

**DIVISION 26**

**ELECTRICAL**

**Part 1 General**

**1.1 REFERENCES**

- .1 Definitions:
  - .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.
  - .2 Reference Standards:
    - .1 CSA Group
    - .2 CSA C22.1-15, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
    - .3 CAN/CSA-C22.3 No.1-[10], Overhead Systems.
  - .3 CAN3-C235-[83(R2010)], Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
  - .1 IEEE SP1122-[2000], The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

**1.2 DESCRIPTION**

- .1 A brief but not necessarily all inclusive list of work to be performed under this contract is given herein.
- .2 The Contractor shall supply all labour, material, equipment, transportation, services and facilities necessary to make, test and place into operation a complete electrical installation as shown on the drawings and/or as specified herein.
- .3 Where the term "provide" is used herein, it shall mean "supply, install, adjust, test and place into operation".
- .4 All systems shall be completely assembled, adjusted, tested and demonstrated to be ready for operation to the satisfaction of the Contract Administrator.
- .5 The Contractor shall carefully examine the drawings and specifications and shall fully inform himself as to all existing conditions and limitations, including all laws, ordinances and regulations affecting the contract and the work and shall include in his Bid all items implied or required to complete the work of this contract.
- .6 The Contractor shall satisfy himself as to working space, storage space, access facilities and all other conditions pertaining to the site, relating to the conduct of his operations, by the inspection of the site and examination of the drawings.
- .7 Refer to all other Divisions of the Specifications to determine their effect upon the work of this Section. All Sections of Divisions 01 to 46 inclusive as well as appendices form part of the Contract Documents.

### **1.3 EXTENT OF WORK**

- .1 This work shall consist of furnishing of all labour, material, equipment and all incidentals required.
- .2 Work shall include, but not be limited to:
  - .1 Coordinate with electric and telephone Utilities on award of project to arrange for servicing.
  - .2 Provide new electrical equipment and systems as required and indicated on drawings.
  - .3 Wire to and make connections to, all electrical power and control items required, including motors, controls, etc.
  - .4 All Power & Control Wiring for system process and HVAC controls to be installed utilizing Teck Cable.
  - .5 Lighting and Emergency Lighting power systems shall be installed in conduit. No exposed conduit shall be permitted in the office areas.

### **1.4 SUBMITTALS**

- .1 Information packages submitted for review and/or approval shall include:
  - .1 An index page.
  - .2 Have component items identified with the Specification Section and equipment tag from the equipment and/or instrument list.
  - .3 Where manufacturers' information, catalog, cut-sheet, or brochure information is used, which list more than one style or member of a family or options, the actual component or item being supplied shall be clearly highlighted.

### **1.5 EXAMINATION OF DRAWINGS**

- .1 The electrical drawings do not show all architectural, mechanical and structural details. All electrical schematics are shown diagrammatically unless otherwise noted. The Contractor shall review the mechanical and structural drawings to obtain building dimensions and details. Verify dimensions accurately by measurements.
- .2 To change the location of electrical equipment, submit a request in writing to the Contract Administrator for approval. If approved, such changes are to be made at no additional cost to the City.
- .3 No extra will be allowed for any additional labour or materials required for relocation of equipment due to interference with equipment of other trades, beams, joists, walls, etc., unless the conflict has been submitted to the Contract Administrator in writing before closing of Bids.

### **1.6 APPROVED DESIGN AND INSTALLATION**

- .1 Equipment and material to be of approved design and manufactured in accordance with all governing regulations such as "Canadian Standards Association", "Canadian Electrical Code", "Provincial Department of Labour", "Underwriters Laboratory", etc. Equipment and material must bear applicable acceptance labels of all associations and governing bodies recognized by the municipal, provincial and federal authorities.

- .2 Install equipment in strict accordance with manufacturer's recommendations and governing rules, regulations and codes.
- .3 Where requirement conflict occurs, install all materials in accordance with the most severe requirements.
- .4 Material installed under this Division to be new and of uniform construction.
- .5 All installations are to ensure maximum headroom, minimum interference with free use of surrounding areas, and best access to equipment.
- .6 To deviate major service runs from the location shown on the drawings, submit to the Contract Administrator suitable drawings showing such deviations together with reasons for deviations and obtain approval from the Contract Administrator before proceeding with the installation.

### **1.7 CODES AND STANDARDS**

- .1 Install all equipment in accordance with current editions of the Electrical Code and Building Code, including all local amendments unless otherwise specified.
- .2 The Contractor shall familiarize themselves with and comply with:
  - .1 City of Winnipeg Water & Waste Department: Identification Standard.
  - .2 City of Winnipeg Water & Waste Department: Electrical Design Guide.
  - .3 City of Winnipeg Environmental Management Policy.
- .3 Perform all work in accordance with drawings, specifications, applicable municipal and provincial regulations, and any pertinent inspection bulletins issued by the electrical inspection authority having jurisdiction over the installation. In no instance shall the standard established by the drawings and specifications be reduced.
- .4 Provide a copy of all standards referred to in this Section for use on site.

### **1.8 PERMITS, INSPECTIONS AND FEES**

- .1 Deliver to the Contract Administrator all necessary interim and final certificates of inspection and approval which may be required by all Inspection Authorities having jurisdiction over the work, as evidence that the work installed conforms to the laws and regulations of all governing authorities.
- .2 Submit copies of all plans and specifications to the authority having jurisdiction for inspections as may be required prior to commencement of work to comply with the above.
- .3 Notify the Inspection Authorities in sufficient time for them to arrange to inspect work.
- .4 Pay all associated fees.

### **1.9 ABBREVIATIONS**

- .1 Abbreviations for electrical terms shall be to CSA Z85-1983.
- .2 Names used throughout these specifications are:

EEMAC	Electrical & Electronic Manufacturers Association of Canada (formerly CEMA)
CSA	Canadian Standards Association

FM	Factory Mutual
NEMA	National Electrical Manufacturers Association (U.S.)
JIC	Joint Industry Conference
IPCEA	Insulated Power Cable Engineers Association
ISA	Instrument Society of America
CEC	Canadian Electrical Code
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
NBC	National Building Code
ANSI	American National Standards Institute

### **1.10 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Division 01.
- .2 Submit shop drawings for all equipment as indicated with the exception of conduit, standard conduit fittings and low voltage wiring.
- .3 Indicate on shop drawings details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.
- .4 Where applicable, include wiring, single line and schematic diagrams.
- .5 Wiring drawings showing interconnection with work or other divisions are required.
- .6 Indicate the number or letter used as an identification symbol on product data for panelboards, lighting fixtures and other equipment.
- .7 All equipment on shop drawings to be clearly identified with specific device tagging as identified in the specifications and drawings. Where tagging is not applicable, make other identification as instructed by the Contract Administrator.

### **1.11 OPERATION AND MAINTENANCE MANUALS**

- .1 Include in the manuals information based on following requirements:
  - .1 Operation and maintenance instructions to be sufficiently detailed with respect to design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.
  - .2 Technical data to be in form of approved shop drawings, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists.
  - .3 Advertising or sales literature is not acceptable.
  - .4 Provide wiring and schematic diagrams and performance curves.
  - .5 Include names and addresses of local suppliers for all items included in the operation and maintenance manuals.
- .2 Submit six (6) complete copies of manuals and “as-built” drawings to the Contract Administrator for review. Revise initial manual as required by the Contract Administrator prior to final submission.

### **1.12 RECORD DRAWINGS**

- .1 Submit record drawings in accordance with Division 01.
- .2 The Contractor shall record all changes made during construction and provide record drawings to the City upon completion of the work.
- .3 At the completion of the project, the Contractor shall submit one (1) set of record drawings, accurately recording all changes, deviations and relocations necessitated by job conditions and equipment approved shop drawings. Record drawings to be a single set compilation of all site changes neatly recorded in red pencil to the satisfaction of the Contract Administrator.
- .4 Include with the record drawings a list for each motor indicating motor or equipment number and name, nameplate voltage, horsepower and current, the size and setting of overload and breaker or fuse protection provided.

### **1.13 DEFINITIONS**

- .1 The following are definitions of terms and expressions used in the specification:
  - .1 "Inspection Authority" means agent of any authority having jurisdiction over construction and safety standards associated with any part of electrical work on site.
  - .2 "Supply Authority" means electrical power company or commission responsible for delivery of electrical power to project.
  - .3 "Electrical Code" means Manitoba Electrical Code 11<sup>th</sup> Edition, August, 2012. The Manitoba Electrical Code includes, modifies, and gives technical advice on the Canadian Electrical Code C22.1-12.
  - .4 "Indicated" means as shown on contract drawings or noted in contract documents.
- .2 Refer to CSA C22.2 No.0-10 for "Definitions and General Requirements".

### **1.14 COOPERATION AND COORDINATION**

- .1 Schedule expediting of all materials and execution of work with associated work specified in other Divisions.
- .2 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete shall be schedule 40 PVC pipe, sized for free passage of conduit, and protruding 50 mm (2")
- .3 Cables, conduits and fittings to be embedded or plastered over neatly and close to building structure so furring can be kept to a minimum.
- .4 Arrange for holes through exterior walls and roof to be flashed and made weatherproof.

### **1.15 SOURCE QUALITY CONTROL**

- .1 Arrange for a plant inspection by Contract Administrator where specified.
- .2 Inform Contract Administrator of manufacturing progress and arrange inspections at appropriate times.
- .3 Action required by factory inspection shall not be construed as final acceptance.

- .4 Obtain a Certificate of Acceptance from the inspection authority on completion of work and provide to the Contract Administrator.
- .5 The Contract Administrator may carry out inspections and prepare deficiency lists for action by the Contractor, during and on completion of project.

**1.16 GUARANTEE**

- .1 Guarantee work described in this Section of the specification against all defects in labour and materials.

**1.17 CARE, OPERATION AND START-UP**

- .1 Instruct the City's operating personnel in the operation, care and maintenance of equipment.
- .2 Arrange and pay for services of manufacturer's factory service representative to supervise start-up of installation, check, test, 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 aspects of its care and operation.

**1.18 APPROVAL OF ALTERNATE MATERIALS**

- .1 Bidders shall be based on the materials, products, and manufacturers specified.
- .2 Alternates to materials, products, and manufacturers specified shall be in accordance with Division 01.

**Part 2 Product**

**2.1 GENERAL**

- .1 All materials shall be fully approved by the Canadian Standards Association (CSA) or cUL, unless otherwise specified, for use as installed and meet the requirements of this specification in all respects.
- .2 Where there is no alternative to supplying equipment which has CSA or cUL approval, submit such equipment to local inspection authority having jurisdiction for special inspection and obtain approval prior to shipment of said equipment to site. Pay all associated fees.
- .3 Materials and equipment shall be of Canadian manufacture except where specified otherwise or where Canadian made materials or equipment do not exist.
- .4 Where two or more units of the same class or type of equipment are required, the units shall be the product of a single manufacturer, although components of equipment need not be products of the same manufacturer.
- .5 Use material and equipment available from regular production of manufacturer.
- .6 Control panels and component assemblies to be shop manufactured.
- .7 Supply, Mount and Install all instrument mounting stands and backboards as indicated

## **2.2 FINISH**

- .1 Finish metal enclosure surfaces by removing rust and scale, cleaning, and applying rust resistant primer inside and outside with at least two coats of finish enamel.
- .2 Paint all outdoor electrical equipment "equipment green" finish to NEMA-Y1.
- .3 Paint all indoor switchgear and distribution enclosure "light grey" to ASA 61 grey.
- .4 Clean, prime and paint exposed hangers, racks, fastenings, etc., to prevent rusting.

## **2.3 VOLTAGE RATINGS**

- .1 Operating voltages to be within those defined in CSA Standard C235-83 (R2010).
- .2 All motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment must be able to operate in extreme operating conditions established in above standard without damage to equipment.

## **2.4 WIRING TERMINATIONS**

- .1 All devices used for termination of wiring must be suitable for copper conductors, where copper is used, and for aluminum conductors, where aluminum is used.

## **2.5 ENCLOSURES**

- .1 Equipment shall have enclosures and environmental ratings suitable for the area they are installed in. Minimum enclosure type to be used is NEMA 12 gasketed nonventilated for ordinary environments (NEMA 12 gasketed and ventilated is acceptable where nonventilated version is not available or practicable), NEMA 4X for wet or corrosive environments, NEMA 7 for hazardous locations, NEMA 4X and NEMA 7 for hazardous and wet or corrosive locations, and NEMA 3R for outdoor installations unless otherwise indicated. Equipment exposed to UV shall be suitable for the exposure.

## **2.6 MANUFACTURERS AND ELECTRICAL CERTIFICATION LABELS**

- .1 Manufacturers' nameplate and electrical certification labels (CSA, cUL, etc.) labels are to be visible and legible after equipment is installed.
- .2 These nameplates shall be in place before equipment is shipped to site.
- .3 On-site approvals will not be acceptable unless express written consent is obtained, prior to the shipment of the equipment to site, from the Contract Administrator. Costs related to on-site approvals will be the responsibility of the equipment provider.

## **2.7 WARNING SIGNS**

- .1 Provide warning signs with suitable background colour and lettering as required to meet requirements of inspection authorities and Contract Administrator. Use decal signs, minimum size 178mm (7 in.) x 250mm (9.8 in.) unless otherwise indicated, or required by said authorities.

## **2.8 IDENTIFICATION OF UNDERGROUND INSTALLATIONS**

- .1 Provide permanently secured lamacoid labels as required in Item 6 of the Manitoba Electrical Code.

- .2 Mark each label, prior to permanent mounting, with the information as indicated.

## **2.9 PLYWOOD MOUNTING BOARDS**

- .1 Mount indicated equipment on plywood mounting boards. Boards shall be provided under this section of the specifications, sized to suit equipment indicated and/or implied.
- .2 Plywood mounting boards shall consist of 20 mm fir plywood fastened securely to wall.
- .3 Plywood mounting boards, strapping and trim shall be treated with wood preservative prior to installation and painted with one coat of primer and two coats of grey enamel ASA61. Painting shall be completed before any electrical equipment is mounted on the plywood.
- .4 Service entrance equipment shall be spaced from the plywood mounting boards to the satisfaction of the inspection authorities.

