems:
  - .1 Support single or multiple cables or conduits on a common steel support channel system supported by 10 mm-diameter threaded rod hangers, washers and nuts where direct fastening to building construction is impractical. Channel to be sandwiched between nuts and washers located on both upper and underside portions of channels.
  - .2 Do not support a single conduit using a threaded rod and a conduit clip.
- .11 For surface mounting of two or more conduits use steel channels. Securely attach channels to hangers with the maximum spacing not greater than:
  - .1 Conduits of one size only:
    - .1 16 mm to 21 mm conduit: 1524 mm spacing
    - .2 27 mm to 35 mm conduit: 1980 mm spacing
    - .3 41 mm and larger conduit: 3050 mm spacing
  - .2 Conduits of mixed size:
    - .1 Arrange supports so that maximum spacing of supports conforms to above, based on smallest conduit diameter.
- .12 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

- .13 Provide adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .14 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .15 Do not use supports or equipment installed for other trades for conduit or cable support.
- .16 Install fastenings and supports as required for each type of equipment, cables and conduits, and in accordance with manufacturer's installation recommendations.
- .17 Fasten individual and multiple runs of armoured cables to structure and in bundles as permitted in Section 26 05 21 - Wire and Cables (0 - 1000V).
- .18 Various suspended types of junction, pull and/or outlet boxes as well as conduits, are to be supported with minimum size 9 mm threaded rod, nuts and flat washers. Secure threaded rods to boxes with one flat washer and nut installed on both sides of box.
  - .1 One (1) rod is required for all type boxes sized 150 mm x 150 mm and smaller (23.3 cm<sup>2</sup> and smaller).
  - .2 Two (2) rods are required for boxes sized 23.3 cm<sup>2</sup> and larger, up to and including those sized 304.8 mm x 304.8 mm (929 cm<sup>2</sup>).
  - .3 Minimum of four (4) rods are required for all boxes sized larger than 929 cm<sup>2</sup>.
- .19 Cut-off excess rod within 13 mm of channel bottom.
- .20 In addition to the CEC minimum conduit spacing requirements, all suspended conduit runs containing horizontal or vertical elbows are to have one additional support rod installed not greater than 300 mm from midpoint of all 90° bends. Maximum spacing between conduit support channels shall be dictated by smallest size conduit(s) being supported and/or secured to same.
- .21 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .22 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SHOP DRAWINGS AND PRODUCT DATA**

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

### **1.02 RELATED SECTIONS**

- .1 Section 26 05 01 - Electrical Identification

## **2 PRODUCTS**

### **2.01 PRODUCTS**

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position. Interior units to be CSA Type 1 enclosure.
- .2 Exterior units to be CSA Type 4X, 304 or 316 stainless steel.
- .3 Main and branch lugs or connection bars to match required size and number of incoming and outgoing conductors as indicated.
- .4 Provide at least three (3) spare terminals on each set of lugs in splitters.

### **2.02 JUNCTION AND PULL BOXES**

- .1 Type C: welded steel construction, hinged cover, catch with hasp. Provision for locking. Surface mounting.
- .2 Type D: welded steel construction with screw-on flat covers for surface mounting. Surface or flush mounting as indicated. Covers with 25mm minimum extension all around, for flush-mounted pull and junction boxes.
- .3 Junction and pull boxes larger than 125mm x 125mm to be Type "E", complete with continuously hinged door. Junction and pull boxes 125mm x 125mm and smaller shall be complete with screw cover.
- .4 Single-gang sectional type devices boxes being used in steel stud walls for the installation of both metallic and non-metallic type cables, must not be sized smaller than 250 cm<sup>2</sup>, complete with wrap around type bracket.

- .5 Two or more flush installed sectional boxes, ganged together or boxes sized 100 mm-square and larger (intended for devices), are to have an additional support bracket installed on opposite side of box, not presently secured to metal stud.
- .6 Where larger sized devices or other types of flush outlet or junction boxes may be required, use suitably sized 100 mm x 100 mm deep or 119 mm square boxes complete with appropriate sized extension tile rings. The use of plaster rings in lieu of tile type extension rings is not acceptable.
- .7 Provide junction boxes 150mm x 150mm used in branch circuit wiring complete with bonding terminal strips.

### **2.03 CABINETS**

- .1 Type E: sheet steel, hinged screw-to-lock, door and return flange overlapping sides, handle, and catch, for surface mounting. Finish ASA-61 grey enamel. Complete with bonding terminal strip.
- .2 Type T: 1.6 mm steel cabinet, 1.9 mm cover, latch lock, two (2) keys. Finish - ASA - 61 grey enamel. Complete with bonding terminal strip.

## **3 EXECUTION**

### **3.01 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.

### **3.02 JUNCTION, PULL BOXES AND CABINETS INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations. Install with hinges at side or bottom of enclosure. Do not install with hinge on top.
- .2 Mount cabinets with top not higher than 2m above finished floor.
- .3 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30m of conduit run between pull boxes. Each run of raceway must not have more than the equivalent of four (4) 90-degree bends installed, including the bends located at an outlet or fitting.

- .4 Where located above accessible ceiling systems, locate enclosures within 750mm of ceiling. Where radiant heating panels are installed, junction boxes are to be in-board of same for easy access.
- .5 Suspend enclosures on 9mm plated steel threaded rod or rods secured to enclosure with one flat washer and one nut on both sides of box.
- .6 Support all suspended types of junction and pull boxes using a minimum of 10 mm threaded rod complete with nuts and flat washers. Secure threaded rods to boxes using one flat washer and nut installed on both sides of box. Provide as follows:
  - .1 Boxes up to 120 mm-square: 1 rod.
  - .2 Boxes from 120 mm- to 250 mm-square: 2 rods.
  - .3 Boxes with dimensions above 300 mm: 4 rods.
- .7 Concealed junction or outlet boxes feeding a maximum of two (2) fixture drops must not be sized smaller than 100mm<sup>2</sup>.
- .8 Bond pull boxes and cabinets to ground utilizing a bonding conductor.
- .9 Use type T cabinets when equipment is required to be housed in a lockable enclosure.
- .10 Place pull boxes in straight sections of conduit run and shall not be used in lieu of a bend.
- .11 In no case will a pull or junction box be installed in a ceiling space that is not considered accessible.
- .12 All junction and or pull boxes 150mm x 150mm in size or larger where surface installed will be either type "C" or "E", complete with hinged cover plate.
- .13 All type "D" junction and / or pull boxes where flush mounted, will have the finish cover plate sized a minimum of 25mm larger than the box.
- .14 All concealed type junction and / or pull boxes larger than 120mm square boxes will be type "C" or "E", complete with hinged cover plates.
- .15 Do not use sectional boxes with PVC. Rigid/thin wall conduit installation section boxes are intended for flexible conduit, AC-90, and/or other types of "pliable" cables.

### **3.03 IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical Identification

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 CSA C22.1-2018, Canadian Electrical Code, Part 1.

### **1.02 RELATED SECTIONS**

- .1 Section 26 05 01 - Electrical Identification.
- .2 Section 26 05 29 - Hangars and Supports for Electrical Systems.
- .3 Section 26 05 34 - Conduits, Conduit Fittings, and Fastenings.

## **2 PRODUCTS**

### **2.01 OUTLET AND CONDUIT BOXES GENERAL**

- .1 Size boxes in accordance with CSA C22.1.
- .2 100 mm square or larger outlet boxes as required for special devices.
- .3 Provide multi-gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Boxes for 347 V devices shall be rated as such.

### **2.02 SHEET STEEL OUTLET BOXES**

- .1 Electro-galvanized steel single and multi-gang flush device boxes for flush installation, minimum size 76mm x 50mm x 38mm or as indicated. 100mm square outlet boxes when more than one conduit enters one side with extension and tile rings as required.
- .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 100mm x 54mm x 47mm.
- .3 100mm square or octagonal outlet boxes for lighting fixture outlets.
- .4 100mm square outlet boxes with extension and tile rings for flush mounting devices in finished walls.
- .5 Tile rings to have square corners. Select appropriate depth of tile ring to suit application.