## **Part 3 Execution**

### **3.1 WORKMANSHIP**

- .1 Where sheet metal enclosures are not provided with knockouts, Greenlee punches shall be used in all cases. Cutting torches shall not be used for making holes.

### **3.2 INSTALLATION**

- .1 Determine manufacturers' recommendations regarding storage and installation of equipment and adhere to these recommendations.
- .2 Check all factory joints and tighten where necessary to ensure continuity.

### **3.3 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is given from finished floor to top of equipment.
- .2 Exact mounting height of unnoted equipment must be verified with the Contract Administrator before proceeding with installation.
- .3 Install electrical equipment at heights listed below unless otherwise indicated. (All heights in millimetres from finished floor unless indicated):
  - .1 Local Switches: 1400
  - .2 Wall Receptacles: 300
  - .3 Lighting Panels: 1800
  - .4 Cabinets: 1800
  - .5 Emergency Lights: 2400 (minimum)
- .4 All dimensions indicated are to the top above finished floor elevation.

### **3.4 SPECIAL PROTECTION**

- .1 Accept the responsibility to protect those working on the project from any physical danger due to exposed electrically energized equipment such as panel mains, outlet wiring, etc. Shield and mark all live parts "LIVE - 600 VOLTS" or with the appropriate voltage.

- .2 Arrange for the installation of temporary doors, barriers, etc., for all electrical equipment. Keep these doors locked at all times except when under direct supervision.
- .3 Where other site work occurs that creates dust, condensing humidity, or corrosive fumes ensure that all electrical components are protected from exposure to said hazards in order to preserve the serviceability and integrity of the electrical systems.

### **3.5 FIREPROOFING**

- .1 Where sleeves or openings are installed in walls, floors, roof or partitions to accommodate raceways, cables or bus duct, provide all necessary seals, fittings, barriers and fire-resistant materials to restore the installation to its original fire rating to the satisfaction of the Contract Administrator and the City's insurance underwriters.

### **3.6 EQUIPMENT IDENTIFICATION**

- .1 Supply and install identification nameplates on all equipment such as motor starters, safety switches, panelboards, pushbutton stations, etc. and any equipment not so supplied. All nameplates shall be securely fastened to equipment with stainless steel screws.
- .2 All identification nameplates, except for motors, shall be laminated phenolic with minimum 6 mm (1/4 inch) black letters on white background, the wording of which shall be identical to that on the single line diagrams and the title of the equipment controlled. Motor nameplates to be of non-corroding metal stamped or engraved with black lettering on light background.
- .3 Warning nameplates shall be laminated phenolic with minimum 6 mm (1/4 inch) white letters on red background, the wording to be reviewed by the Contract Administrator. All warning nameplates to be screwed to equipment.
- .4 Warning nameplates required by Inspection Authorities shall be provided for all electrical switchgear and equipment and on access doors to electrical rooms, vaults, switchyards, etc. in accordance with the applicable Code regulations. Obtain all necessary details from the Inspection Authorities.
- .5 Submit proposed lamacoid sizes and lettering to the Contract Administrator for review and modification.
- .6 Install Underground Installation labels as required by the Inspection Authority in the Electrical Code.
- .7 Identify pull boxes, terminal cabinets and junction boxes enclosing cables or connections with nameplates indicating voltage, box number and circuit number.
- .8 Provide junction boxes, relay panels and miscellaneous equipment energized from two or more sources with a warning nameplate prominently displayed, noting number and location of sources and their voltage.
- .9 Provide a typewritten circuit directory with a clear plastic cover for each panelboard in a suitable holder on the inside of each panel door. Unless otherwise noted, the directory shall indicate breaker or switch circuit number, rating, load description and associated load data.
- .10 Manufacturer's nameplates and electrical certification labels to be visible and legible after equipment is installed.

### **3.7 TOUCH-UP PAINTING**

- .1 Be responsible for field touch-up painting of all shop painted electrical equipment installed in this Contract.
- .2 All surfaces to be painted shall be dry, clean, free from dust, dirt, grease, frost, rust, loose crystals or extraneous matter, tool and machine marks. Feather out edges of scratch marks to make patch inconspicuous.
- .3 Apply one or more coats of paint until the damaged surface has been restored to original finish condition. Do not apply succeeding coats until preceding coat is dry and hard. Sand lightly between coats with No. 00 sandpaper.
- .4 Be responsible for obtaining the necessary touch-up paint of the original type and quality from the equipment manufacturer.
- .5 Supervise priming and finish painting of all electrical equipment and material not shop painted.

### **3.8 SLEEVES AND OPENINGS**

- .1 Provide sleeves and openings for exposed conduits, busways, and wireways, where they pass through walls or floors conforming to relevant fire codes where applicable.
- .2 Sleeves for individual conduits shall be galvanized steel in ordinary areas or stainless steel in corrosive environments.
- .3 Pack or fill sleeves and openings after the completed work is in place. Filling shall provide a waterproof seal to prevent leakage of water or other liquids through the sleeve or opening.
- .4 Sleeves and openings shall not displace reinforcing steel, and shall receive approval of the Contract Administrator prior to placement.

### **3.9 CUTTING AND PATCHING**

- .1 Do all drilling, cutting, fitting and patching necessary for the running and securing of conduits, cable tray, wireways, and other electrical equipment.
- .2 Provide supports necessary for same.
- .3 Provide bracing and anchorage of work subject to the Contract Administrator's approval.
- .4 No cutting of the structural members or of their fireproofing shall be done without the written consent of the Contract Administrator.
- .5 Caulk and flash all conduits passing through walls, roofs or other surfaces exposed to weather or as indicated on the drawings to prevent the passage of water and/or sewer gases.

### **3.10 HANGERS AND SUPPORTS**

- .1 Provide hangers, angles, channels, and other supports necessitated by field conditions to install all items of electrical equipment. Design of supports and methods of fastening to building structures shall be subject to the Contract Administrator's approval.
- .2 All local motor control devices are to be grouped and mounted on a free-standing frame of stainless steel construction easily accessible and as close to the motor as possible.

- .3 Provide weight-distribution facilities, where required, so as not to exceed the load-bearing capacities of floors or walls that bear the weight of, or support, electrical items.
- .4 Paint all exposed parts of hangers and supports with a rust inhibiting primer.
- .5 Equipment shall not be held in place by its own weight. Provide base anchor fasteners in each case.

### **3.11 PROTECTION OF EQUIPMENT**

- .1 Protect conduit and wireway openings against the entrance of foreign matter by means of plugs or caps.
- .2 Fixtures, materials, equipment, or devices damaged prior to final acceptance of the work shall be restored to their original condition or replaced by the Contractor.

### **3.12 TESTING OF ELECTRICAL SYSTEMS**

- .1 General
  - .1 Prior to the Contract Administrator's acceptance, all electrical equipment, materials and systems installed shall be subject to an inspection and applicable performance tests supervised by the Contract Administrator to ensure that the operation of the system and components satisfy the requirements of the Specifications.
  - .2 Ensure that the system and its components are ready prior to the inspection and test for acceptance.
  - .3 All testing shall be conducted by fully qualified personnel only. Tests requiring initial power energization of a system shall not be made without notification of the Contract Administrator. Tests, checks and the like carried out by or on behalf of the Contractor shall be documented and certified at no additional cost to the City. Submit six copies of the test certificates to the Contract Administrator. Carefully check wiring for each system and/or part of a system to ensure that the system will function properly as indicated by wiring and schematic diagrams, description of operation, etc.
  - .4 Carefully check wiring for each system and/or part of a system to ensure that the system will function properly as indicated by wiring and schematic diagrams, description of operation, etc.
  - .5 Manually operate alarms and control devices to check whether their operation during normal and abnormal operating conditions causes the proper effect.
  - .6 In addition to tests on purely electrical systems, supply the necessary labour and equipment for operational tests required by other Divisions where electrical services are involved and make final adjustments to the electrical controls at no additional cost to the City.
  - .7 Perform tests on auxiliary or specialized systems with the assistance of the manufacturer's representative. Upon successful conclusion of the tests, obtain a certificate from the manufacturer stating that the system has been installed to their satisfaction and that it is in good working order.
  - .8 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to values and settings as indicated.

- .2 Supply all instruments, meters and personnel required for the tests.
- .3 Refer to 01 90 00 – Equipment Installation

### **3.13 ARC FLASH LABELING AND COORDINATION SETTINGS**

- .1 The Contractor shall provide information to the Contract Administrator for arc flash, short circuit, and coordination purposes.
  - .1 Submit complete and comprehensive data for equipment identifying
    - .1 Withstand ratings
    - .2 Interrupt ratings
    - .3 Trip curves
    - .4 Trip curve adjustments
    - .5 Clearing times
    - .6 Generator withstand and decrement curves and fault performance data
  - .2 Prior to shop drawing submissions, submit anticipated conductor lengths for all power wiring except:
    - .1 Branch circuits feeding loads other than motors.
  - .3 Update conductor length information as requested by Contract Administrator as construction proceeds.
  - .4 Provide other equipment or site information as requested by the Contract Administrator to allow for the completion of the analyses.
- .2 The Contract Administrator will provide Arc Flash information including energy levels, approach boundaries, and PPE levels to the Contractor at no cost to the Contractor. The Contractor shall provide Arc Flash warning labels on equipment.
- .3 The Contract Administrator will provide Coordination information including settings for adjustable overcurrent protective devices to the Contractor at no cost to the Contractor. The Contractor shall make adjustments to the overcurrent protective device settings to match the settings given. Prior to receiving the settings, the Contractor shall adjust settings to their normal practices.

### **3.14 CABLE AND WIRE 1000 VOLT AND BELOW**

- .1 Tests on cables in this voltage range shall be limited to insulation resistance measurements using a 500V megger for systems up to 350V and a 1000V megger for 351-600V systems.
- .2 All testing to be completed prior to connection of equipment, with cable ends suitably isolated to prevent accidental contact with equipment. Under no circumstances shall testing be completed with wires/cables connected.
- .3 Record all test results in a log book and submit to the Contract Administrator for reference. Replace or repair all circuits, which do not meet minimum requirements specified in the Electrical Code, Table 24. Insulation resistance of the following circuits shall be measured:
  - .1 Power, lighting and motor feeders: phase-to- phase, phase-to-neutral and phase-to- ground.
  - .2 Control circuits: measure to ground only.

**3.15 GROUNDING SYSTEM**

- .1 Test the grounding system efficacy for compliance with the Electrical Code and the Supply Authority requirements. Record the resistance of each ground electrode group. Report the test results to the Contract Administrator for review and approval prior to energizing the system.
- .2 Notify Inspection and Supply Authorities so that they may be present to witness Contractor testing, and provide any assistance required by these Authorities for their own testing procedures.

**3.16 TRAINING**

- .1 Provide for the training of the City's representatives in the operation, maintenance and testing of all systems and equipment including the provision of qualified manufacturer's technical representatives for specialized systems.
- .2 Refer to Section 01 79 00 Demonstration and Training

**3.17 DELIVERY AND STORAGE**

- .1 Ship and store equipment as per manufacturer's recommendations.
- .2 Ship channel bases and anchor stencils in advance of equipment.
- .3 Keep equipment doors locked. Protect equipment from damage, dust and weather during shipping and storage.
- .4 Block moving parts when necessary to prevent damage during movement and shipment of equipment. Instructions to remove blocking before putting equipment in service to be clearly and conspicuously displayed.
- .5 Store all electrical equipment indoors. Temperature sensitive equipment to be stored in heated spaces.

**3.18 COMMISSIONING**

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

**END OF SECTION**

**Part 1           General**

**1.1               GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All Sections of all Divisions of the Specifications and these documents inclusive form part of the Contract documents.
- .4 All wire and cable shall have CSA, cUL, or ETL certification.

**1.2               SCOPE**

- .1 Refer to Section 25 05 00 for project electrical scope of work.
- .2 Furnish all labour, materials, supervision, equipment and services specified herein, indicated or requested to install the complete wiring systems including, but not limited to:
  - .1 Low voltage wire and cable (1000V and below)
  - .2 Control wiring
- .3 The wiring system shall include all wiring, terminations, wire markers, cable tags, cable ties, splice fittings, insulating tapes, connectors and miscellaneous materials necessary to complete the wiring system both functionally, and to the Electrical Code.

**Part 2           Products**

**2.1               LOW VOLTAGE WIRE 1000 VOLT AND BELOW**

- .1 All wire shall have stranded, annealed copper conductors, cross-linked polyethylene (XLPE) insulation, minus 40°C, 90°C maximum conductor temperature, limited flame spread.
- .2 Except where otherwise stated, the minimum conductor insulation rating shall be equal to or greater than the highest voltage to which the insulation may be exposed, but in no case less than 300V.
- .3 The wiring shall be suitable for installation in wet environment and rated RW-90.
- .4 For direct buried installations, or for installation in direct buried polyethylene pipe, the cable shall be cross linked polyethylene, rated RWU-90.
- .5 Minimum conductor size shall be #12 AWG unless otherwise specified. #14 AWG copper may be used for control wiring, 250 MCM for aluminium.
- .6 Use GTF fixture wire, 600-volt, 125°C, flexible copper conductor for all connections between lighting fixtures and outlet boxes.

- .7 Colour coding of insulated conductors shall conform to the following:

*Single Phase Systems*

Phase A	Red
Phase B	Black
Neutral	White
Ground	Green

*Three Phase Four Wire Systems*

Phase A	Red
Phase B	Black
Phase C	Blue
Neutral	White
Ground	Green

- .8 Insulated ground conductors forming part of a multi-conductor cable assembly shall have green colour coding.
- .9 Cable and wire shall be as manufactured by:
- .1 For copper: Nexans Canada, Phillips Cables Ltd., Prysmian FP, General Cable Inc., Southwire

**2.2 TECK CABLE**

- .1 Conductors:
- .1 Grounding conductor: copper
  - .2 Circuit conductors: copper
- .2 Insulation:
- .1 Chemically cross-linked thermosetting polyethylene rated 600-volt
    - .1 RW90 for normal and wet locations
    - .2 RWU90 for buried locations
- .3 Inner Jacket: polyvinyl chloride material
- .4 Armor: interlocking aluminum
- .5 Overall covering PVC material, colour black, flame retardant, FT4 rated, AG14.
- .6 Fastenings:
- .1 One-hole straps to secure surface cables 50 mm and smaller. Two-hole straps for cables larger than 50 mm. All straps to have inert spacers between spacer and concrete.
  - .2 Channel type supports for two or more cables.
  - .3 Minimum 3/8" (6mm) diameter threaded rods, or larger per manufacturer's guidelines to support the load carried upon suspended channels.
  - .4 All fastenings and supports must:

- .1 Suit the environment in which they are installed, per Electrical Code, and as outlined in section 26 05 00
  - .2 Be compatible with the strut, channel, and/or cable tray with which they are in contact per the manufacturer's instructions
- .7 Connectors:
- .1 Watertight approved for Teck
- .8 Lugs:
- .1 Copper and listed by CSA, or cUL, for use with Copper conductors and sized to accept copper conductors of the ampacity specified.

### **2.3 CONTROL WIRING**

- .1 Unless specified otherwise, all conductors for control wiring shall be copper with RW90, X-link insulation, insulation voltage to be suitable for the highest voltage to which the conductors may be exposed.
- .2 Colours:
  - .1 Neutral conductors shall be white
  - .2 Grounding conductors shall be green
  - .3 DC conductors shall be blue
  - .4 AC conductors shall be red.
- .3 Instrumentation wiring for analog signals shall be individually shielded, multi-pair cable #16 AWG (7x16) tinned copper.
- .4 Wiring for PLC digital inputs to be #14 AWG minimum.

### **2.4 WIRING ACCESSORIES**

- .1 Wire markers, black letters on white background, shall be heat shrink type as manufactured by Critchley or Brady.
- .2 Cable markers for cables or conductors greater than 13 mm (1/2 inch) diameter, shall be strap-on type, rigid PVC, black letters on white background.
- .3 Terminal blocks shall be minimum 600-volt rated, modular, sized to accommodate conductor size used, as manufactured by Weidmuller, Phoenix, Allen-Bradley.
- .4 Where screw-type terminals are provided on equipment, field wiring shall be terminated with insulated fork tongue terminals, as manufactured by Thomas & Betts, Sta-Kon.
- .5 Cable ties shall be nylon, one-piece, self-locking type, as manufactured by Thomas & Betts, Burndy, Electrovert.
- .6 Electrical insulating tape as manufactured by 3M Scotch 88.
- .7 Cable grips shall be provided for all vertical and catenary cable suspension installations to reduce cable tension at connectors or at cable bends. The cable grips shall be selected to accommodate the type and geometry of cable supported and shall be of the single weave, variable mesh design, as manufactured by Kellems, Arrow-Hart.
- .8 Cable pulling lubricant shall be compatible with cable covering and shall not cause damage and corrosion to conduits or ducts.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install all wire according to the drawings.
- .2 Install wire into ducts, cable trays, and conduits in accordance with the manufacturer's recommendations, using patented wire grips suitable for the type of wire or using pulling eyes to be installed directly onto the conductors.
- .3 Limit pulling tensions to those recommended by the manufacturer to avoid overstressing wire.
- .4 Utilize adequate lubricant when pulling wires through ducts and conduits to minimize wear on cable jackets.
- .5 Make connections to equipment "pig-tails" with mechanical, insulated, screw-on connectors for wire sizes #14-10 AWG. For wire sizes #8 AWG and larger utilize split-bolt connectors, taped with three layers minimum of insulating tape. For both copper and aluminium terminations, wire through the conductor, apply joint compound anti-oxidant, and torque to lug manufacturer's recommended torque levels.
- .6 No splices shall be permitted in cable or wiring runs without the written permission of the Contract Administrator, and shall only be permitted in junction boxes.
- .7 Neutral conductors shall be identified. Paint or other means of colouring the insulation shall not be used.
- .8 Unless otherwise specified, make all wiring taps, splices and terminations with identified compression screw type terminal blocks, securely fastened to avoid loosening under vibration or normal strain. Make connections for interior and exterior lighting circuits and 120-volt, 15-amp convenience receptacle circuits using screw-on or split-bolt connectors and insulating tape.
- .9 Determine the exact length of cable required to avoid splices.
- .10 Identify each conductor by specified markers at each termination indicating the circuit designation or wire number.

#### **3.2 WIRING IDENTIFICATION**

- .1 Provide permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring. Maintain phase sequence and identification throughout system, i.e., panelboards, starters, terminal blocks, disconnect switches.
- .2 All control system wiring to be labeled using permanent heat-shrink wire labels, labels to be installed at each termination point. Wire labels to match control system wiring diagrams produced by successful control panel manufacturer defined in Section 25 14 23.
- .3 Maintain identification system at all junction boxes, splitters, cabinets and outlet boxes.
- .4 Use colour coded wires in communication cables, matched throughout system. All colour coding must adhere to the Electrical Code.

#### **3.3 CABLE IDENTIFICATION**

- .1 Identify each cable by attaching a suitable marker, stamped or indelibly marked with the cable number, at each end of the cable and in all junction boxes and pull boxes.

- .2 Update cable schedule for all cables installed to match cable identifications as installed on site.

**END OF SECTION**

## **Part 1 General**

### **1.1 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

### **1.2 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 Furnish all labour, materials, equipment and services specified, indicated or requested to install a complete grounding system. The grounding system shall include ground rods, all wiring, ground bus, thermit welds, mechanical fittings, connectors, links and miscellaneous materials necessary to complete a grounding system acceptable to the Inspection Authorities.

### **1.3 REFERENCES**

- .1 Grounding equipment to CSA C22.2 No. 41-13.

## **Part 2 Products**

### **2.1 GROUND AND BONDING CONDUCTORS**

- .1 Conductors shall be concentric stranded, soft drawn copper. Insulated conductors, where required by Inspection Authorities or specified, shall be type TW, 600-volt rating, green colour, and shall meet the same flame-spread requirements of all wiring in the area and conditions where they are installed.
- .2 Conductors shall be sized at least per the requirements of the latest version of the Canadian Electrical Code and of the local Authority, or as indicated, whichever is the greater size. The minimum size for the grounding conductor and buried ground electrode conductors shall be 2/0 AGW copper.
- .3 Where direct buried bare ground conductor comes into contact with corrosive material, the conductor shall be tinned.

### **2.2 GROUND CLAMPS AND CONNECTORS**

- .1 Where a ground rod network is used for grounding, connections between the rods and to the grounding conductor shall be of a CSA or cUL certified thermit weld type connection by T&B, Burndy, Erico.

### **2.3 COMPRESSION CONNECTIONS**

- .1 Compression devices shall be of pure wrought copper material, factory fitted with oxide inhibiting compound, as manufactured by T & B, Burndy, Erico and be CSA or cUL certified for the application.

### **2.4 MECHANICAL CONNECTIONS**

- .1 Mechanical connectors shall be of bronze, copper or brass construction, selected and sized specifically for the particular application and be CSA or cUL certified for the application.

### **2.5 GROUND RODS**

- .1 Ground rods shall be minimum 19 mm (3/4") diameter, 3 m (10 feet) long, copper clad steel construction with the 0.010" (minimum) copper exterior coating permanently bonded to the steel core.
- .2 Ground rods shall be coupled to 6 m length with threadless connectors and driven to a depth of 300 mm - 500 mm below grade.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install ground rod networks as indicated.
- .2 Install main ground bus as indicated.
- .3 Install the ground rod access points such that the covers are flush with the final grade to prevent burial.
- .4 Make connections between the ground conductor and the grounding rod grid using themit weld connectors.
- .5 Make all other buried or encased conductor joints, splices and connections with permanent-type thermit welds.
- .6 Make bonding connections to building steel or flat metallic surfaces with thermit welds. Locate connections where they will not be subject to mechanical damage and, where possible, be accessible for inspection.
- .7 Make bonding and ground electrode conductor connections to the main ground bus as indicated.
- .8 All other joints, splices and connections: as indicated.
- .9 Where compression type hardware is used, install using the hydraulic tools and methods, as specified the hardware manufacturer.
- .10 Protect grounding and bonding conductors or bus subject to mechanical damage by rigid steel conduit or steel guards which shall be effectively grounded at both ends to the ground conductor they are protecting, regardless of their length.
- .11 Securely bond metal enclosures, motor frames, steel supports for starters, panels, switches, etc., which are not rigidly secured to and in contact with grounded structural

steel of a building or conduit system, or which are subject to excessive vibration, to building steel or conduit system with stranded copper conductors.

- .12 Install ground conductors passing through masonry walls, floors, foundations, etc. in 25 mm (1") rigid PVC conduit sleeves. Where sleeves are installed in walls or floors below grade, seal the sleeves watertight after installation of ground conductor.
- .13 Use driving studs to drive ground rods without damaging or mushrooming the end of the rod.

### **3.2 EQUIPMENT GROUNDING**

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to the following list: service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steelwork, distribution panels, outdoor lighting, telephone backboard.

### **3.3 TESTS**

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of the Contract Administrator and inspection authority having jurisdiction.
- .3 Perform tests, submit reports, and obtain approval of the Contract Administrator before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.
- .5 Perform tests in presence of the Contract Administrator.
- .6 Submit written test results to the Contract Administrator.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.2 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 This section covers the supply and installation of all fastenings and supports for equipment mounted under the electrical contract.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Expansive screw anchors, shields, or other fastening items containing lead or other material that might loosen or melt under fire conditions shall not be used.
- .2 Fastenings, supports, and associated hardware shall be of the following materials:
  - .1 Category 1 Humid (Electrical Code – Section 22): 316 Stainless steel
  - .2 Category 2 Corrosive (Electrical Code – Section 22): 316 Stainless Steel
  - .3 Normal (neither Category 1 or 2): Galvanized Steel
- .3 Fastenings and supports (including channels), and their associated hardware shall be made of the same materials to reduce corrosion potential.
- .4 Power-actuated fasteners and devices shall not be used.
- .5 Support channels, length as required, U-shaped, size as required by carried load, or manufacturer's recommendations.
- .6 Support equipment, conduit or cable clips, spring loaded bolts, cable clamps etc., to be purpose-built accessories for standard channel members.
- .7 Two-hole PVC straps to secure surface conduits 50 mm and smaller.
- .8 Beam clamps to secure conduit to exposed steel work.
- .9 Support individual cable or conduit runs with minimum 6.0 mm diameter threaded rods and spring clips. Use larger diameter rod and appropriate spring clips where the carried load or manufacturer's recommendations require.
- .10 Support two or more cables or conduits on channels supported by 6.0 mm diameter threaded rod hangers where direct fastening to building construction is impractical. Use larger diameter rod and hangers where the carried load or manufacturer's recommendations require.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install fastenings and supports as required for each type of equipment, cables and conduit to manufacturer's installation recommendations.
- .2 Provide metal brackets, frames, hangers, clamps and related support structures where indicated or as required to support conduit and cable runs.
- .3 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .4 Provide adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .5 Do not use supports of other equipment installed for conduit or cable support except with permission and approval of the Contract Administrator.
- .6 Any aluminum support bracket or channel that is in direct contact with concrete is required to have inert spacers to reduce chemical reaction between support and concrete.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-[06], Canadian Electrical Code, Part 1, 10<sup>th</sup> Edition.

**1.2 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.3 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 Furnish all labour, materials, equipment and services specified, indicated or requested to install the electrical boxes specified herein and on the drawings.

**Part 2 Products**

**2.1 OUTLET BOXES**

- .1 Size boxes in accordance with the Electrical Code.
- .2 100 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 All outlet boxes shall be supplied with ground stud.
- .6 Surface mounted outlet and switch boxes shall be:
  - .1 PVC
  - .2 Ipex F-Series or equivalent.
  - .3 To CSA C22.2 No. 18.2-06 (R2011) Non-metallic Outlet Boxes.
- .7 Flush-mounted outlet boxes for the office areas shall:
  - .1 Be galvanized steel.
  - .2 Be to CSA C22.2 NO. 18.1-13 – Metallic Outlet Boxes.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install boxes to clear all building and mechanical services equipment. Where two or more devices are shown at one location, utilize multi-gang boxes. Supply all outlet boxes with covers as required.
- .2 Size all boxes to accommodate the number of conduits, conductors and terminal blocks. Provide junction boxes with 20% spare terminal blocks.
- .3 Securely fasten surface-mounted boxes to the building or mounting structure and support independently of the conduits entering the box.
- .4 Securely fasten flush-mounted boxes to supporting studs or wall structure and support independently of the conduit or cables entering the box.
- .5 Install junction and pull boxes mounted on brick, concrete or block walls with 3 mm (1/8 inch) thick lead or nylon washers between box and wall face.
- .6 Provide pull boxes sized to Electrical Code requirements, in all conduit raceway systems to limit length of straight conduit runs to 30 m (100 ft). Reduce this length by 7.5 m (25 ft) for each 90 degrees bend or 4 m (12 ft) for each 45 degree bend or offset.
- .7 Mark location and size of all pull boxes on the record drawings.

**3.2 APPLICATION**

- .1 Location of outlets indicated may be changed by the Contract Administrator at no extra cost or credit, providing distance moved does not exceed 3000 mm, and notice is given before installation is completed.

**3.3 MOUNTING HEIGHTS**

- .1 Refer to Section 26 05 00.
- .2 Exact mounting height of unnoted equipment must be verified with the Contract Administrator before proceeding with installation.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.2 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install a complete conduit raceway system. The raceway systems shall be comprised of the supply and installation of all conduits, fittings, supports, hangers and miscellaneous support materials and hardware required.

**1.3 REFERENCES**

- .1 Rigid PVC (Unplasticized) conduit to CSA C22.2 No. 211.2-06.
- .2 Liquid-tight flexible metal conduit to CSA C22.2 No. 56-13.
- .3 Steel rigid metal and epoxy coated conduit to CSA C22.2 No. 45.1-07 (R2012).