- .6 Provide the following for each multi-media outlet:
  - .1 A 119 mm x 119 mm x 53mm deep box with 38 mm extension ring and a single gang, square, welded tile ring, located where indicated.

### **2.03 MASONRY BOXES**

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

### **2.04 CONCRETE BOXES**

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

### **2.05 CONDUIT BOXES**

- .1 Cast FS aluminum boxes with factory-threaded hubs and mounting feet for all surface wiring of devices (switches, receptacle, thermostats and similar devices) installed lower than 2440 mm AFF. Matching steel type FS metal device plates specifically made for FS boxes are to utilize 4-point fastening.
- .2 Surface type boxes larger in size than 119 mm-square where installed on or within ceiling spaces to be type "E" complete with hinged-type cover plates. Hinged covers are not required for pull boxes.

### **2.06 FITTINGS- GENERAL**

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Double locknuts and insulated bushings on sheet metal boxes.

### **2.07 COLOUR CODING**

- .1 Colour coding of system to be as per Section 26 05 01.

## **3 EXECUTION**

### **3.01 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 6mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Install flush mounted boxes in all finished areas unless otherwise indicated.
- .6 Install surface mounted boxes in service rooms and above ceilings unless otherwise indicated.
- .7 Install flush mounted boxes in exterior walls unless otherwise indicated.
- .8 Install type FS boxes for all surface-mounted devices (regardless of system type involved).
- .9 Install concealed boxes in accessible locations.
- .10 For flush installed 100mm or 120mm square boxes being used as a pull boxes or junction boxes, install a single or double gauge tile ring and blank cover installed on the box.
- .11 Do not use sectional type boxes with rigid galvanized steel conduit, rigid PVC conduit, or EMT.
- .12 Connect boxes to AC-90 cables specifically made for only AC-90 cables.
- .13 When installing flush boxes in metal drywall partitions where the grouping of multiple device boxes is required, support the box between the studs with a box mounting bracket. Where a single flush box is installed, this box may be supported by the wall stud without any additional support required.
- .14 Identify all boxes in accordance with Section 26 05 01.

**END OF SECTION**

## 1 GENERAL

### 1.01 LOCATION OF CONDUIT

- .1 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.

### 1.02 REFERENCES

- .1 CAN/CSA C22.2 No. 45.1-07(R2017), Electrical Rigid Metal Conduit - Steel.
- .2 CSA C22.2 No. 56-2017, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- .3 CSA C22.2 No. 83-1985(R2017), Electrical Metal Tubing.
- .4 CSA C22.2 No. 211.2-06 (R2016), Rigid PVC (Unplasticized) Conduit.

### 1.03 TRADE SIZE

- .1 The following are Metric trade sizes and Imperial trade size equivalent based on CEC Metric Units.

<u>Metric (mm)</u>	<u>Imperial (inch)</u>
12	3/8
16	1/2
21	3/4
27	1
35	1-1/4
41	1-1/2
53	2
63	2-1/2
78	3
91	3-1/2
103	4
129	5
155	6

### 1.04 RELATED WORK

- .1 Section 26 05 29 - Hangers and Supports for Electrical Systems.

## **2 PRODUCTS**

### **2.01 CONDUITS**

- .1 Rigid galvanized steel threaded conduit, fittings and connectors: to CSA C22.2 No. 45.1.
- .2 Electrical metallic tubing (EMT) with steel set screw couplings: to CSA C22.2 No. 83.
- .3 Rigid PVC conduit, fittings; couplings and connectors: to CSA C22.2 No. 211.2.
- .4 Flexible aluminum conduit and liquid-tight flexible metal conduit: to CSA C22.2 No. 56.
- .5 ENT conduit is not permitted.

### **2.02 CONDUIT FASTENINGS**

- .1 One hole steel straps to secure surface conduits smaller than 41mm. Two hole steel straps for conduits 41mm and larger.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1.5m oc.
- .4 10mm dia. threaded rods to support suspended channels.

### **2.03 CONDUIT FITTINGS**

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Use conduit fittings (LB, LL, LR) for 90° bends. "Ells", or corner pulling elbows are prohibited.
- .3 Connectors and couplings for EMT: galvanized steel set-screws type c/w case hardened steel locknuts. Provide insulated throats on connectors up to and including 27 mm. Install metal thread-on bushings on all EMT connectors sized 35 mm or larger.
- .4 Use waterproof type connectors on all vertical conduit runs connecting equipment. Equip connectors with a rubber "O" Ring gasket. In addition, any conduit couplings in the vertical portion of the conduit run over equipment enclosures equipped with sprinkler hoods must be rain tight.
- .5 Flexible metal conduit connectors to be nylon insulated, steel or malleable iron type similar to T & B Tite-Bite #3115 thru 3124.

Provide insulating bushings (anti-shorts) for flexible metal conduit connectors. Install plastic thread-on bushings on all flexible metal conduit connectors sized 35 mm or larger.

- .6 Liquid-tight flexible metal conduit fittings:
  - .1 Specifically listed for liquid tight flexible metal conduit.
  - .2 Steel type, to match conduit size.
  - .3 Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
  - .4 Safe edge ground type.
  - .5 Connectors to have insulated throats.
- .7 Plastic screw-on bushings for conduit ends up to 35mm diameter; metal bushings for larger sizes.

#### **2.04 GENERAL FITTINGS**

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Double locknuts and insulated bushings on sheet metal boxes.

#### **2.05 EXPANSION FITTINGS FOR RIGID CONDUIT**

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 205 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 21 mm deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

#### **2.06 FISH CORD**

- .1 Polypropylene: minimum 3mm diameter.

### **3 EXECUTION**

#### **3.01 INSTALLATION**

- .1 Install conduits as high as possible 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. Install conduits as high as possible and secured to building structure with approved supports.
- .3 Use electrical metallic tubing (EMT) except in cast concrete.
- .4 Install EMT as a complete system and securely fasten in place within 300 mm of each outlet box, junction box, cabinet, couplings, fittings and changes in direction and the spacing between supports as follows:
  - .1 Not greater than 1500 mm for 16 mm and 21 mm trade size EMT
  - .2 Not greater than 1800 mm for 27 mm and 35 mm trade size EMT
  - .3 Not greater than 3000 mm for 41 mm trade size EMT or larger.
- .5 Use rigid galvanized steel threaded conduit through poured concrete floor slabs and where otherwise specified.
- .6 Use rigid PVC conduit underground: minimum size 21mm dia.
- .7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment.
- .8 Minimum conduit size for lighting and power circuits: 21mm.
- .9 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .10 Mechanically bend steel conduit over 21mm dia.
- .11 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .12 Install fish cord in empty conduits.
- .13 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .14 Dry conduits out before installing wire.
- .15 Install insulated copper bonding conductor in all conduit runs. Minimum size: #12 AWG or Table 16 of CEC whichever is larger.
- .16 Non-connected PVC or steel raceways protruding up through open bottoms of free-standing equipment require PVC bell ends and steel type ground bushings installed on ends of respective types of conduits. Extend conduits a minimum of 50mm above housekeeping pad or concrete trough.