**1.4 LOCATION OF CONDUIT**

- .1 Conduit, as described in this section, shall be used for the lighting and emergency lighting systems in the Category 1 – Humid, and Category 2 – Corrosive areas as indicated.
- .2 The drawings do not show specific conduit runs. All conduit shall be surface unless otherwise indicated in the specifications and/or shown on the drawings. All devices associated with the conduit system shall be surface mounted type except as shown.

**Part 2 Products**

**2.1 CONDUITS**

- .1 Conduit in the Category 1 – Humid and Category 2 – Corrosive environments shall be Rigid PVC. Minimum size to be 21 mm.
- .2 PVC-jacketed, liquid-tight flexible metal conduit for motor and equipment connections.
- .3 EMT shall be permitted within office and hallway area only. Exposed conduit or accessory boxes shall not be permitted.

## **2.2 STRUT CHANNEL AND ACCESSORIES**

- .1 Strut channel and associated accessories shall be of the following materials, dependent upon location conditions and rated for the loads to be supported:
  - .1 Category 1 Humid (Electrical Code – Section 22): 316 Stainless Steel
  - .2 Category 2 Corrosive (Electrical Code – Section 22): 316 Stainless Steel
  - .3 Normal (neither Category 1 or 2): Galvanized Steel
- .2 Strut clamps shall be one piece heavy-duty construction with parallel hook design.

## **2.3 FASTENINGS**

- .1 Fastenings and supports (including channels), and their associated hardware shall be made of the same materials to reduce corrosion potential.
- .2 Two hole PVC straps to secure surface conduits. Fasteners to be of materials suited for the installation area as outlined in 2.2 above.
- .3 Beam clamps to secure conduits to exposed steel work.

## **2.4 FITTINGS**

- .1 Fittings shall be manufactured for use with conduit specified. Materials and coatings shall be same as conduit.
- .2 Factory “ells” where 90° bends are required for 25mm and larger conduits.

## **2.5 EXPANSION FITTINGS FOR PVC CONDUIT**

- .1 All conduits entering outlet boxes and devices that are located in walls subject to movement shall be terminated by means of liquid-tight flexible conduit, approximately 450 mm in length between the PVC conduit and the outlet box or device which is being supplied. All conduits, bus duct, wireways, etc., passing through or across expansion joints of the building shall be installed with the use of approved expansion fittings.

## **2.6 FISH CORD**

- .1 Polypropylene of sufficient diameter and strength to pull in future additional cables.

## **Part 3 Execution**

### **3.1 GENERAL INSTALLATION REQUIREMENTS**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass. All conduits shall be surface mounted unless otherwise indicated.
- .2 Cut conduit ends square and ream to remove burrs and sharp edges. Ensure that conduits butt in couplings and other fittings.
- .3 Where any galvanized or epoxy coated components are cut, drilled, welded, or the surface otherwise compromised, the area shall be repaired using the manufacturer’s recommended methods and materials to restore the corrosion resistance of the components to original standards.

- .4 Bends and offsets shall have a radius of curvature not less than the minimum bending radius of the cable to be installed.
- .5 Temporarily plug all conduits terminating in cabinets and boxes where moisture and foreign matter may enter.
- .6 Blow all conduits through with clean compressed air to clear all foreign matter and moisture prior to the installation of wires or cables.
- .7 Install fish cord in all conduits.
- .8 Group exposed conduits together wherever possible and run parallel to building lines, supported from structural members and protected by the flanges of the structural member where practical.
- .9 All conduit fastened to the surfaces of the structure shall be mounted on strut channel. Strut channel to be suitably spaced to meet manufacturer and code requirements. Direct mounting of conduit to surface of structure will not be permitted.
- .10 Use manufacturer-recommended mounting clips to secure conduit to strut channel.
- .11 Support strut channel to structure with suitable fasteners or beam clamps for attaching to structure. Make no holes in building structural members for supporting conduits without the permission of the Contract Administrator.
- .12 Provide additional strut channel supports at each elbow and terminations at a box or cabinet.
- .13 Perforated metal straps used to support conduits are unacceptable.
- .14 Install conduits at least 150 mm (6") clear of all steam pipes and flues, and 1 m (39") clear of heaters. Do not bend over sharp objects or improperly form.
- .15 The maximum length of straight conduit run shall be 30 m (100 feet) between pull boxes or other terminations. This length shall be reduced by 10 m (32 feet) for each 90 degree bend or 5 m (12.5 feet) for each 45 degree bend or offset. Conduit runs shall not include more than the equivalent of two 90 degree bends between pull boxes except where indicated otherwise on the drawings.
- .16 Where conduits pass through roof, seal with flashing and make weatherproof. For conduits passing through exterior walls, above or below grade, seal with waterproof sealing compound.
- .17 All conduits originating or passing through an area containing corrosive or explosive gases and entering normal areas, control panels, junction boxes, MCCs or any other equipment shall be suitably sealed at each point of entry to prevent any ingress of corrosive or explosive gases.
- .18 Sleeve and seal all conduits passing through floors.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.2 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical Scope of Work.
- .2 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to provide all trenching and backfilling as necessary for the installation of all underground cables, etc., as indicated.

**1.3 REFERENCES**

- .1 Installation of cables in trenches and ducts shall meet the requirements of the Electrical Code.

**Part 2 Products**

**2.1 TRENCHING AND BACKFILLING**

- .1 Trenching shall be approximately 1000 mm in depth, width to suit proper installation.
- .2 Backfill for trenches for all direct buried cables, ducts, conduits, etc., shall consist of fine sand (minimum 100 mm below and above cables, etc.) and firmly compacted. Backfill finishing material shall be as indicated in Division 31 of the specification.
- .3 All direct buried cables, ducts, etc., crossing over each other or over/under other types of underground service shall be encased in wood planks treated with pentachlorophenol.
- .4 Frozen earth, large lumps or boulders shall not be used for backfill material.
- .5 Provide treated wood planks meeting approved wood treatment materials over all buried cables, etc., under existing or future roads and sidewalks.
- .6 Provide sleeves under all parking, concrete and traffic areas for cables.
- .7 Where cables enter building provide a vertical 100 x 250 mm white sign with black wording ELECTRICAL CABLES securely fastened to the exterior of the building wall approximately 300 mm above finished grade.

**2.2 CABLE PROTECTION**

- .1 Provide identification tape labelled as indicated showing location of direct buried cables.

### **Part 3 Execution**

#### **3.1 DIRECT BURIAL OF CABLES**

- .1 After specified sand bed is in place, lay cables in trench, maintaining a 75 mm minimum clearance from each side of trench to nearest cable. Do not pull cable into trench.
- .2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 metres of run, maintaining minimum cable separation and bending radius requirements.
- .3 Underground cable splices are not acceptable.
- .4 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.
- .5 Maintain 190 mm minimum separation between cables of different circuits. Maintain 300 mm horizontal separation between low and high voltage cables. When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position. At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 190 mm between high voltage cables. Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables with fire alarm and control cables in upper position. Install treated planks on lower cables 600 mm in each direction at crossings.
- .6 After sand protective cover is in place, install continuous row of overlapping 38 x 140 mm pressure treated planks as indicated to cover length of run.

#### **3.2 FIELD QUALITY CONTROL**

- .1 Provide digital photographs of each phase of the installation, photographs to include standard reference point on site to provide spatial relationship of the photograph. Photograph phases to include at minimum open trench, first layer of sand, cable installation, second layer of sand, protective planking, first layer of clean fill, marking tape and final layer of fill.
- .2 Perform tests in accordance with Section 26 05 00 – Common Work Results - Electrical.
- .3 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .4 Check phase rotation and identify each phase conductor of each feeder.
- .5 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

#### **3.3 PRE-ACCEPTANCE TESTS.**

- .1 After installing cable but before terminating, perform insulation resistance test with 1000V megger on each phase conductor.
- .2 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested and result of each test.
- .3 Remove and replace entire length of cable if cable fails to meet any of test criteria.

- .4 Contractor responsible for making all necessary repairs to installation resulting from improper backfilling, compaction, etc.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 CSA International
  - .1 CSA C9-[02(R2007)], Dry-Type Transformers.
  - .2 CAN/CSA-C802.2-[06], Minimum Efficiency Values for Dry Type Transformers.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
  - .1 EEMAC GL1-3-[1988], Transformer and Reactor Bushings.
  - .2 National Electrical Manufacturers Association (NEMA)

**1.2 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.3 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 This section covers the supply and installation of all dry-type transformers.

**1.4 REFERENCES**

- .1 To CSA C22.2 No. 47-13 - Air Cooled Transformers (Dry Type)
- .2 To CSA C9-02 (R2011) - Dry-Type Transformers
- .3 To CSA C802.2-12 – Minimum Efficiency Values For Dry-Type Transformers
- .4 To Electrical Code Section 26-260 "Marking of Transformers".

**1.5 SUBMITTALS**

- .1 Shop drawings in accordance with Section 26 05 00.
  - .1 Voltage ranges and taps.
  - .2 KVA rating.
  - .3 Mounting configurations.
  - .4 Weight.
  - .5 Cable terminal sizes.
  - .6 Nameplate data.

**Part 2 Products**

**2.1 TRANSFORMERS**

- .1 Use transformers of one manufacturer throughout project. If this is not possible, submit constraint conditions and specifications to the Departmental Representative for approval.
- .2 Transformers to have the following characteristics:
  - .1 Type: Where located indoors provide with Sprinkler-proof enclosure  
Where located outdoors provide with NEMA 3R enclosure.
  - .2 Three phase, 600V delta-connected primary, 120/208V wye-connected secondary.
  - .3 kVA rating as indicated on drawings.
  - .4 Operating frequency of 60 Hz.
  - .5 Winding insulation of 1000 V class, 150° degree temperature rise.
  - .6 Maximum impedance of 5%.
  - .7 Minimum K-Factor 4.
  - .8 Sound rating: standard.
  - .9 Hipot is standard.
  - .10 Taps 4 – 2 1/2 percent FCAN, FCBN.
  - .11 Air ventilated via louvres.
  - .12 Termination at bottom of transformer.
  - .13 Finish shall be ASA 61 grey.
  - .14 All transformer windings to be copper.

**2.2 MANUFACTURERS**

- .1 Acceptable manufacturer(s): Hammond, Square "D", Bemag, Delta Transformer, or approved equal in accordance with B7.

**Part 3 Execution**

**3.1 MOUNTING**

- .1 Installation to Electrical Code - Section 26-248.
- .2 Units shall be pad mounted outdoors, floor or wall mounted as indicated on drawings.
- .3 Mount transformers in level upright position.
- .4 Units shall be clear of air obstructions per manufacturer's installation requirements to ensure adequate ventilation.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.

**3.2 CONNECTIONS**

- .1 Make primary and secondary connections.

- .2 Energize transformers immediately after installation is completed, where practicable.

**3.3 TESTING**

- .1 Testing of transformers is accordance with Section 26 05 00.

**3.4 EQUIPMENT IDENTIFICATION**

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

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.2 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 This section covers the supply and installation of all distribution and power panelboards, including mounting hardware and breakers.

**1.3 REFERENCES**

- .1 All equipment to CSA Standard C22.2 No. 29-11 – Panelboards and Enclosed Panelboards.
- .2 Fault current ratings to be indicated on nameplates.

**1.4 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 26 05 00.
- .2 Submittals shall include drawings of panelboards showing doors open and doors closed. Indicate dimensioning of main breaker location and branch breaker locations.

**Part 2 Products**

**2.1 PANELBOARDS**

- .1 All panelboards shall be supplied by one manufacturer.
- .2 120/208V, 3-phase, 4-wire and 120/240V, bus and breakers to be rated 10,000 amps interrupting capacity unless noted otherwise.
- .3 347/600V, 3-phase, 4-wire power panelboard bus and breakers to be rated 18,000 amps (symmetrical) interrupting capacity unless noted otherwise.
- .4 Panelboard mains, number of circuits, and number and size of branch circuit breakers shall be as indicated on the drawings.
- .5 The main bus bars shall be copper and shall be equipped with solderless lugs for incoming cables. Neutral to be of same ampere rating as mains.
- .6 Distribution section to accommodate circuit breakers. Breakers shall be the interchangeable trip type.

- .7 Doors shall have spring hatches and cylinder locks, and all locks shall be keyed alike with two keys per panelboard.
- .8 NEMA 4X enclosure in corrosive environments, NEMA 12 gasketed nonventilated enclosure in ordinary areas.
- .9 Distribution panelboard acceptable manufacturer(s): Schneider Canada Square “D” type NQ, Cutler-Hammer Pow-R-Line Series.
- .10 Power panelboard acceptable manufacturer(s): Schneider Canada Square “D” I-Line, Cutler-Hammer Pow-R-Line series..

## **2.2 CIRCUIT BREAKERS**

- .1 Refer to Section 26 28 16 for breaker specification.
- .2 Breakers shall be the bolt-on type and shall provide instantaneous trip on over-currents and time-delay trip on overloads.
- .3 Breakers shall be compatible with fault current rating of the panel.
- .4 Breakers shall be of the thermal magnetic tripping type.
- .5 Breakers protection receptacles located up to 1m and closer to any source of water shall be of the GFCI type.
- .6 Main breaker shall be separately mounted on top or bottom of panel to suit cable entry as required. When mounted vertically, down position should open breaker.

## **Part 3 Execution**

### **3.1 PLANT ASSEMBLY**

- .1 Install circuit breakers in panelboards before shipment.

### **3.2 INSTALLATION**

- .1 Locate panelboards as indicated on the drawings and mount securely, plumb true and square.
- .2 Install each panelboard 1980 mm above finished floor measured to the top of the enclosure.
- .3 Install panelboards mounted on brick, concrete or block walls on plywood backboards or use 3 mm thick lead washers between enclosure and wall face. Where practical, group panels on common backboard. If mounted in a humid or corrosive rated environment, follow the Electrical Code, Section 22 for installation requirements.
- .4 Make all field wiring connections and terminations. Connect loads to circuits as indicated and connect neutral conductors to common neutral bus with respective neutral identified.

### **3.3 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Provide nameplate for each panelboard engraved as directed.

- .3 Provide complete circuit directory for each panelboard, with typewritten legend showing location and load of each circuit.

**END OF SECTION**

**Part 1           General**

**1.1               REFERENCE**

- .1    CSA International
  - .1       CAN/CSA C22.2 No.94.1-[07], Enclosures for Electrical Equipment, Non Environment Considerations.
- .2    National Electrical Manufacturers Association (NEMA)
  - .1       NEMA 250-[2008], Enclosures for Electrical Equipment (1000 Volts Maximum).
- .3    The Munsell System of Colour Notation

**1.2               GENERAL CONDITIONS**

- .1    All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2    Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3    All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.3               SCOPE**

- .1    Refer to Section 26 05 00 for project electrical scope of work.
- .2    This section covers the supply and installation of all receptacles, toggle switches, and cover plates.
- .3    All wiring devices shall be at the same manufacturer throughout the Contract.

**1.4               SUBMITTALS**

- .1    Submit shop drawings for all wiring devices in accordance with Section 26 05 00.

**Part 2           Products**

**2.1               RECEPTACLES**

- .1    This specification applies to single and duplex receptacles and receptacles of other voltage and ampacity as indicated on the drawings.
- .2    Type NEMA 5-15R or 5-20R as the circuit requires, 125V, U-ground, heavy duty specification grade to CSA C22.2 No. 42-10 – General Use Receptacles.
- .3    Receptacle shall have heavy duty nylon face with steel reinforcing plate in centre.
- .4    Receptacle shall have spring loaded back wiring.
- .5    Receptacle shall have raised ground for safety.
- .6    Receptacle contacts shall have spring steel clips to reduce contact fatigue.
- .7    Receptacle shall be suitable for No. 10 AWG back and side wiring.

- .8 All screws shall be combination slotted socket head design to accept #6 socket head screwdriver on all screws.
- .9 Receptacles in ordinary and humid corrosive locations shall be duplex-type, manufactured by Bryant, Cooper, Leviton.

## **2.2 SWITCHES**

- .1 Switches shall be 15A, 120V, single pole, double pole, or three-way as indicated on the drawings.
- .2 Must adhere to CSA 22.2 No. 111-10 – General-use Snap Switches, unless specified for use in hazardous areas.
- .3 Switches to be manually-operated heavy duty with the following features:
  - .1 Heavy duty mounting strap
  - .2 One piece Lexan toggle, lever, and cam
  - .3 Silver alloy contacts
  - .4 Spring loaded back wired
  - .5 Green hex head grounding terminal
  - .6 All screws socket/slotted head suited to accommodate #6 socket head screwdriver
  - .7 Switches to be fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 Switches in ordinary and humid corrosive locations shall be manufactured by Bryant, Cooper, Leviton. Type 1201 (number to suit application and amperage).

## **2.3 COVER PLATES**

- .1 Cover plates from one manufacturer throughout project to match switches and receptacles.
- .2 Cover plates to be PVC.
- .3 For wiring devices mounted in flush-mounted outlet boxes, thickness to be 2.5 mm.
- .4 Cover plates shall be suitable for IPEX FS/FD boxes.
- .5 Acceptable manufacturer is IPEX, Leviton, Crouse-Hinds, Hubbell.

## **2.4 WEATHERPROOF COVER PLATES**

- .1 Weatherproof covers for duplex receptacles located indoors, for Category 1 and Category 2 areas, shall be self-closing, two independent spring-loaded self-closing doors, PVC complete with non-corrosion stainless steel springs and stainless steel mounting screws.
- .2 Weatherproof covers for duplex receptacles located outdoors shall be weatherproof-in-use.
- .3 Weatherproof covers for light switches shall be plunger style, PVC complete with non-corrosive stainless steel mounting screws.
- .4 Covers shall be complete with EPDM gasket material suitable for -45°C to 85°C.
- .5 Acceptable manufacturers are IPEX, Leviton, Crouse-Hinds, Hubbell.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch is closed.
  - .2 Utilize gang type outlet box where more than one switch is required in one location.
  - .3 Mount toggle switches at height specified in Section 26 05 00 or as indicated.
- .2 Receptacles:
  - .1 Mount duplex receptacles vertically unless otherwise noted.
  - .2 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .3 Mount receptacles at height specified in Section 26 05 00 or as indicated.
  - .4 The location of all outlets as shown on the electrical plans is approximately correct at the time of planning, but as these drawings do not show all structural details, measure any work requiring accurate dimensions either on the project or from the architectural details.
  - .5 The location of outlets shown on the drawings may be changed by the Contract Administrator at no extra cost to the City, providing the distance does not exceed 3000 mm and the information is given before installation.
- .3 Cover Plates:
  - .1 Install all cover plates prior to energization.
  - .2 Cover plates shall be straight and true.
  - .3 Install suitable common cover plates where wiring devices are grouped.
  - .4 Flush-mounted cover plates shall be flush with the wall.
  - .5 Do not use cover plates meant for flush-mounted outlet boxes on surface-mounted boxes.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.2 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 This section covers the supply and installation of all magnetic and thermal magnetic circuit breakers.
- .3 Specific circuit breaker voltage, phase, ampacity, pole numbers, interrupting capacity, breaker type and settings are indicated elsewhere in the specifications or on the drawings.

**1.3 REFERENCES**

- .1 All equipment to CSA Standard C22.2, No. 5-13 – Molded-case Circuit Breakers.

**1.4 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 26 05 00, including:
  - .1 Component function, make and model no.
  - .2 Breaker voltage and amperage.
  - .3 Breaker phase, number of poles & number of wires.
  - .4 Indication of solid neutral if required.
- .2 Submit time-current characteristic curves for breakers with:
  - .1 Ampacity of 15 A and over, or
  - .2 Required to have an interrupting capacity of 22,000 A symmetrical (rms) or over at system voltage.

**Part 2 Products**

**2.1 BREAKERS - GENERAL**

- .1 Moulded case circuit breakers, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .2 Common-trip breakers with single handle for multi-pole applications.
- .3 Magnetic instantaneous trip elements in circuit breakers are to operate only when the value of current reaches setting. Trip settings on breakers with adjustable trips to have an adjustable range from 3-10 times current rating.

- .4 Circuit breakers with interchangeable trips as indicated.

## **2.2 THERMAL MAGNETIC BREAKERS**

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

## **2.3 MAGNETIC BREAKERS**

- .1 Magnetic circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection (motor starters).

## **2.4 ENCLOSURES**

- .1 All breakers shall be housed in an NEMA 12 rated panelboards, motor panels, or MCC. Wall mounted breakers to be housed in NEMA 4X rated enclosures.

## **2.5 MANUFACTURERS**

- .1 For circuit breakers protecting fans, heating elements, transformers and panelboards, acceptable manufacturer(s): Schneider Canada, Federal Pioneer FHL, Cutler-Hammer Series C, Moeller NZM Series.

For circuit breakers protecting electric motors, acceptable manufacturer(s): Schneider Canada Square "D" Mag-Guard MCP, Cutler-Hammer Series C HMCP, Moeller NZM Series, Allen Bradley-Bulletin 140U, Frame I, JD or K.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install circuit breakers in panelboards as indicated.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 CSA Group
  - .1 CAN/CSA-C22.2 No.4-[04(R2009 )], Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98).
  - .2 CSA C22.2 No.39-[13], Fuseholder Assemblies.

**1.2 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.3 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 This section covers the supply and installation of all motor and equipment disconnect switches.

**1.4 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 26 05 00 including the following information:
  - .2 Scale drawing of switch and enclosure.
  - .3 Switch voltage rating.

**1.5 REFERENCES**

- .1 All disconnect switches to be CSA, cUL, or ETL certified for the area in which they are mounted.

**Part 2 Products**

**2.1 UNFUSED DISCONNECT SWITCHES**

- .1 Provide unfused disconnect switches, voltage and amperage rated to suit loads.
- .2 Disconnect shall be front-operational, heavy duty, industrial grade, quick-make, quick-break type.
- .3 Make provision for padlocking in the "OFF" position.
- .4 Mechanically interlocked door to prevent opening when handle in "ON" position.

- .5 "ON/OFF" switch position indication on switch enclosure cover.
- .6 Disconnect enclosures shall be NEMA 4 in humid-only environments, NEMA 4X in corrosive environments and NEMA 12 gasketed nonventilated in ordinary areas, unless otherwise indicated.
- .7 Disconnect switches to be 100% load-make, load-break rated.
- .8 Disconnects shall each have auxiliary contact(s) where required, and as indicated, on drawings.

## **2.2 FUSED DISCONNECT SWITCHES**

- .1 Provide fused disconnect switches, voltage and amperage rated to suit loads.
- .2 Disconnect shall be front-operational, heavy duty, industrial grade, quick-make, quick-break type.
- .3 Make provision for padlocking in the "OFF" position.
- .4 Mechanically interlocked door to prevent opening when handle in "ON" position.
- .5 "ON/OFF" switch position indication on switch enclosure cover.
- .6 Disconnect enclosures shall be NEMA 4 in humid-only environments, NEMA 4X in corrosive environments and NEMA 12 gasketed nonventilated in ordinary areas, unless otherwise indicated.
- .7 Disconnect switches to be 100% load-make, load-break rated.
- .8 Disconnects shall each have auxiliary contact(s) where required, and as indicated, on drawings.

## **2.3 MANUFACTURERS**

- .1 Disconnects for all equipment specified shall be as manufactured by Cooper Crouse-Hinds GHG series, Arrow Hart AH series, Cutler-Hammer HD series, Schneider Canada Square "D" CHU series.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install disconnect switches as per manufacturer's recommendations.
- .2 Mount switches at 1400 mm above finished floor to the underside of the switch enclosure.

### **3.2 IDENTIFICATION**

- .1 .1 Provide lamacoid nameplate on front face of switch identifying equipment.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1            International Electrotechnical Commission (IEC)
  - .1            IEC 947-4-1-[2002], Part 4: Electromechanical contactors and motor-starters.

**1.2                GENERAL CONDITIONS**

- .1            All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2            Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3            All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.3                SCOPE**

- .1            Refer to Section 26 05 00 for project electrical scope of work.
- .2            This section covers the supply and installation of the motor starters.

**1.4                SHOP DRAWINGS AND PRODUCT DATA**

- .1            Submit shop drawings in accordance with Section 26 05 00. 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

**1.5                STANDARDS**

- .1            IEC Standards are acceptable for magnetic starters and contactors if application size doubled.
- .2            NEMA standards to apply, unless item 1 above is applied.
- .3            Open-wound starters or relay coils are not allowed.
- .4            All coils to be epoxy potted.

**1.6                OPERATION AND MAINTENANCE DATA**

- .1            Provide operation and maintenance data as specified in Section 26 05 00.
- .2            Include operation and maintenance data for each type and style of starter.

**1.7                MAINTENANCE MATERIALS**

- .1            Provide maintenance materials in accordance with the Section 26 05 00.

- .2 Provide listed spare parts for each different size and type of starter:
  - .1 2 sets of contacts, stationary.
  - .2 2 sets of contacts, movable.
  - .3 1 set of contacts, auxiliary.
  - .4 1 control transformer for each VA rating supplied.
  - .5 1 operating coil for each starter size supplied.
  - .6 2 fuses of each rating.
  - .7 4 indicating lamps, for each type supplied.
  - .8 1 communication module of each type supplied
  - .9 List local suppliers for all above parts.

## **Part 2 Product**

### **2.1 MATERIAL**

- .1 Half size starters not acceptable.
- .2 Smallest size starter to be size 1.

### **2.2 WALL MOUNTED MANUAL MOTOR STARTERS**

- .1 Single- or three-phase manual motor starters of size, type and rating, with components as follows:
  - .1 Switching mechanism: quick make and break.
  - .2 One or three overload heaters, manual reset, trip indicating handle as required.
  - .3 NEMA rated for the area in which they are installed.
  - .4 Made sprinkler proof in areas with sprinkler systems per Electrical Code section 26-008.
- .2 Accessories:
  - .1 Toggle switch: standard heavy duty oiltight labeled as indicated.
  - .2 Indicating light: heavy duty oiltight type and colour as indicated.
  - .3 Locking tab to permit padlocking in "ON" and "OFF" positions.
- .3 Acceptable manufacturer shall be Schneider per City standardization.

### **2.3 FULL VOLTAGE MAGNETIC STARTERS**

- .1 Magnetic and combination magnetic starters of size, type and rating 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 Power and control terminal blocks
  - .4 Wiring and schematic diagram located inside starter enclosure in a visible location.

- .5 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
  - .6 NEMA rated for the area in which they are installed.
  - .7 Made sprinkler proof in areas with sprinkler systems per Electrical Code section 26-008.
- .2 Combination type starters to include motor circuit protector with operating lever on outside of enclosure to control motor circuit protector and provision for:
- .1 Locking in "OFF" position with up to 3 padlocks.
  - .2 Locking in "ON" position.
  - .3 Independent locking of enclosure door.
  - .4 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
- .1 Pushbuttons and selector switches: standard heavy duty oiltight labeled as indicated.
  - .2 Indicating lights: Push-to-test transformer heavy duty oiltight type and colour as indicated.
  - .3 1-N.O. and 1-N.C. spare auxiliary contacts unless otherwise indicated.
- .4 Starter sizes shall be Electrical Code suitable to applied loads as indicated on drawings.
- .5 Acceptable manufacturer shall be Schneider per City standardization.

## **2.4 TWO SPEED MAGNETIC STARTERS**

- .1 Two speed magnetic starters of size, type and rating indicated with components as follows:
- .1 One-3-pole contactor for each winding for separate winding motors.
  - .2 3 overload relays with three heater and manual reset for each speed.
  - .3 Power and control terminal blocks
  - .4 Wiring and schematic diagram located inside starter enclosure in a visible location.
  - .5 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
  - .6 NEMA rated for the area in which they are installed.
  - .7 Made sprinkler proof in areas with sprinkler systems per Electrical Code section 26-008.
- .2 Combination type starters to include motor circuit protector with operating lever on outside of enclosure to control motor circuit protector and with the following features:
- .1 Locking in "OFF" position with up to 3 padlocks.
  - .2 Locking in "ON" position.
  - .3 Independent locking of enclosure door.
  - .4 Prevention of switching to "ON" position while enclosure door open.
  - .5 Mechanical interlocks to prevent simultaneous energization of both speed circuits with adjustable time delay when changing from high to low speeds. Time delay

shall be adjusted on site to suit the deceleration of the driven load to prevent back generation by an over-running motor.