- .17 Install plastic bushings in all EMT sized 35mm and larger before pulling in conductors.
- .18 Installation of conduit for control circuit wiring and structured cabling.
  - .1 Install surface wiring in EMT.
  - .2 Conduit to extend 750mm of all various control devices associated with the operation of any given piece of mechanical equipment or device they may feed.
  - .3 Unless indicated otherwise, use liquid tight flexible metal conduit complete with matching connectors for final connection between EMT and applicable control device. Junction or pull boxes may also be used to make this transition.
  - .4 Locate EMT type conduit wall stub complete with flush installed device box in all partitions to accommodate wiring between device and accessible ceiling.
  - .5 Install EMT connectors complete with nylon insulated throat or threaded type bushing on end of EMT stub where it protrudes through the wall above the accessible ceiling. EMT plastic end cap bushings that are CSA approved may also be used.
  - .6 Bond EMT conduit stubs to ground as required by the CEC.
  - .7 Turn out EMT conduit stubs installed in walls into the accessible ceiling space in the room where the associated wall box is located. Provide separate stubs for each room.
- .19 Where construction consists of metal Q-deck and steel joists (roof deck), install conduits as follows:
  - .1 In such a manner that the nearest outside surface of the conduit is not less than 38mm from the nearest surface of the metal roof deck. Typically, this would involve the installation of conduits on the underside of the top flange, secured with beam clamps or canstrut.
  - .2 Installation of conduits or raceways between the top flange of a steel support structure and a steel roof deck is not permitted due to the possible penetration of roof deck mechanical screws or fasteners.
- .20 Where construction consists of metal Q-deck and steel joists (non-roof deck), install conduits as follows:
  - .1 Between the top flange of a steel support structure and the Q-deck.
  - .2 Where conduit sizes preclude the above mentioned method, install as high as possible in the space to conserve headroom.
- .21 Provide expansion joints for rigid conduit systems to the requirements of the CEC.

- .22 Code approved conduits will be used for underground or below slab installations.
- .23 Liquid tight flexible metal conduit will be used for equipment such as cameras or motors. Limit length to 1.2m. Confirm feeds to camera are secure and inaccessible
- .24 Provide two (2) 20mm spare conduits to accommodate future power or data etc., into any areas that may become inaccessible after construction or if installation at a later time would cause a major disruption to the operation
- .25 Install spare conduits in a concealed secure manner but allowing for future access.
- .26 Clearly show in slab or underground conduits on the record drawings.
- .27 Do not install conduits (indoors or outdoors) in a manner in which they may be used as a climbing aide to gain access to rooftops or non-secured areas.
- .28 All distribution panelboards, motor control centers, splitter troughs, various other systems control panels, etc. that are fed underground to utilize code approved, rigid type, thick wall and PVC conduit unless concrete encased, which may be the thin-walled PVC DB II conduit.
- .29 PVC conduits sized 25mm diameter and larger will be installed in trenches not less than 300mm in depth from underside of concrete floor slab to bottom of trench. Place conduits on a 50mm bed of sand and place a second 150mm of sand on top of and completely around conduits prior to backfilling.
- .30 PVC conduits of "all" sizes are to have transition to threaded steel take place as indicated by the design drawings or prior to turning up through floor slab if not otherwise indicated.
- .31 Fire barrier material equivalent to 3M will be provided for all penetrations of conduits between walls, floors or ceilings.

### **3.02 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5m clearance.
- .3 Run conduits in flanged portion of structural steel.

- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 76mm parallel to steam or hot water lines with minimum of 25mm at crossovers.

### 3.03 CONDUITS UNDERGROUND

- .1 Slope conduits to provide drainage. Slope conduits entering/exiting the building away from the building.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.
- .3 Conduits are only permitted to be installed below floors and are not to be installed in concrete floors unless specifically indicated otherwise.
- .4 Install PVC conduits sized 35mm and larger are in trenches not less than 305mm in depth from underside of concrete floor slab to bottom of trench. Place conduits on a 50mm bed of sand and place a second 150mm bed of sand on top. Completely surround conduits with 150 mm of sand prior to backfilling.
- .5 Wiring for all various systems devices and/or outlets installed below ground floor concrete floor slabs may be performed utilizing minimum 21mm PVC rigid conduit. Transition from PVC rigid thick wall conduit to rigid steel threaded conduit is to take place below the floor slab. Transition from rigid steel to EMT above concrete floor slab.
- .6 PVC conduits of all sizes prior to turning-up through floor slabs, unless specifically indicated otherwise, are to have transition to rigid steel threaded conduit take place as previously indicated.
- .7 All underground conduit must be upsized one (1) trade size above the minimum code requirement.
- .8 Rigid PVC (thick wall) conduit shall be permitted to be direct buried.
- .9 Conduit installation is not to influence the thickness of the floor slab.
- .10 Do not run conduits along concrete walls installed to reinforce wall installations.

- .11 The installation of PVC type conduits above ground is prohibited.
- .12 All underground conduits are to be up-sized at least one trade size above the minimum code requirement for ease of pulling.
- .13 Only use rigid Types EB1 and DB II/ES2 PVC (thin wall) Conduit (CSA C22.2 211.1) where embedded in concrete.
- .14 Direct bury rigid PVC (thick wall) Conduit (CSA C22.2 No. 211.2).

**END OF SECTION**

## **1 GENERAL**

### **1.01 SECTION INCLUDES**

- .1 This section specifies the requirements to supply and install cables in ducts installed in previous phases of the Work.

### **1.02 RELATED SECTIONS**

- .1 Section 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

## **2 PRODUCTS**

### **2.01 MATERIALS**

- .1 Provide cables in accordance with Section 26 05 21 - Wires and Cables (0-1000V).

## **3 EXECUTION**

### **3.01 CABLE INSTALLATION IN DUCTS**

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

### **3.02 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Confirm resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance tests.
  - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
  - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
- .6 Provide Departmental Representative with list of test results showing location at which each test was made, circuit tested and result of each test.
- .7 Remove and replace entire length of cable if cable fails to meet any of test criteria.

**END OF SECTION**

## **1 GENERAL**

### **1.01 PRODUCT DATA**

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

### **1.02 RELATED SECTIONS**

- .1 Section 26 05 01 - Electrical Identification.

## **2 PRODUCTS**

### **2.01 TRANSFORMERS**

- .1 Use transformers of a single manufacturer throughout project.
- .2 Design 1:
  - .1 Type: dry.
  - .2 3 phase, kVA as indicated, 600 V input, 120/208 V output, 60 Hz.
  - .3 Voltage taps: standard.
  - .4 Insulation: Class 220, 150°C temperature rise.
  - .5 Basic Impulse Level (BIL): standard.
  - .6 Hipot: standard.
  - .7 Average sound level: standard.
  - .8 Impedance at 170°C: standard.
  - .9 Enclosure: EEMAC 2, ventilated removable metal front panel and hood, drip proof.
  - .10 Mounting: as indicated.
  - .11 Finish: in accordance with Section 26 05 00 - Electrical General Requirements.
  - .12 Winding configuration: Delta primary, grounded Y secondary unless indicated otherwise by Design Drawings. All windings copper.
  - .13 Vibration isolators, for all dual rated spade type transformer lug for ground/bonding of transformers.
  - .14 Acceptable material:
    - .1 Delta
    - .2 Siemens
    - .3 Hammond Power Solutions

### **2.02 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical Identification.

- .2 Label size: 7.

### 3 EXECUTION

#### 3.01 INSTALLATION

- .1 Securely mount dry type transformer on wall or floor as indicated. External vibration isolators to be provided on transformer support channels on each four corners and between transformer enclosure legs and floor in locations where transformers are secured to concrete.
  - .1 Acceptable Material: Vibro-Acoustics RM series, size as required.
- .2 Ensure adequate clearance around transformer for ventilation. Minimum clearance from combustible material and other equipment: 300mm
- .3 Install transformers in level upright position.
- .4 Remove shipping supports only after transformer is installed and just before putting into service.
- .5 Loosen isolation pad bolts until no compression is visible.
- .6 Megger primary and secondary windings with 1000 V and 500 V megger, respectively, and report immediately any reading below 100 mega-ohms.
- .7 Ensure transformer is on the tap providing rated voltage at full load.
- .8 Add lugs for copper conductors when double neutrals are used.
- .9 All dry type transformers are to be complete with a Dual-Rated Spade-Type Transformer Lugs, sized as required to facilitate both grounding and bonding conductor requirements.
  - .1 Bolt directly to transformer enclosure (chassis) with a minimum of two (2) 12mm bolts, flat and lock washers and accompanying nuts etc.
  - .2 To contain number of termination openings as necessary to ensure individual termination of each grounding and each bonding conductor is achieved.
- .10 Connect electrostatic shield and transformer neutral and case solidly to ground.