- .3 Accessories:
  - .1 Pushbuttons and selector switches: standard heavy duty oiltight labeled as indicated.
  - .2 Indicating lights: Push-to-test transformer heavy duty oiltight type and colour as indicated.
  - .3 1-N.O. and 1-N.C. spare auxiliary contacts unless otherwise indicated.
- .4 Starter sizes shall be Electrical Code suitable to applied load as indicated on drawings.
- .5 Acceptable manufacturer shall be Schneider per City standardization.

## **2.5 SOFT START MOTOR STARTERS**

- .1 The enclosed soft start controller shall be a pre-engineered enclosure package with a disconnect means and a starter for soft starting and stopping of standard, three-phase, asynchronous induction motors. The enclosed soft start controller shall contain:
  - .1 Current limiting provisions to achieve short circuit ratings for the unit.
  - .2 Customer terminal blocks for control connections.
  - .3 Load terminals (T1/T2/T3) for motor connections to the soft starter
  - .4 A disconnect (circuit breaker or fused switch) with an external handle
  - .5 A door mounted keypad display for diagnostics and set up.
  - .6 Motor protection functions.
  - .7 Solid state overload protection built in to the soft starter
  - .8 Start/Stop pushbuttons, Hand-Off-Auto selector switch, E-Stop pushbutton, Ready (Blue), Run (Green), and Fault (Red) pilot lights, electronic ammeter, elapsed time meter.
  - .9 NEMA 12 gasketed nonventilated enclosure.
  - .10 Configuration such that a fault does not lock out the soft starter in such a way that manual intervention is required to restart.
  - .11 Analog output for motor current.
- .2 Provide external Bypass Contactors. Provide external Isolation Contactors. External contactors shall be NEMA rated. Provide manual controls to operate the Bypass and Isolation function, and Bypassed (Yellow) pilot light. The Bypass Contactor shall be complete with hardware to operate as a bypass starter including overloads with aux contacts, HOA, Bypass Run (Green), Bypass Ready (Blue), Bypass Fault (Red) pilot lights.
- .3 When the E-Stop is pushed, the controller and Bypass Contactor shall deenergize and shall require a Reset before being able to start. The Reset shall not cause the motor to start but shall only permit it to start. On a power failure and return of power, the motor shall not be in a locked out status requiring a Reset.
- .4 Acceptable manufacturer shall be Schneider per City standardization.
- .5 Acceptable product: AltiStart ATS48.

## **2.6 CONTROL TRANSFORMERS**

- .1 Single phase, dry type, control transformer with primary voltage matched to the supply voltage and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load required plus 100% spare capacity.

## **2.7 COMMUNICATIONS**

- .1 Each Starter Drive shall be equipped with Ethernet communication card and shall be capable of communicating directly with the PLC without the need for an external protocol converter.

## **2.8 EQUIPMENT IDENTIFICATION**

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

## **Part 3 Execution**

### **3.1 PRODUCT RATINGS**

- .1 The Integrator shall review the available fault currents or required interrupt ratings at the starter location and select suitably rated equipment.

### **3.2 INSTALLATION**

- .1 Install starters, connect power and control circuits as indicated.
- .2 Install auxiliary contacts and connect wiring.
- .3 Ensure correct MCP settings and overload devices elements installed.
- .4 Make all settings and configuration.
- .5 Preferred current limit setting for soft starters is 300%. This shall be set higher if there is sign of difficulty starting, excessive voltage dip, or prolonged acceleration time. The highest setting should be 400%.
- .6 Record settings in a table and submit in O&M Manual. Show date of settings.
- .7 Manual motor starters shall be mounted 1500 mm above finished floor level to top of starter enclosure.

### **3.3 TESTS**

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

**END OF SECTION**

**Part 1           General**

**1.1               GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.2               SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 This section covers the following:
  - .1 Electrical work pertaining to installation of equipment, which is specified under other divisions.
  - .2 Automatic control devices specified in other divisions, supplied and installed under that division, and wired and connected under this division.
  - .3 Wiring associated with control wiring schematics on electrical drawings under this division.

**1.3               REFERENCES**

- .1 Coordinate with mechanical shop drawings for electrical requirements. Where mechanical shop drawings differ in control or power requirements this shall be reported to the Contract Administrator.

**Part 2           Products**

**2.1               MATERIALS**

- .1 Refer to other sections for equipment specifications.
- .2 Circuit breaker and feeder sizes as indicated on the electrical drawings for all motors, fans, HVAC equipment, etc., as supplied under the Mechanical Division are based on design data only. Contractor responsible for coordinating with the Mechanical Division to determine exact voltage and amperage of all equipment on site and ensure starters, breakers, feeder wiring, conduit sizes, etc., are correctly sized for the equipment being fed in addition to informing the Contract Administrator of all required changes. No extras will be allowed for costs incurred resulting from failure to properly execute this coordination.

**Part 3           Execution**

**3.1               INSTALLATION**

- .1 Refer to individual sections for execution.

- .2 Coordinate overcurrent and overload protective devices with the nameplate ratings of the motors.
- .3 Fill out a "MOTOR DATA SHEET" for each single phase and 3-phase motor. Provide these completed sheets to the Contract Administrator at least 2-weeks prior to commissioning.

**END OF SECTION**

**MOTOR DATA SHEET**

EQUIPMENT NAME AND NUMBER \_\_\_\_\_

**NAMEPLATE INFORMATION**

MANUFACTURER \_\_\_\_\_

KW(HP) \_\_\_\_\_ MAX AMBIENT \_\_\_\_\_ °C

R.P.M. \_\_\_\_\_ SERVICE FACTOR \_\_\_\_\_

VOLTS \_\_\_\_\_ INSULATION CLASS \_\_\_\_\_

AMPS \_\_\_\_\_ NEMA DESIGN \_\_\_\_\_

PHASE \_\_\_\_\_ SERIAL NUMBER \_\_\_\_\_

FRAME \_\_\_\_\_ MODEL NUMBER \_\_\_\_\_

**OPERATION CONDITIONS**

FULL LOAD AMPS \_\_\_\_\_ A \_\_\_\_\_ B \_\_\_\_\_ C

FULL LOAD OPERATING  
VOLTAGE AT MOTOR \_\_\_\_\_ A-B \_\_\_\_\_ B-C \_\_\_\_\_ C-A

OVERLOAD RELAY INSTALLED \_\_\_\_\_ ADJUSTABLE SETTING AT \_\_\_\_\_

M.C.P. AMPS \_\_\_\_\_ ADJUSTABLE SETTING AT \_\_\_\_\_

ACCELERATING TIME (IF OVER 5 SECONDS) \_\_\_\_\_

REDUCED VOLTAGE STARTER TRANSITION TIME SETTING \_\_\_\_\_

SPECIAL CONTROLS AND REMARKS (THERMISTOR AND RELAY TYPE, CAPACITORS AND  
WHERE CONNECTED, ETC.)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Part 1 General**

**1.1 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.2 SCOPE**

- .1 This section covers the supply and installation of the standby natural gas electric generator set.
- .2 The generator sets supplied shall have the following features and requirements:
  - .1 Shop Drawings and Product Data
  - .2 Submit shop drawings for review and approval. Include:
    - .1 Engine: make and model, with performance curves
    - .2 Alternator: make and model
    - .3 Voltage regulator: make, model and type
    - .4 Automatic transfer switch: make, model and type
    - .5 Battery: make, type and capacity
    - .6 Battery charger: make, type and model
    - .7 Alternator control panel: make and type of meters and controls
    - .8 Governor type and model
    - .9 Flow diagrams for:
      - .1 Lubricating oil
      - .2 Cooling air
  - .3 Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, and total weight
  - .4 Electrical connection drawings including:
    - .1 Connection points for remote starting signal
    - .2 Connections and ampacity of any power feeds to the unit during idle or off periods (heating, ventilation, charging, etc.).
    - .3 Connection points for remote indication of alarm conditions.
    - .4 The electrical requirements of those connection points (voltage and/or current requirements, relay or transistor switching, etc.).
  - .5 Continuous full load output of the set at 0.8 PF lagging
  - .6 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 temperature
  - .4 Low lube oil pressure
- .4 Over and under frequency protection.
- .5 Over and under voltage protection.

### **1.3 SOURCE QUALITY CONTROL**

- .1 Conduct equipment inspection at manufacturer's plant.
- .2 Provide manufacturer's type test certificates.
- .3 Submit written test results to the Contract Administrator.

## **Part 2 Products**

### **2.1 GENSET CHARACTERISTICS**

- .1 The electric set shall be rated 125kW continuous standby rating, 0.8% P.F., 347/600 volt, 3-phase, 4-wire, 60 hertz for standby power application at an ambient temperature of 85°F/29°C. The starting kVA capability shall be 540kVA at 35% voltage dip. Ratings must be substantiated with manufacturer's standard published curves. The engine shall operate at approximately 1800 RPM and suitable governor shall be provided such that frequency variations shall not exceed 5%. Ratings must reflect the net power available after deducting all engine driven accessories.
- .2 An automatic solid state voltage regulator shall be provided by the generator manufacturer to match the characteristics of the generator. Voltage regulations shall be (+/-) 2% from no-load to full load.
- .3 The engine shall be natural gas, four-stroke cycle, single acting, solid injection, turbo charged, liquid-cooled inline type
- .4 The engine shall be equipped with a reliable lube oil and intake air filters, lube oil cooler, any attachments required for continued, dependable operation. Engine shall be complete with a fill of manufacturer's recommended lubrication and 60% ethylene glycol concentration in the cooling system.
- .5 Genset shall be Kohler model 125REZGC or equivalent by Cummins or Caterpillar meeting all specifications and performance criteria.

### **2.2 ALTERNATOR**

- .1 Alternator shall be single bearing, self-aligning, continuous standby duty, salient pole, synchronous type with amortisseur winding. It shall be of the drip proof type, entirely self-contained and with line leads brought out for load connections. Insulation shall be

rated NEMA Class "F". Generator shall be so designed that with a minimum amount of labour all components will become completely accessible. Engine and generator shall be completely compatible and warranted by the same manufacturer, or their representative. Replacement parts shall be readily available.

- .2 Alternator to be of 130° rise design.

### **2.3 COOLING SYSTEM**

- .1 Provide a unit mounted radiator for the standby generator set complete with all necessary connections. The coolant shall be supplied with a 60% ethylene glycol solution, capable of withstanding temperatures down to -51°C (-60°F).

### **2.4 EXHAUST SYSTEM**

- .1 Provide a critical type horizontally mounted exhaust silencer, with condensate drain, properly sized according to the silencer manufacturer's recommendation for the engine used. A flexible exhaust fitting shall be provided for mounting between the engine exhaust and the exhaust pipe. The silencer size and pipe size shall be sufficient to ensure against loss of power due to excessive back pressure.

### **2.5 CONNECTORS**

- .1 Unit to be complete with flexible connections for fuel, exhaust and ventilation.
- .2 Provide all control wiring.

### **2.6 AUTOMATIC STARTING SYSTEM**

- .1 The generator system shall be provided with a 12Vdc or 24Vdc direct electric starting system suitable for automatic start-stop operation.
- .2 A fully automatic engine start-stop control shall be installed in the generator control panel. Control shall provide for overcrank lockout, pilot lights for low oil pressure, high water temperature, overspeed, and overcrank, a 3-position selector switch marked "Auto"- "Off"- "Manual". Control shall be equipped with timers which provide for 15-second timed cycle cranking consisting of three timed-crank periods each followed by a 10-second rest period.
- .3 The engine shall be furnished with an engine mounted thermal circulation type water heater to maintain engine jacket water at 90°F, in an ambient temperature of 50°F. A heater mounted thermostat shall be supplied.
- .4 Provide a heavy duty starting type lead acid storage battery set. Battery cables, inter-connectors and steel rack shall also be provided. Batteries to be of VARTA manufacture, or approved equal in accordance with B7. Battery rack to hold batteries minimum 150 m (6") above floor surface.
- .5 Provide and install battery chargers which shall be Vulcan fully automatic 10 amp capacity, or approved equal in accordance with B7.
- .6 The necessary relays to provide the operation as described in clause "Operation" are to be included.
- .7 Provide a thermostatically controlled 200W engine oil heater.

## **2.7 MOUNTING**

- .1 The units shall be complete with and mounted on structural steel sub-base, and shall be provided with spring vibration isolators.

## **2.8 GENERATOR CONTROL PANEL**

- .1 Provide a control panel incorporating complete controls for all functions of the electrical set. The panel shall be a unit mounted type, complete AC voltmeter (0-750 volts) and selector switch, AC ammeter (0-1200 amps) and selector switch; frequency meter, and voltage regulator adjusting rheostat, running time meter, pilot lights, engine start selector switch, etc. Panel shall incorporate the engine automatic cranking panel. Generator line circuit breaker c/w neutral bar, shall be rated at 1000 amps, 600-volts, 3-phase, 3-pole.
- .2 Provision shall be made to transmit "Generator Running", "Generator Trouble" and "Generator Loss of Control Power" and other signals to pumping station PLC via dry (voltage free) contacts rated at a minimum of 5 amps at 120Vac.
- .3 Provide at minimum seven more dry contact type relays for signalling to remote systems.
- .4 Provision shall be made to receive an "Estop" signal and shut down the generator.
- .5 Provision shall be made to receive a "Natural gas leak detected" signal and shut down the generator.

## **2.9 ENGINE GOVERNOR**

- .1 The governor shall be of current model and manufacture, to provide the specified "no load" to "full load" 5% maximum speed variation.
- .2 Governor response shall be such that rated engine speed is established within three (3) seconds during a no-load to full-load condition and vice-versa.