- .11 Make primary and secondary connections in accordance with wiring diagram.
- .12 Energize transformers after installation end testing is complete.
- .13 For transformers mounted above the floor, construct a support structure from steel channel.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SHOP DRAWINGS**

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

### **1.02 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for panelboards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals
- .2 Include panel schedules.

### **1.03 RELATED SECTIONS**

- .1 Section 01 91 13 - General Commissioning Requirements
- .2 Section 26 05 00 - Common Work Results for Electrical
- .3 Section 26 05 01 - Electrical Identification
- .4 Section 26 28 21 - Moulded Case Circuit Breakers

## **2 PRODUCTS**

### **2.01 PANEL BOARDS**

- .1 Panelboards: provide the product of one (1) manufacturer.
- .2 250 and 600 V panelboards: bus and breakers rated as indicated.
- .3 Sequence phase busing 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 Provide two (2) keys for each panelboard, and key panelboards alike.

- .6 Tin-plated copper bus. Neutral bus to have same rating as mains, except where 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 Minimum of one (1) terminal screw on factory installed neutral bar for each circuit breaker position.
- .11 Panelboards rated 400A and below to be minimum 508 mm wide.
- .12 Panelboards rated above 400A shall be minimum 279 mm deep and 914 mm wide, complete with drip hood.
- .13 Panelboards to have 20% minimum spare breakers.

## **2.02 BREAKERS**

- .1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to the Departmental Representative.
- .5 Breakers installed in panelboards rated above 400A must be capable of being padlocked in the on or off position.

## **2.03 EQUIPMENT IDENTIFICATION**

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

### **3 EXECUTION**

#### **3.01 INSTALLATION**

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces. Provide plywood backboards as per Section 26 05 00 - Common Work Results for Electrical
- .2 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.
- .3 Connect loads to circuits.
- .4 Connect neutral conductors to common neutral bus with respective neutral identified.
- .5 Where more than one (1) bonding terminal strip is present in one panel, hardwire both together using same size bonding conductor as the one that accompanies the panel feeder conductors.

#### **3.02 COMMISSIONING**

- .1 Refer to Section 01 91 13 - Commissioning General Requirements.

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 CSA C22.2 No. 111-2018, General-use Snap Switches.
- .2 CSA C22.2 No. 55-15, Special Use Switches.
- .3 CSA C22.2 No. 42-10(R2017), General use Receptacles, Attachment Plugs, and Similar Wiring Devices

### **1.02 SHOP DRAWINGS**

- .1 Submit shop drawings for each device and cover plate type as per Section 01 33 00 - Submittal Procedures.

### **1.03 OPERATIONAL AND MAINTENANCE DATA**

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

### **1.04 RELATED SECTIONS**

- .1 01 91 13 - General Commissioning Requirements

## **2 PRODUCTS**

### **2.01 SWITCHES**

- .1 20 A, 120 V, specification grade single pole, two way switches.
- .2 Manually-operated general purpose ac switches with following features:
  - .1 Terminal holes approved for No. 10 AWG wire.
  - .2 Silver alloy contacts.
  - .3 Urea or melamine molding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 Ivory nylon, heavy duty toggle.
  - .6 Integral ground terminal.
- .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

- .4 Use the switches of one (1) manufacturer throughout project.

## 2.02 RECEPTACLES

- .1 Type 1:
  - .1 General purpose duplex receptacles, specification grade CSA type 5-15R, 125 V, 15 A, U ground, with following features:
    - .1 Ivory urea molded housing for all power receptacles.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Break-off links for use as split receptacles.
    - .4 Eight back wired entrances, four side wiring screws.
    - .5 Triple wipe contacts and riveted grounding contacts.
- .2 Type 2:
  - .1 Duplex receptacles, specification grade CSA type 5-20R (T-Slot), 125 V, 15/20A, U ground, with following features:
    - .1 Ivory urea molded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Break-off links for use as split receptacles.
    - .4 Eight back wired entrances, four side wiring screws.
    - .5 Triple wipe contacts and riveted grounding contacts.
- .3 Type 3:
  - .1 GFCI duplex receptacles, specification grade CSA type 5-15R, 125 V, 15 A, U ground, with following features:
    - .1 Ivory urea molded housing for all power receptacles.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Break-off links for use as split receptacles.
    - .4 Eight back wired entrances, four side wiring screws.
    - .5 Triple wipe contacts and riveted grounding contacts.
    - .6 GFCI Class A test and reset buttons.
- .4 Type 4:
  - .1 GFCI duplex receptacles, specification grade CSA type 5-20R (T-Slot), 125 V, 15/20A, U ground, with following features:
    - .1 Ivory urea molded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Break-off links for use as split receptacles.
    - .4 Eight back wired entrances, four side wiring screws.
    - .5 Triple wipe contacts and riveted grounding contacts.
    - .6 GFCI Class A test and reset buttons.
- .5 Type 5:
  - .1 Duplex receptacles, specification grade CSA type 6-20R (T-Slot), 250 V, 15/20A, U ground, with following features:
    - .1 Ivory urea molded housing.
    - .2 Suitable for No. 10 AWG for back and side wiring.
    - .3 Break-off links for use as split receptacles.
    - .4 Eight back wired entrances, four side wiring screws.
    - .5 Triple wipe contacts and riveted grounding contacts.

- .6 Other receptacles with ampacity and voltage as indicated.
- .7 Provide the receptacles of one (1) manufacturer throughout project.

### **2.03 EXTERIOR RECEPTACLES**

- .1 Provide UV-resistant polycarbonate lockable cover.
- .2 Provide two (2) keys to the Departmental Representative.

### **2.04 COVER PLATES**

- .1 Cover plates for wiring devices.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Brushed stainless steel plates for wiring devices mounted in flush-mounted outlet box.
- .4 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .5 Weatherproof while-in-use cover, complete with neoprene gaskets and enclosure key, for duplex receptacles mounted on exterior of building.

## **3 EXECUTION**

### **3.01 INSTALLATION**

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height as indicated.
- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height as indicated.
  - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
  - .4 Mount receptacles with "U" ground up for vertically mounted and neutral slot at top for horizontally mounted receptacle.

- .5 Install pigtail type leads on conductors in all device or outlet boxes where feeding through to other receptacles. Daisy-chaining or looping through of conductors from one device to another is not acceptable. Provide separate pigtail conductor leads for final termination to each receptacle for phase, neutral and bond conductors.
- .6 Test all receptacles for polarity.
- .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 Device leveller and retainer shall be an approved accessory for securing devices to flush installed device boxes.
- .5 Single gang adjustable box extension is an approved accessory for extending single gang box openings a maximum of 22mm. Their use is acceptable in non-combustible type walls where front edges of boxes have not been installed greater than 28mm from wall surface.

### **3.02 COMMISSIONING**

- .1 Refer to Section 01 91 13 - Commissioning General Requirements.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SHOP DRAWINGS AND PRODUCT DATA**

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

### **1.02 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with Section 01 33 00.
- .2 Six (6) spare fuses of each type and size.

### **1.03 DELIVERY AND STORAGE**

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in storage cabinet.
- .4 Provide fuse cabinet in main electrical room 304 mm x 304 mm x 100 mm.

## **2 PRODUCTS**

### **2.01 FUSES GENERAL**

- .1 Fuses: use the product of a single manufacturer throughout the Work.

### **2.02 USE TYPES**

- .1 HRCI-J fuses (formerly Class J), rating as indicated
- .2 RKI time delay: rating as indicated
- .3 Acceptable materials
  - .1 Cooper
  - .2 Ferraz
  - .3 Littelfuse

### **3 EXECUTION**

#### **3.01 INSTALLATION**

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Fit correct fuses to physically matched mounting devices.
- .3 Confirm correct fuses are fitted to assigned electrical circuit.
- .4 Confirm fuse size is correctly identified on equipment.

**END OF SECTION**

## **1 GENERAL**

### **1.01 PRODUCT DATA**

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include circuit breaker types, ratings, magnetic adjustment ranges and time-current characteristic curves for breakers with ampacity of 225 A and over. LSI and LSIG adjustment ranges to be included for LSI and LSIG breakers.

### **1.02 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for circuit breakers for incorporation into Manual specified in Section 01 78 00 - Closeout Submittals
- .2 Include matrix of individual circuit breaker settings for all breakers with adjustable settings.

## **2 PRODUCTS**

### **2.01 BREAKERS GENERAL**

- .1 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .2 Multiple-pole breakers to have single handle.
- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable instantaneous trips to range from 3-8 times rated maximum circuit current.
- .4 Circuit breakers with interchangeable trips as indicated.
- .5 Circuit breakers to have interrupting capacity as indicated on the drawings. Circuit breakers are not to utilize series rating in determining their interrupting capacity.
- .6 Circuit breakers rated 225 A and above are to be complete with adjustable solid-state trip units.

## **2.02 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.

## **2.03 MAGNETIC BREAKERS**

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

## **2.04 SOLID STATE TRIP BREAKERS**

- .1 Moulded case circuit breaker to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long-time, short time, and/or instantaneous tripping for phase and/or ground fault short circuit protection as indicated by design drawings. Settings to be individually adjustable.

## **2.05 OPTIONAL FEATURES**

- .1 Include:
  - .1 On-off locking device for 10% of branch breakers and all breakers supplying emergency lighting battery units, security and fire alarm devices.
- .2 Fire Pump Circuits: provide auxiliary dry contacts on breakers to indicate whether breaker is open or closed.

## **2.06 GROUND FAULT CIRCUIT INTERRUPTER CIRCUIT BREAKERS**

- .1 Moulded case thermal magnetic circuit breaker with CSA Class A ground fault protection

# **3 EXECUTION**

## **3.01 INSTALLATION**

- .1 Install circuit breakers as required. Factory install breakers in all panelboards, switchboards, MCCs, and distribution panels.
- .2 Adjust circuit breaker settings to the values indicated on the manufacturer's supplied Coordination Study.

- .3 Install individual circuit breakers in adequately rated enclosures complete with bond and neutral connections.
- .4 Wire auxiliary contacts on fire pump circuit breakers to fire pump controller.

**END OF SECTION**

## **1 GENERAL**

### **1.01 SHOP DRAWINGS AND PRODUCT DATA**

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

### **1.02 OPERATION AND MAINTENANCE DATA**

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

### **1.03 RELATED SECTIONS**

- .1 01 91 13 - General Commissioning Requirements
- .2 26 05 00 - Common Work
- .3 26 05 01 - Electrical Identification

## **2 PRODUCTS**

### **2.01 MATERIALS**

- .1 Starters: EEMAC E14-1
  - .1 Half size starters are not acceptable.
  - .2 IEC equipment not acceptable.

### **2.02 MANUAL MOTOR STARTERS**

- .1 Single phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
  - .1 Switching mechanism, quick make and break.

- .2 All phase conductors to have overload heaters, manual reset, and trip indicating handle.
- .2 Accessories:
  - .1 Toggle switch: heavy duty labelled as indicated.
  - .2 Indicating light: LED and colour as indicated.
- .3 Locking tab to permit padlocking in "ON" or "OFF" position.

## **2.03 FULL VOLTAGE MAGNETIC STARTERS**

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated 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 selection switch in cover.
  - .6 LED pilot light indicating coil is energized.
  - .7 LED pilot light indicating unit is powered.
- .2 Combination-type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:
  - .1 Locking in "OFF" position with up to three (3) padlocks.
  - .2 Independent locking of enclosure door.
  - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 All combination-type starters are to be complete with solid-core current sensors. Wire all connections to a factory-installed terminal strip.
- .4 All combination-type starters are to be complete with mechanical relay and relay base. Relay to be DPDT with 12 VDC coil and 120 VAC, 6 A contacts. Wire all connections to a factory-installed terminal strip.
- .5 Accessories:
  - .1 Selector switches: heavy duty labelled as indicated.
  - .2 Indicating lights: LED type and color as indicated.
  - .3 One (1)-N/O and one (1)-N/C spare auxiliary contacts unless otherwise indicated.
  - .4 Provide solid state protection complete with single phasing protection.

- .5 Provide one (1) 24 VAC interposing relay complete with two (2) normally open and two (2) normally closed contacts mounted in starter cell. Connect relay as indicated.

#### **2.04 CONTROL TRANSFORMER**

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

#### **2.05 FINISHES**

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

#### **2.06 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical Identification.

### **3 EXECUTION**

#### **3.01 INSTALLATION**

- .1 Install starters, connect power and control as indicated.
- .2 Confirm fuses and overload elements are correct for the actual loads. Obtain correct information from Divisions 21 and 23 prior to ordering and setting overloads.
- .3 Coordinate with Controls contractor.

#### **3.02 FIELD QUALITY CONTROL**

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

- .5 Provide test forms to Commissioning Agent for each motor starter confirming operation and settings.

### **3.03 COMMISSIONING**

- .1 Refer to Section 01 91 13 - Commissioning - General Requirements.

**END OF SECTION**

## **1 GENERAL**

### **1.01 RELATED WORK**

- .1 Common Work Results for Electrical: Section 26 05 00
- .2 Electrical Identification: Section 26 05 01
- .3 Automatic Load Transfer Equipment: Section 26 36 23
- .4 Packaged Fire Pump: Section 21 30 00
- .5 Aboveground Fuel Storage Tanks: Section 33 56 13

### **1.02 REFERENCES**

- .1 API 650-2018, Welded Steel Tanks for Oil Storage.
- .2 ASTM D975-19, Standard Specification for Diesel Fuel Oils.
- .3 NEMA MG 1-2016, Motors and Generators.
- .4 CAN/CGSB 3.6-2000 AMEND No. 1, Regular Sulphur Diesel Fuel.
- .5 ISO 3046/1-2002, Specification for Reciprocating Internal Combustion Engines: Performance.
- .6 ULC-S601-2014, Shop Fabricated Steel, Aboveground Tanks for Flammable and Combustible Liquids.

### **1.03 DESCRIPTION OF SYSTEM**

- .1 Generating system consists of:
  - .1 Diesel engine.
  - .2 Alternator.
  - .3 Alternator control panel.
  - .4 Automatic transfer equipment.
  - .5 Battery charger and battery.
  - .6 Ventilation system.
  - .7 Fuel supply system.
  - .8 Exhaust system.
  - .9 Steel mounting base.
- .2 System designed to operate unattended as standby power.

#### 1.04 SHOP DRAWINGS

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

#### 1.05 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for diesel generator for incorporation into manual specified in Section 01 78 00.
- .2 Include in Operation and Maintenance Manual instructions for particular unit supplied and not general description of units manufactured by supplier and:
  - .1 Operation and maintenance instructions for engine, alternator, control panel, battery charger, battery, fuel

system, engine room ventilation system, exhaust system and accessories, to permit effective operation, maintenance and repair.

- .2 Technical data:
  - .1 Illustrated parts lists with parts catalogue numbers.
  - .2 Schematic diagram of electrical controls.
  - .3 Flow diagrams for:
    - .1 Fuel system.
    - .2 Lubricating oil.
    - .3 Cooling system.
  - .4 Certified copy of factory test results.
  - .5 Maintenance and overhaul instructions and schedules.
  - .6 Precise details for adjustment and setting of time delay relays or sensing controls which require on site adjustment.