## **2.10 GUARDS**

- .1 Provide guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.

## **2.11 DRIP PANS**

- .1 Supply and install 25 mm deep galvanized metal drip pans under the engine.
- .2 These pans shall be sized to fit between the base channels and will be slid under the engine from the generator end when the unit is installed on site.
- .3 The maximum panel length shall not exceed 1m and if more than one pan is required to cover the required floor space, there must be an overlap on the edge on the pan to prevent oil from dripping between the pans.

## **2.12 OIL DRAIN**

- .1 Extend oil drain valve to make it accessible alongside of the genset engine.

## **2.13 GENERATOR ENCLOSURE**

- .1 Generator shall be indoor open style and shall come with the following features:
  - .1 Double solenoid valve for genset gas shut off.

- .2 Automatic battery charger.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install the standby generator set along with the following items, where so equipped:
  - .1 Generator control panel and generator breaker
  - .2 Battery charger
  - .3 Engine block heater
  - .4 Engine silencer
  - .5 Flexible natural gas and exhaust connections (mechanical)
  - .6 Batteries, battery rack, and battery cables
  - .7 Vibration isolators
  - .8 Necessary power and control wiring for a complete and operational system
  - .9 Radiator and cooling system
- .2 Control wiring from engine and generator devices to be installed in a separate conduit from all power wiring.
- .3 Generator ventilation system shall be interlocked with engine controls.
- .4 Connect natural gas leak detection signal to generator control panel for shut down.
- .5 All wiring to the generator control panel shall be stranded extra flexible.

#### **3.2 START UP SERVICES**

- .1 Standby set supplier to provide complete start-up service in the form of technical assistance for the installing contractor.
- .2 Components requiring field adjustment such as governor settings, etc., to be performed specifically by this supplier in the presence of the installing contractor. These services to be submitted along with the generator set operation instruction books to the Contract Administrator. Operating instructions (complete with spare parts lists) on the engine, generator, governor, exciter system, control panel, heaters, dampers, charger and batteries shall be contained in hard-backed binders and to be delivered to the Contract Administrator.

#### **3.3 OPERATION**

- .1 With the generator selector switch in Auto position, and the normal supply voltage operating, the generator set is on "automatic service" and shall start automatically on a signal from the Automatic Transfer Switch on utility power failure. Upon return of utility power supply voltage, the generator set will continue to run for a pre-set period of time (initially set at 5 minutes, but adjustable) before transfer to utility power. The engine will then continue running for a preset period of time (initially set at 5 minutes, but adjustable) and will then be automatically turned off.
- .2 Selector switch in "MANUAL" position, engine starts and runs up to required output until shut off manually. (No transfer takes place).

- .3 Selector switch in "TEST" position, engine starts and the system transfers to generator service. (Simulating power failure as described for Automatic Conditions).

### 3.4 TESTING

- .1 Prior to acceptance of the installation, the equipment shall be tested to the satisfaction of the Contract Administrator and subject to a full load test. Any defects which become evident during this test shall be corrected prior to shipment.
- .2 On the completion of the installation, the initial start-up shall be performed by a factory trained representative of the System Supplier. At the time of start-up operating instructions and maintenance procedures shall be thoroughly explained to the operating personnel.
- .3 Tests shall be conducted and certified written report of the tests submitted to the Contract Administrator, tests to include:
  - .1 "A" - Factory Test
    - .1 Standard factory test shall be performed.
    - .2 Unless already included in the factory test:
      - .1 With generator running on "no-load", a block load of not less than 100% of full load shall be applied and voltage and frequency dip recorded and the subsequent recovery time recorded. Voltage regulation shall be recorded.
      - .2 With generator running on 100% (min.) of full load, the load shall be disconnected, voltage and frequency variations and subsequent recovery times recorded.
    - .3 Submit test information, including ambient temperature (exterior, interior).
    - .4 Test shall be run for minimum six (6) hours with continuous standby rating applied.
  - .2 "B" - On Site Run Test
    - .1 A run-up test of the generating set with the generator control panel controlling its functions and include the simulated power failure conditions to ensure proper operation.
    - .2 The Run test does not require plant operating loads. It is a test of the generator starting, running, and stopping features, along with the Automatic Transfer switching system.
    - .3 When completed, this test will have verified the switching of the system from Utility to Backup and back to Utility power sources.
  - .3 "C" - On Site Load Test
    - .1 Running tests shall be conducted at full load (continuous standby rating) and operated for sufficient time for the engine temperature to stabilize plus additional two (2) hours.
    - .2 With generator running on "no-load", a block load of not less than 100% of full load shall be applied and voltage and frequency dip recorded and the subsequent recovery time recorded. Voltage regulation shall be recorded.

- .3 With generator running on 100% (min.) of full load, the load shall be disconnected, voltage and frequency variations and subsequent recovery times recorded.
  - .4 All safety features shall be tested by appropriately simulating the fail condition.
  - .5 Insulation tests shall be conducted on all electrical equipment in accordance with the applicable standards.
  - .6 Loading of generator shall be continuous. (Use all available site loads).
  - .7 All tests shall be performed on site in the presence of the Contract Administrator or their appointed representative and the Generator Manufacturer's representative. NOTIFY the Contract Administrator ONE (1) WEEK PRIOR TO CONDUCTING TESTS to allow for coordination of travel to site.
- .4 Record test results and submit to the Contract Administrator (record ambient temperatures, etc.).

### **3.5 SPARE PARTS**

- .1 Provide spare parts for each set. Include:
  - .1 Air cleaner Element
  - .2 2 each of Lube Oil Filters
  - .3 2 Sets of Control Fuses
  - .4 Lubricant Oil for two Oil Changes
  - .5 2 sets pilot lights lamps
  - .6 Special Tools for Unit servicing

### **3.6 COMMISSIONING AND TRAINING**

- .1 The manufacturer's representative shall be present during commissioning by the Contract Administrator.
- .2 Instruct the City's staff (Plant Operator(s)) in the proper operation, maintenance and repair procedures.
- .3 Training shall include operation, maintenance and repairs. (A minimum of 4 hours shall be included for training).

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 CSA International
  - .1 CAN/CSA-C813.1-[01(R2006)], Performance Test Method for Uninterruptible Power Supplies.

**1.2 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.3 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 This section describes the supply and installation of any uninterruptible power supply.

**1.4 RELATED SECTIONS**

- .1 Field Equipment Panels - Section 25 14 23.

**1.5 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 26 05 00.

**1.6 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for uninterruptible power supply for incorporation into the Operation and Maintenance Manual as specified in Section 26 05 00.

**Part 2 Products**

**2.1 GENERAL**

- .1 Line interactive uninterruptible power supplies for computer station, instrumentation and network communication systems as indicated.
- .2 Compact, reliable UPS system units based on automatic voltage regulation (AVR) technology.
- .3 Microprocessor controlled.
- .4 Auto-sleep mode, instant restart, protection against power variations, and overload.

## 2.2 UNINTERRUPTIBLE POWER SUPPLY

- .1 Capacity: Size kW and kVA capacity for the greater of double the connected load plus any shown future load, or 750W.
- .2 Input:
  - .1 Nominal voltage: 120Vac
  - .2 Voltage range: 80 – 140Vac
  - .3 Nominal input frequency: 60 Hz, +/- 5 Hz.
  - .4 Input power factor correction (PFC): > 0.98 @ full load.
  - .5 Input short circuit protection: Circuit Breaker on front of the UPS.
  - .6 Connection: Unit is to be wired, via pluggable connection, to a bypass switch as indicated.
- .3 Output:
  - .1 Nominal Output Voltage: 120Vac.
  - .2 Voltage distortion: Less than 5% at full load.
  - .3 Output Voltage Regulation: < 3 % @ Linear Load.
  - .4 High Efficiency Mode (AC-to-AC): > 86%.
  - .5 Crest factor: 5 : 1.
  - .6 Output frequency: 60 Hz, +/- 3 Hz.
  - .7 Output waveform: Sine wave at less than 3% THD.
  - .8 Connection: Unit is to be wired via a pluggable connection, to a bypass switch as indicated.
- .4 Overload Protection: Sustaining at least 120 seconds at 101-110% load, 111-150% max 12 seconds. Immediate shutdown and transfer of load to bypass at 150% load. Auto transfer back to UPS when overload is removed.
- .5 Battery
  - .1 Maintenance-free, sealed, battery with suspended electrolyte,
  - .2 Leakproof; hot swappable
  - .3 Backup Time: 30 minutes at 50% of full load.
  - .4 Maximum Recharge Time: 3 hours to 90%.
- .6 Transfer: On-line, double conversion technology with zero transfer time (< 1 ms).
- .7 Operation: Transition from, or to, battery operation is accomplished with no interruption of power to the load. Upon restoration of input power, the UPS will automatically resume normal operation and recharge the battery.
- .8 LED Indicators:
  - .1 Normal AC mode.
  - .2 Battery backup mode.
  - .3 UPS fault / alarms:
    - .1 Backup DC mode.

- .2 Low battery voltage.
- .3 Frequency error.
- .4 Charger failure.
- .5 Overload.
- .9 Signalling:
  - .1 Dry (voltage free) relay output contacts for each of:
    - .1 Fault
- .10 Environmental:
  - .1 Operating temperature: 0°C to +40°C.
  - .2 Storage temperature: -15°C to +50°C.
  - .3 Humidity: 0% to 95%, non-condensing.
- .11 Acceptable manufacturer: Phoenix Contact, model TRIO-UPS/1AC/24DC/ 5.

### **2.3 UPS PANEL BOARD**

- .1 Total number of circuits, configuration, and location as indicated.
- .2 Manufacturer, installation, labelling, etc., as defined in Section 26 24 16 - Panelboards

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Installed in as indicated.

### **3.2 STORAGE AND HANDLING**

- .1 Store all UPS(s), whether shipped loose or mounted in panels, indoors in heated spaces. Care shall be taken to protect UPS(s) and all other temperature sensitive equipment from extreme heat or cold.
- .2 Keep equipment doors locked. Protect equipment from damage and dust.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.5-[09], Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).
  - .2 CSA C22.2 No.178.1-[2007], Automatic Transfer Switches.
  - .3 CAN/CSA C60044-1-[07], Instrument Transformers.
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA ICS 2-[1996(R2009)], Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.

**1.2 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.3 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical Scope of Work.
- .2 This section covers the supply and installation of the automatic transfer switch. The transfer switch shall be installed, connected tested and commissioned as specified herein.

**1.4 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Section 26 05 00. Include:
  - .1 Panel layouts
  - .2 Wiring connections and diagrams
  - .3 Dimensions
  - .4 Electrical characteristics of each component
  - .5 Connection requirements

**Part 2 Products**

**2.1 AUTOMATIC TRANSFER SWITCH**

- .1 Automatic transfer switch shall:
  - .1 Be contactor-based, open transfer

- .2 Be voltage and current rated as indicated, 3-phase, 4-wire service.
- .3 Include all the necessary control components to connect to genset controls to provide automatic utility-to-genset operation and vice versa.
- .2 Connections to Utility and Generator power to be coordinated with electrical contractor.
- .3 The switch system shall be CSA, cUL, or ETL certified, and meet the fault current rating of the system as indicated on the single line diagram.
- .4 Transfer switch shall come c/w the following options:
  - .1 Adjustable engine start delay, set at 3 sec.
  - .2 Adjustable transfer delay, set at 3 sec.
  - .3 Adjustable re-transfer delay, set at 5 min.
  - .4 Adjustable stop delay, set at 5 min.
  - .5 3-phase voltage sensing that includes utility phase-loss detection.
  - .6 Programmed transition
  - .7 Test switch
  - .8 Dry (voltage-free) contacts, each rated at least 1 amp @ 120Vac, to produce the following status points to be monitored by the plant's SCADA system:
    - .1 Alarm or Fault
    - .2 In Normal Power Position
    - .3 Normal Source Available
    - .4 In Standby Position
    - .5 Standby Source Available
    - .6 Not In Auto
    - .7 2 Spare additional programmable contacts
- .5 Transfer switch manufactured by Kohler, model KCP-ANTA-0225S, or equivalent by Cummins or Caterpillar. The manufacturer of the transfer switch shall be the same manufacturer as the standby generator.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install transfer switches as per manufacturer's recommendations.
- .2 Provide and install all required power and control cables and cable hardware to complete transfer switch operation.

#### **3.2 IDENTIFICATION**

- .1 Provide lamacoid nameplate on front face of switches identifying function.

#### **3.3 OPERATION**

- .1 On loss of normal power emergency generator shall start on a signal from transfer switch. Switch shall transfer to emergency power feed from generator on confirmation of generator bus nominal voltage and frequency.

- .2 On return of normal power, switch shall transfer to normal power from emergency power feed on confirmation of nominal voltage and frequency.

3.4 **TESTING**

- .1 On the completion of the installation, the initial start-up shall be performed by a factory trained representative who shall verify satisfactory operation of the transfer switch and generator. At the time of start-up operating instructions and maintenance procedures shall be thoroughly explained to the operating personnel.
- .2 Tests shall be conducted and certified written report of the tests submitted to the Contract Administrator.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL CONDITIONS**

- .1 All Sections of General Conditions shall form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.2 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical Scope of Work.
- .2 This section covers the supply and installation of all transient voltage surge suppressors.

**1.3 STANDARDS**

- .1 The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards.
- .2 Underwriters Laboratories UL 1283 and UL 1449
- .3 Canadian Standards: cUL, CSA, ETL.
- .4 Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11-2012, C62.41-1991, C62.45-2002)
- .5 Electrical Code

**1.4 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 26 05 00 including:
- .2 Unit dimensions, mass, installation instruction details and wiring configuration.
- .3 Voltage, IEEE let through voltage for each waveform listed, UL 1449 latest revision, latest edition, suppressed voltage ratings, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period and replacement terms, conductor size, conductor type and lead length.
- .4 List and detail all protection systems such as fuses, disconnecting means and protective features.
- .5 Provide verification that the Surge Suppressor device complies with the required UL 1449, and UL1283, latest editions, latest revisions, and CSA, or cUL, or ETL approvals.
- .6 Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Categories C, B, and A (as indicated on the drawings), tested in accordance with ANSI/IEEE C62.45.
- .7 Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per phase mode basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a

complete TVSS with internal fusing in place. Test data on an individual module is not acceptable.

## **1.5 QUALITY ASSURANCE AND WARRANTY**

- .1 The TVSS and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of ten (10) years from the date of substantial completion and activation of the system to which the suppressor is attached. Additionally, the warranty shall state that during the applicable warranty period any Surge Suppressor which fails due to any transient surge activity, including lightning, shall be repaired or replaced by the manufacturer without charge. The warranty must specifically provide for unlimited free replacements of the TVSS in the event of failure caused by the effects of lightening and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.

## **Part 2 Product**

### **2.1 GENERAL PRODUCT**

- .1 The transient voltage surge suppressors (TVSS) described by this specification are to be installed in the various locations as indicated.
- .2 All TVSS devices shall be listed under UL 1449 and certified by CSA, cUL, ETL.
- .3 TVSS device enclosure shall be rated NEMA 12.
- .4 The TVSS shall protect all modes L-G, L-N, and N-G, have discrete suppression circuitry in L-G, L-N and N-G, and have bi-directional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable.
- .5 The maximum continuous operating voltage (MCOV) of all components shall not be less than 125% for a 120V system and 120% for 220V and 240V systems, and 115% for 277V and 600V systems.
- .6 All TVSS's shall be equipped with a comprehensive monitoring system which shall include a visual LCD panel display providing information on unit status and phase loss/protection loss.
- .7 Internal Fusing – Overcurrent Protection:
- .8 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the TVSS to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the TVSS is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more than one MOV per mode.
- .9 For arc quenching capability, minimization of smoke and contaminants in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.
- .10 Fusing shall be present in every mode, including Neutral-to-Ground.

TRANSIENT VOLTAGE SURGE SUPPRESSORS

- .11 The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied
- .12 Each suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability and shall have at minimum an NEMA 12 steel enclosure, sprinkler proof
- .13 Devices are to be installed as indicated.
- .14 The TVSS shall have an audible alarm, with mute, on front cover.

**2.2 600V PROTECTION**

- .1 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length pursuant to the latest ANSI/IEEE C62.41 and C62.45,, categories C1 and C3 bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic test except N-G and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41 Measured Limiting Voltage B3/C1 Impulse (6kV, 3kA) Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	725V	726V	1098V	728V
120/240 (1S240)	725V	726V	1098V	728V
347/600 (3Y600)	1273V	1281V	2161V	1295V
600 delta (600NN)	-	2095V	2098V	-
C3 Impulse (20kV, 10kA) Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	907V	1173V	1267V	1090V
120/240 (1S240)	907V	1173V	1267V	1090V
347/600 (3Y600)	1537V	1707V	2470V	1800V
600 delta (600NN)	-	2160V	2470V	-
UL 1449 Voltage Protection Ratings Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	800V	800V	1200V	800V
120/240 (1S240)	800V	800V	2500V	800V
347/600 (3Y600)	1500V	1500V	2500V	1500V
600 delta (600NN)	-	2500V	2500V	-

**2.3 120/208V DISTRIBUTION PANEL PROTECTION (INSTALLED AT PANELS)**

- .1 Each suppressor shall incorporate enhanced tracking filtering technology to attenuate transients that fall within the sine wave normal voltage envelope (Enhanced Transient Filter).
- .2 The manufacturer shall provide written specifications showing let-through voltage of the unit pursuant to the latest ANSI/IEEE C62.41 and C62.45, categories A1 and A3 ringwave and category B3/C1 impulse, 90 or 180 degree phase angle as listed below, positive polarity, dynamic or static test, which shall be no higher than:

A1 (2kV, 67A) (180 degrees)	A3 (6kV, 200A) (90 degrees)	B3/C1 (6kV, 3kA) (90 degrees)
L-N 28	L-N 108	L-N 444
L-G 28	L-G 104	L-G 440
N-G 28	N-G 100	N-G 456

**2.4 ACCEPTABLE MANUFACTURER**

- .1 TVSS products shall be of the same manufacturer as the distribution panelboards.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install the TVSS devices with the conductors under 350mm in length and straight as practicably possible. Utilize high strand count extra flexible wiring. Route conductors as straight as practicable, minimize number of bends and make bends a smooth, large radius.
- .2 Follow the TVSS manufacturer's recommended installation practice as outlined in the equipment installation manual. The electrical contractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated TVSS.
- .3 Main service entrance units shall be installed on a 60A breaker or, where indicated, shall be installed on a non-fused disconnect switch that meets or exceeds the fault current rating of the switchgear.
- .4 Distribution branch panel units shall be installed on 30A dedicated circuit breaker or, where indicated, shall be wired directly to the main lugs or feed through lugs, or wired directly to the bus bars.
- .5 The installing contractor shall comply with all applicable codes.

**END OF SECTION**

## **Part 1 General**

### **1.1 REFERENCES**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI C82.1-[04], Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.
  - .2 ANSI C82.4-[02(R2007)], Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps Multi Supply Type.
- .2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1 ANSI/IEEE C62.41-[1991], Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .3 ASTM International Inc.
  - .1 ASTM F1137-[00(2006)], Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 Canadian Standards Association (CSA International)
- .5 ICES-005-[07], Radio Frequency Lighting Devices.
- .6 Underwriters' Laboratories of Canada (ULC)

### **1.2 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

### **1.3 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 This section covers the supply and installation of lighting fixtures and lamps.

### **1.4 GENERAL REQUIREMENTS**

- .1 Supply and install where shown and as specified on the drawing, all lighting fixtures c/w suspension devices, lamps and other attachments as specified or required to give the best appearance and mechanical installation.
- .2 All fixtures to be CSA, cUL or ETL certified for the installed location and application.
- .3 All fixtures, stem hangers, ballast compartments, canopies, reflectors, wireways, brackets, etc., used in conjunction with the fixtures shall be factory finished, baked enamel, unless otherwise specified.

- .4 All fixtures which have minor scratches after installation shall be "touched up" with an approved enamel to match the fixture finish to the complete satisfaction of the Contract Administrator.

## **1.5 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 26 05 00 showing information such as width, depth, finish, etc., of each fixture in addition to all pertinent lamp data. Include lighting fixture literature in electrical O&M manuals in accordance with Section 26 05 00.

## **Part 2 Products**

### **2.1 FIXTURE SCHEDULE**

- .1 Refer to fixture schedule on electrical drawings for specific fixture and lamp, makes and models.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated on lighting layout drawings.
- .2 Coordinate installation of fixtures with other sections.
- .3 Unit shall conform to building lines, being parallel or perpendicular.
- .4 For suspended ceiling installations, support luminaires from ceiling grid in accordance with local inspection requirements.
- .5 Installation of all lighting equipment shall comply with the relevant Sections of this Specification and the Electrical Code.
- .6 At the completion of construction and acceptance of work, all lighting fixtures shall be clean, complete with all necessary accessories and provided with the required operating lamp(s).

**END OF SECTION**

**Part 1            General**

**1.1                GENERAL CONDITIONS**

- .1     Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .2     All sections of all the Divisions of the Specification and all other documents included as part of this document form part of the Contract documents.

**1.2                SCOPE**

- .1     Refer to Section 26 05 00 for project electrical scope of work.
- .2     This section covers the supply and installation of emergency battery banks and remote fixtures.

**1.3                STANDARDS**

- .1     National Building Code of Canada - 2010
- .2     National Fire Code of Canada - 2010
- .3     All product shall be certified by CSA, cUL, or ETL for the area and application.

**1.4                SUBMITTALS**

- .1     Submit shop drawings in accordance with Section 26 05 00.

**Part 2            Products**

**2.1                EQUIPMENT**

- .1     Emergency Lighting Equipment:
  - .1     Supply voltage: 120 Vac
  - .2     Output voltage: 12 Vdc
  - .3     Operating time on battery: 30 minutes, minimum.
  - .4     Battery: Long life, sealed, rated as indicated on drawings.
  - .5     Charger(s): Solid state, multi-rate voltage/current regulated, inverse temperature compensated, short circuit protected.
  - .6     Solid state or relay transfer.
  - .7     Low voltage disconnect: Solid state, modular, operates at 80% battery output voltage.
  - .8     Signal lights: LED, for
    - .1     Battery Failure
    - .2     AC power ON
    - .3     High Charge Rate
    - .4     Battery Disconnected
    - .5     Lamp Failure

- .6 Charger Failure
- .7 Service Alarm
- .9 Lamp heads: Integral on unit, single and/or double as indicated. Lamp type: LED, wattage as shown.
- .10 Remote heads, single and/or double as indicated. Lamp type: LED, wattage as indicated.
- .11 Cabinet: Suitable for wall mounting or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 Enclosure: rated for Normal area or Humid/Corrosive area as indicated.
- .13 Battery Bank's required installed, auxiliary equipment:
  - .1 Lamp disconnect switch
  - .2 Test switch
  - .3 Time delay relay
  - .4 AC input and DC output terminal blocks inside cabinet
- .14 Manufacturer and model as Indicated.
- .2 Exit Signs
  - .1 Manufacturer and model as Indicated.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 General
  - .1 Install unit equipment and remote mounted fixtures at indicated locations.
- .2 Exit Signs
  - .1 Mount centered over door, 200mm from the top edge of door trim to bottom of fixture.
- .3 Remote Light Fixtures
  - .1 Wall-mounted units: 2740 mm from floor to bottom of fixture. Direct lights downward and angled to illuminate the maximum amount of floor area possible in a continuous exit path from work areas to the exit doors.

#### **3.2 WIRING OF REMOTE HEADS**

- .1 Conduit: to Section 26 05 34
- .2 Conductors: to Section 26 05 21, maximum allowable voltage drop not to exceed 5%.

#### **3.3 WIRING OF EXIT SIGNS**

- .1 Conduit: to Section 26 05 34

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL CONDITIONS**

- .1 All Sections of General Conditions form a part of this Specification. They shall be read and fully adhered to exactly as if repeated here in full.
- .2 Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.
- .3 All Sections of all Divisions of the Specifications and these documents inclusive form part of the Contract documents.

**1.2 SCOPE**

- .1 Refer to Section 26 05 00 for project electrical scope of work.
- .2 Supply and installation of all electric heaters, force flow heaters and baseboard heaters shall be by Division 26.

**1.3 QUALITY ASSURANCE**

- .1 CSA C22.2 No. 46-13 – Electric Air-heaters
- .2 Electrical Code - Section 62

**1.4 REFERENCES**

- .1 Underwriters' Laboratories (UL) Inc.
  - .1 UL 2021-1997, Fixed and Location-Dedicated Electric Room Heaters.

**1.5 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for unit heaters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, cleaning procedures.
- .4 Submit shop drawings in accordance with section 26 05 00. Include:
  - .1 Physical size and mounting methods.
  - .2 Layout and wiring diagrams of electric heaters including low voltage controls.
  - .3 kW rating, voltage, phase.
  - .4 Required clearances from combustible materials.
  - .5 Heater construction and finish.

**1.6 CLOSEOUT SUBMITTALS**

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

**1.7 DELIVERY, STORAGE AND HANDLING**

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

**Part 2 Products**

**2.1 GENERAL**

- .1 All product to be supplied suitable to area classifications as indicated on drawings.

**2.2 ELECTRIC UNIT HEATERS**

- .1 Horizontal discharge complete with adjustable louvers finished to match cabinet.
- .2 Fan type unit heaters with built-in high heat limit protection. Liquid tight flex connecting the control enclosure to the motor.
- .3 Fan motor: Totally enclosed, permanently lubricated ball bearing type with resilient mount. Built in fan motor thermal overload protection.
- .4 Wall or ceiling mounting bracket as required.
- .5 Controls: Provide remote thermostat controls for all unit heaters as indicated, from the same manufacturer as the heater. Provide built-in thermostat where indicated. Provide all necessary control relays, transformers, contactors, wiring, etc. that are required for a functional system.
- .6 Normal Areas:
  - .1 Epoxy coated cabinet
  - .2 Finned tubular sheath elements
  - .3 Balanced aluminum fan blade
  - .4 Acceptable manufacturer(s): Ouellet OAS series, Caloritech RGX series, or approved equal in accordance with B7.

- .7 Category I and II Areas:
  - .1 NEMA 4X enclosure, stainless steel or non-metallic
  - .2 Epoxy coated fan blade
  - .3 Stainless steel construction
  - .4 Acceptable manufacturer(s): Ruffneck CR1 series, Dimplex DX-234, Beacon Morris BRT60 or approved equal in accordance with B7.

### **2.3 THERMOSTATS**

- .1 Provide heater control remote thermostats as required, if not already specified as part of a heater system as specified above.
- .2 Remote control thermostats shall be suitable for wall mounting rated 24Vac for low voltage and 240Vac for line voltage. All thermostats shall be low voltage type unless otherwise specified.
- .3 NEMA 4X.
- .4 Acceptable manufacturer(s): Honeywell No. T631A, or approved equal in accordance with B7.

## **Part 3 Execution**

### **3.1 EXAMINATION**

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

### **3.2 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Include double swing pipe joints as indicated.
- .3 Check final location with Contract Administrator if different from that indicated prior to installation.
  - .1 Should deviations beyond allowable clearances arise, request and follow Contract Administrator's directive.
- .4 Clean finned tubes and comb straight.
- .5 Provide supplementary suspension steel as required.
- .6 Install thermostats in locations as indicated.
- .7 Before acceptance, set discharge patterns and fan speeds to suit requirements.

- .8 Support unit heaters from wall at minimum 2.4m above floor where indicated.
- .9 Install baseboard heaters where indicated. All baseboard heaters shall be wall or floor mounted as indicated. Provide all required labour and materials to install heaters in existing areas in a neat and workmanlike manner.
- .10 Make power and control connections.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Ensure that heaters and controls operate correctly.

**3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.5 PROTECTION**

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

**END OF SECTION**