#### 1.06 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00.
- .2 Include:
  - .1 Six (6) fuel filter replacement elements.
  - .2 Six (6) lube oil filter replacement elements.
  - .3 Six (6) air cleaner filter elements.
  - .4 Two (2) sets of fuses for control panel.
  - .5 Special tools for unit servicing.

#### 1.07 SOURCE QUALITY CONTROL

- .1 Factory test generator set including engine, alternator, control panels, transfer switch and accessories in presence of the Departmental Representative.
- .2 Notify the Departmental Representative ten (10) days in advance of date of factory test.
- .3 Test procedure:
  - .1 Prepare blank forms and check sheet with spaces to record data. At top of first sheet record:
    - .1 Date.
    - .2 Generator set serial no.
    - .3 Engine, make, model, serial no.
    - .4 Alternator, make, model, serial no.
    - .5 Rating of generator set, kW, kV.A, V, A, r/min, Hz.
  - .2 Mark check sheet and record data on forms in duplicate as test proceeds.
  - .3 Obtain the Departmental Representative's signature on completed forms to indicate concurrence in results of test.

- .4 Tests:
  - .1 With 100% rated load, operate set for 8 h, taking readings at 30 min intervals, and record following:
    - .1 Time of reading.
    - .2 Running time.
    - .3 Ambient temp in °C.
    - .4 Lube oil pressure in kPa.
    - .5 Lube oil temp in °C.
    - .6 Engine coolant temp in °C.
    - .7 Exhaust stack temp in °C.
    - .8 Alternator voltage: phase 1, 2, 3.
    - .9 Alternator current: phase 1, 2, 3.
    - .10 Power in kW.
    - .11 Frequency in Hz.
    - .12 Power Factor.
    - .13 Battery charger current in A.
    - .14 Battery voltage.
    - .15 Alternator cooling air outlet temp.
  - .2 After completion of 8 h run, demonstrate following shut down devices and alarms:
    - .1 Overcranking.
    - .2 Overspeed.
    - .3 High engine temp.
    - .4 Low lube oil pressure.
    - .5 Short circuit.
    - .6 Alternator overvoltage.
    - .7 Low battery voltage, or no battery charge.
    - .8 High alternator temperature.
  - .3 Next install continuous strip chart recorders to record frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments to include:
    - .1 No load to full load to no load.
    - .2 No load to 70% load to no load.
    - .3 No load to 20% load to no load.
    - .4 20% load to 40% load to no load.
    - .5 40% load to 60% load to no load.
    - .6 60% load to 80% load to no load.
- .5 Demonstrate:
  - .1 Automatic starting of set and automatic transfer of load on failure of normal power.
  - .2 Operation of manual bypass switch.
  - .3 Automatic shutdown of engine on resumption of normal power.
  - .4 That battery charger reverts to high rate charge after cranking.
- .6 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.

## 1.08 WARRANTY

- .1 For the diesel engine driven generator set, the 12 month warranty period is extended to 60 months or 1500 operating hours, whichever occurs first.

## 2 PRODUCTS

### 2.01 DIESEL ENGINE

- .1 Diesel engine: to ISO 3046-1 and ISO 8528-1.
  - .1 Engine: standard product of current manufacture, from company regularly engaged in production of such equipment.
- .2 Turbo charged synchronous speed 1800 r/min.
- .3 Capacity:
  - .1 Rated continuous power in kW at rated speed, after adjustment for system losses in auxiliary equipment necessary for engine operation; to be calculated as follows: Rated continuous output = Generator kW / Generator Efficiency @ Full Load
    - .1 Under following site conditions:
      - .1 Altitude: 150 m.
      - .2 Ambient temperature: 40°C.
      - .3 Relative humidity: 98%.
- .4 Cooling System:
  - .1 Liquid cooled: heavy duty industrial radiator mounted on generating set base with engine driven pusher type fan to direct air through radiator from engine side with ethylene glycol anti-freeze non-sludging above minus 46 °C.
  - .2 To maintain manufacturer's recommended engine temperature range at 10% continuous overload in ambient temperature of 40°C.
  - .3 Block heater: thermostatically controlled lube oil or liquid coolant heater connected to line side of automatic transfer switch to allow engine to start in room ambient 0°C. Provide shut-off valve mounted directly on engine block.
    - .1 Switch and fuse in heater circuit, mounted in engine-alternator control cubicle and fed from line side of automatic transfer switch.
- .5 Fuel:
  - .1 Grade No. 2 diesel to ASTM D975.

- .6 Fuel system: solid injection, mechanical fuel transfer pump, fuel filters and air cleaner, fuel rack solenoid energized when engine running.
- .7 Governor:
  - .1 Electronic isochronous governor capable of controlling engine speed within  $\pm 0.25\%$  for any steady state load from no load to full load.
- .8 Lubrication system:
  - .1 Pressure lubricated by engine driven pump.
  - .2 Lube oil filter: replaceable, full flow type, removable without disconnecting piping.
  - .3 Lube oil cooler.
  - .4 Engine sump drain valve.
  - .5 Oil level dip-stick.
- .9 Starting system:
  - .1 Positive shift, gear engaging starter 12 or 24V dc.
  - .2 Cranking limiter to provide 3 cranking periods of 10s duration, each separated by 10 s rest.
  - .3 Lead acid, 12 or 24V storage battery with sufficient capacity to crank engine for 1 min at 10°C without using more than 20% of ampere hour capacity. Batteries to be installed in insulated box with cover to completely enclose batteries. Provide steel stand for batteries.
  - .4 Automatic battery charging alternator with solid-state voltage regulation.
  - .5 Battery charger: constant voltage, solid state, two stage from trickle charge at standby to boost charge after use. Regulation: plus or minus 1% output for plus or minus 10% input variation. Equipped with dc voltmeter, dc ammeter and on-off switch.
- .10 Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.
- .11 Drip-proof construction.
- .12 Permanent Magnet Generator based excitation.

## 2.02 ALTERNATOR

- .1 Alternator: to NEMA MG1.
- .2 Rating: 3 phase, 120/208 V, 4 wire, 510 kW, 60Hz, at 0.8PF.
- .3 Output at 40°C ambient:

- .1 100% full load continuously.
- .2 110% full load for 1 h.
- .3 150% full load for 1 min.
  
- .4 Revolving field, brushless, single bearing.
- .5 Drip proof.
- .6 Amortisseur windings.
- .7 Synchronous type.
- .8 Exciter: permanent magnet.
- .9 EEMAC class H insulation on windings.
- .10 Thermistors embedded in stator winding and connected to alternator control circuitry.
- .11 Voltage regulator: digital output voltage regulation integrated into control system:
  - .1 Stability:  $\pm 0.25\%$  maximum voltage variation at any constant load from no load to full load.
  - .2 Regulation: 1.5% maximum voltage deviation between no-load steady state and full-load steady state.
  - .3 Transient: 10% maximum voltage dip on one-step application of 0.8PF full load.
  - .4 Transient: 12% maximum voltage rise on one-step removal of 0.8PF full load.
  - .5 Transient: 1 s maximum voltage recovery time with application or removal of 0.8PF full load.
- .12 Alternator: capable of sustaining 300% rated current for period not less than 10s permitting selective tripping of down line protective devices when short circuit occurs.

## 2.03 CONTROL PANEL

- .1 NFPA 110 generator control shall be totally enclosed, generator mounted, microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
- .2 Operating and safety indications, protective devices, system controls, engine gauges and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator set vibration.
- .3 Monitoring:
  - .1 AC voltmeter: 3-phase, line-to-line and line-to-neutral for each phase.

- .2 AC ammeter: 3-phase, line-to-line and line-to-neutral for each phase.
- .3 Current transformers and potential transformers as necessary.
- .4 AC frequency meter (reed type is not acceptable).
- .5 AC Power kW: total and for each phase.
- .6 AC power kVA: total and for each phase.
- .7 DC voltmeter: local battery voltage.
- .8 Engine coolant temperature gauge.
- .9 Engine lubricating oil pressure gauge.
- .10 Running time meter.
- .4 Controls:
  - .1 Engine start button.
  - .2 Automatic remote start capability.
  - .3 Mode Selector switch: Off-Auto-Manual.
  - .4 Voltage adjustment control: raise/lower switches or buttons (rheostats are not acceptable).
  - .5 Engine emergency stop button and provision for remote emergency stop button.
  - .6 Automatic voltage regulator.
  - .7 Status LED indicating lamps to indicate not in auto, existing shutdown condition, existing alarm condition and system ready.
  - .8 Controls for automatic shutdown of the engine and contacts contacts wired to terminal blocks for common remote and local audible indication on:
    - .1 Overcrank
    - .2 High engine temperature
    - .3 Low lube oil pressure
    - .4 Overspeed
  - .9 Additional contacts wired to terminal blocks for common remote and local audible alarm indication on:
    - .1 Low engine temperature
    - .2 High engine temperature pre-alarm
    - .3 Low fuel
    - .4 Low battery voltage
    - .5 Low coolant level
    - .6 Automatic transfer switch in non-auto mode or bypass mode
    - .7 Main disconnect/overcurrent device open
  - .10 Alphanumeric text based display for individual fault indication of any of the alarm or shutdown conditions listed above.
  - .11 Lamp test button.
  - .12 Engine control panel to automatically shut down engine on critical alarms.
  - .13 Emergency generator shall be provided with a single lockable overcurrent device that shall be monitored by the control panel as indicated above.

#### **2.04 STEEL MOUNTING BASE**

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

#### **2.05 EXHAUST SYSTEM**

- .1 Heavy duty critical horizontally mounted exhaust silencer with condensate drain, plug and flanged couplings.
- .2 Heavy duty flexible exhaust pipe with flanged couplings as required.
- .3 Wall sleeve, fittings and accessories as required.
- .4 Expansion joints: stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion.
- .5 High temperature insulation, 100 mm thick, mineral pipe fibreglass to C547-9363 up to 650° C complete with aluminum jacket.

#### **2.06 FINISHES**

- .1 Apply finishes in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 Alternator control cubicle: paint inside, exterior to match engine and alternator.
- .3 Exhaust and inlet air hoods international orange.
- .4 Other ducts and racks grey.
- .5 Supply 0.25L of touch-up enamel: color to match equipment.

## **2.07 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00.

## **2.08 FABRICATION**

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

## **2.09 STANDARD OF ACCEPTANCE**

- .1 Kohler 500REOZJB

## **2.10 APPROVED ALTERNATES**

- .1 Cummins
- .2 Caterpillar

## **3 EXECUTION**

### **3.01 INSTALLATION**

- .1 Locate generating unit and install as indicated inside the generator building.
- .2 Complete wiring and interconnections as indicated.
- .3 Start generating set and test to ensure correct performance of components.

### **3.02 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 Notify the Departmental Representative 10 working days in advance of test date.
- .3 Provide fuel for testing and leave full tanks on acceptance.

- .4 Provide resistive load bank sized for full rating of generator for testing.
- .5 Demonstrate:
  - .1 Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.
  - .2 Unit start and shut down on "Manual" control.
  - .3 Unit start and transfer on "Test" control.
  - .4 Unit start on "Engine start" control.
  - .5 Operation of manual bypass switch.
  - .6 Operation of automatic alarms and shut down devices.
- .6 Run unit on full load for minimum period of 4 h to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling.
- .7 At end of test run, check battery voltage to demonstrate battery charger has returned battery to fully charged state.

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 IEC 60044-2004, Instrument Transformers.
- .2 NEMA ICS 2-2008, Industrial Control and System Controllers, Contactors and Overload Relays Rated 600 Volts.

### **1.02 SYSTEM DESCRIPTION**

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

### **1.03 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Include:
  - .1 Make, model and type.
  - .2 Single line diagram showing controls and relays.
  - .3 Description of equipment operation including:
    - .1 Automatic starting and transfer to standby unit and back to normal power.
    - .2 Test control.
    - .3 Manual control.
    - .4 Automatic shutdown.

#### **1.04 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 01 78 00.
- .2 Detailed instructions to permit effective operation, maintenance and repair.
- .3 Technical data:
  - .1 Schematic diagram of components, controls and relays.
  - .2 Illustrated parts lists with parts catalogue numbers.
  - .3 Certified copy of factory test results.

### **2 PRODUCTS**

#### **2.01 MATERIALS**

- .1 Instrument transformers: to IEC 60044.
- .2 Contactors: to NEMA ICS2.

#### **2.02 MECHANICALLY HELD AUTOMATIC TRANSFER SWITCH**

- .1 Electrically operated and mechanically held with momentarily energized, single solenoid mechanism electrical operator.
- .2 Mechanically interlocked to ensure only two possible positions, normal or emergency.
- .3 Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switch shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- .4 Rated: 208 V, 60Hz, 800 A, 4 wire, switched neutral.
- .5 Fully rated overlapping neutral transfer contacts shall be connected only during transfer and retransfer operation.
- .6 Main contacts: silver composition, protected by arc disruption means.
- .7 Positively locked and unaffected by momentary outages.

- .8 Automatic transfer switch assembly mounted on draw out carriage. Carriage with engaged, test and disengaged positions.

## 2.03 BYPASS ISOLATION SWITCH

- .1 A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.
- .2 Power interconnections shall be silver-plated copper bus bar. The only field installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control inter-wiring shall be provided with disconnect plugs.
- .3 Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door. Designs requiring insertion of loose operating handles or opening of the enclosure door to operate are not acceptable.
- .4 Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.
- .5 The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.
- .6 When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.

- .7 Designs requiring operation of key interlocks for bypass isolation of ATS's that cannot be completely withdrawn when isolated are not acceptable.

## 2.04 CONTROLS

- .1 The controller's sensing and logic shall be provided by a single built-in microprocessor and have the ability to communicate serially through an optional serial communication module. Interfacing relays shall be industrial grade plug-in type.
- .2 LCD display and keypad integral to controller for viewing available data and setting operational parameters.
- .3 Voltage, frequency and phase rotation sensing on both normal and emergency.
- .4 Field adjustable voltage and frequency settings.
- .5 All customer connections shall be wired to a common terminal block to simplify field-wiring connections.
- .6 Three position momentary-type test switch for "Test", "Auto", and "Reset" modes".
  - .1 Test position - Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.
  - .2 Reset position - Time delays bypassed on either transfer to emergency or retransfer to normal.
  - .3 Auto position - Normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.
- .7 Control transformers: dry type with 120V secondary to isolate control circuits from:
  - .1 Normal power supply.
  - .2 Standby power supply.
- .8 Relays: continuous duty, industrial control type, with wiping action contacts rated 10A minimum:
- .9 Time delays:
  - .1 Adjustable time delay on transfer to emergency power, 0 to 60 minutes.
  - .2 Adjustable time delay to override momentary normal source outages or dips, 0 to 60 minutes.
  - .3 Adjustable time delay for shutdown of engine for cool down, 0 to 60 minutes.

## 2.05 ACCESSORIES

- .1 Pilot lights to indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel remote.
- .2 Auxiliary relay to provide two (2) N.O. and two (2) N.C. contacts for remote alarms.
- .3 Instruments:
  - .1 Flush mounted digital power meter with the following data available on the display and remotely via serial communication:
    - .1 Voltage (line to line and phase)
    - .2 Current (line to line and phase)
    - .3 kW power
    - .4 kVA power
    - .5 Power factor
    - .6 Frequency
  - .2 Potential transformers and current transformers as required.

## 2.06 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01.

## 2.07 SOURCE QUALITY CONTROL

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of the Departmental Representative.
- .2 Notify the Departmental Representative ten (10) days in advance of date of factory test.
- .3 Tests:
  - .1 Operate equipment both mechanically and electrically to ensure proper performance.
  - .2 Check selector switch, in all modes of operation Test, Auto, Manual, Engine Start and record results.
  - .3 Check voltage sensing and time delay relay settings.
  - .4 Check:
    - .1 Automatic starting and transfer of load on failure of normal power.
    - .2 Retransfer of load when normal power supply resumed.
    - .3 Automatic shutdown.

- .4 In-phase monitor operation.

### **3 EXECUTION**

#### **3.01 INSTALLATION**

- .1 Locate, install and connect transfer equipment according to Section 26 05 00.
- .2 Check solid state monitors and adjust as required.

#### **3.02 FIELD QUALITY CONTROL**

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

**END OF SECTION**

## **1 GENERAL**

### **1.01 REFERENCES**

- .1 ANSI C62.41.1-02(R2008), IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 ANSI C62.45-1987, Guide on Surge Testing for Equipment Connected to Low- Voltage AC Power Circuits.
- .3 CSA C22.2 No. 250.13-17, Light Emitting Diode (LED) Equipment for Lighting Applications.
- .4 NECA/NEIS 500-2006, Recommended Practice for Installing Indoor Commercial Lighting Systems.
- .5 ASTM F 1137-2011, American Society for Testing and Materials Specification for phosphate/oil and phosphate/organic corrosion protective coatings for fasteners.
- .6 FCC CFR47, USA Federal Communications Commission Frequency allocations and radio treaty matters; general rules and regulations.
- .7 IES LM-79-08, Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
- .8 IES LM-80-2015, Approved Method: Measuring Lumen Maintenance of LED Light Sources.
- .9 NEMA SSL 1-2016, Electronic Drivers for LED Devices, Arrays, or Systems.

### **1.02 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 78 00 - Closeout Submittals
- .3 Section 01 91 13 - Commissioning General Requirements

### **1.03 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings for the following:
  - .1 Luminaire.

- .2 Driver for each luminaire type.
- .3 Shop Drawings:
  - .1 Shop drawings to clearly indicate the following:
    - .1 Luminaire ID number as identified in contract documents.
    - .2 Fixture specification as identified in Part 2 and on the drawings.
    - .3 Driver specification as identified in Part 2 and on the drawings.
    - .4 Photometric data for each luminaire type.
    - .5 Energy data for luminaires.
- .4 Catalogue cut sheets lacking sufficient detail to indicate compliance with Contract Documents will not be acceptable.
- .5 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by the Departmental Representative. Photometric data to include:
  - .1 VCP Table, spacing criterion.
  - .2 Total input watts.
  - .3 Candlepower summary, candela distribution, zonal lumen summary.
  - .4 Luminaire efficiency, C.I.E. type, coefficient of utilization.
  - .5 Lamp type.
  - .6 Lumen ratings.
  - .7 Summary in accordance with IES procedures.
  - .8 Electronic IES file (provide on CD).

#### **1.04 OPERATION AND MAINTENANCE**

- .1 Provide operation and maintenance data for inclusion in the manual specified in Section 01 78 00 - Closeout Submittals.

## **2 PRODUCTS**

### **2.01 LED DRIVERS**

- .1 Electronic LED drivers:
  - .1 Performance requirements:
    - .1 Voltage: 120 V, 60 Hz.
    - .2 Power factor: greater than 0.90.
    - .3 Total harmonic distortion: less than 20%.
    - .4 Efficiency: 85% or greater.
  - .2 Regulatory requirements:
    - .1 Underwriters Laboratories (UL) listed and Canadian Standards Association (CSA) approved.

- .2 Meet or exceed ANSI C62.41 Category A for transient protection.
- .3 Meet or exceed NEMA SSL 1 where applicable.
- .4 Meet or exceed the requirements of the Federal Communications commission (FCC) rules and regulations, Title 47 CFR part 15, non-consumer (Class A) for EMI/RFI (conducted and radiated).

## **2.02 SPARES**

- .1 For LED fixtures, provide 10% spare LED lamp modules for each type and 5% spare drivers for each type.

## **2.03 LUMINAIRES**

- .1 Luminaires are specified on the drawings.
- .2 Paint interior troffers after fabrication.
- .3 Recessed troffers, in order to eliminate raw edges and corrosion, and to maximize efficiency, paint the fixture housing and driver cover with a baked white polyester enamel powder coat with 90% minimum reflectivity after fabrication using an electrostatic process. This need not include the lens frame.

## **3 EXECUTION**

### **3.01 INSTALLATION**

- .1 Locate and install luminaires as indicated. Provide and install all necessary hangars, supports, fittings, etc. as necessary for a complete installation.
- .2 Coordinate installation with all other services.
- .3 For open ceilings where there are pipes running through the ceiling, mount luminaires to accommodate pipes and be flush for maximum illumination performance.

### **3.02 WIRING**

- .1 Connect luminaires to lighting circuits as indicated.
- .2 Provide separate neutrals for all lighting circuits.
- .3 Each light fixture must have a separate fixture power drop installed and connected to hard wired junction box or outlet box in ceiling space.

- .4 Recessed and/or surface type light fixtures are not to be wired in a daisy-chain manner or have their power sources looped between fixtures unless the fixtures are installed end-to-end or house an integral junction box.
- .5 Provide suspended fixtures mounted in continuous rows with a separate #12 AWG bonding conductor in the fixture raceway.

### **3.03 LUMINAIRE SUPPORTS**

- .1 For suspended ceiling installations support luminaires independent of ceiling using an approved support method. Supporting luminaires from any part of the ceiling system is strictly prohibited.
- .2 Refer to drawings for support details of other fixtures. Provide all required mounting hardware.

### **3.04 LUMINAIRE ALIGNMENT**

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line; inform Departmental Representative if interferences are encountered.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

### **3.05 COMMISSIONING**

- .1 Refer to Section 01 91 13 -Commissioning General Requirements.

**END OF SECTION**

## **1 GENERAL**

### **1.01 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 78 00 - Closeout Submittals
- .3 Section 26 05 34 - Conduits, Conduit Fastenings and Fittings

### **1.02 PRODUCT DATA**

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

### **1.03 OPERATION AND MAINTENANCE DATA**

- .1 Submit operation and maintenance data for incorporation in the Manual specified in Section 01 78 00 - Closeout Submittals.

### **1.04 REFERENCES**

- .1 CAN/CSA C22.2 No. 141-15, Unit Emergency Lighting Equipment

## **2 PRODUCTS**

### **2.01 BATTERY UNIT**

- .1 Supply voltage: 120 VAC.
- .2 Output voltage: 12 VDC.
- .3 Operating time: 120 min. based on actual DC load plus.
- .4 Battery: sealed, maintenance free, ten (10) year life warranty.
- .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 10% input variations.
- .6 Solid state transfer circuit.

- .7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .8 Signal lights: LED solid state, for 'AC Power ON' and 'High Charge'.
- .9 Lamp heads: integral on unit, 345 degree horizontal and 180 degree vertical adjustment. Lamp type: LED.
- .10 Cabinet: surface mounted steel cabinet, suitable for wall mounting.
- .11 Finish: white.
- .12 Battery and Charger: to match Emergency Lighting, Section 26 52 01.
- .13 Auxiliary equipment:
  - .1 Test switch.
  - .2 Self-Diagnostic circuitry.

## **2.02 REMOTE UNIT**

- .1 12Vdc double head remote units, suitable for wall or ceiling mounting.
- .2 Lamp heads: integral on unit, 345 degree horizontal and 180 degree vertical adjustment. Lamp type: LED MR16.

## **3 EXECUTION**

### **3.01 INSTALLATION**

- .1 Install equipment and fixtures as indicated.
- .2 Make connections.
- .3 Test and verify operation of units upon loss and restoration of normal ac power. Verify 120 minute battery life upon loss of power.
- .4 Feed the emergency lighting system from the same circuit which feeds the normal lights in that area or as indicated on the drawings.

**END OF SECTION**