

Electrical General Requirement Specification

Specification 26 05 00

Revision 02

September 2025

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Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes
Cover Page	March 2023	Removed 'Capital Projects Group' to reflect organizational changes.
1.2.3, 1.3.4	March 2023	Updated numbering on Electrical Identification and Nomenclature Specification.
3.3.24, 3.3.25, 3.1.4.2	March 2023	Updated and added installation requirements and testing requirements.
Various	September 2025	Updated format and added new requirements.

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1. GENERAL

1.1. SCOPE OF WORK

- 1.1.1. Labour, products, equipment, and services necessary for electrical general requirements work in accordance with the Contract Documents.
- 1.1.2. This Section covers general requirements for supply and installation of electrical equipment specified in Divisions 26, 27 and 28, as detailed on Contract Drawings.
- 1.1.3. The equipment furnished and the equipment installation, wiring methods and materials used shall conform to the latest edition of the Ontario Electrical Safety Code, Electrical Safety Authority (ESA) Bulletins and Supplements issued by the Electrical Safety Authority, and the applicable Metrolinx Standards. In case of any conflicts, the more stringent requirement shall apply.
- 1.1.4. In general, the following summarizes the electrical scope of work; refer to Contract Documents for project-specific requirements:
- a) Electrical distribution equipment, including but not limited to switchboards, transformers, motor control centres, motor starters, panelboards, generators, automatic transfer switches, UPSs, inverters, chargers, cables, wire management systems, BAS, raceways, duct banks, receptacles, and plugs shall be provided as per Contract Documents;
 - b) Grounding and bonding system shall be provided as per Contract Documents;
 - c) Lighting, interior and exterior, complete with lighting panels, fixtures, conduit, poles, wiring and controls shall be provided as per Contract Documents;
 - d) Egress and emergency lighting, complete with lighting panels, fixtures, conduit, poles, wiring and controls shall be provided per Contract Documents;
 - e) Receptacles and drop cords, complete with conduits and wiring, shall be provided per Contract Documents;
 - f) Heat tracing system shall be provided per Contract Documents;
 - g) Fire Alarm (FA) System shall be provided as per Contract Documents;
 - h) Public address system, complete with conduit and wiring, shall be provided as per Contract Documents;
 - i) Intercom system, complete with conduit and wiring, shall be provided as per Contract Documents;

- j) Conduit and wiring between the Building Automation System (or SCADA as required) and equipment shall be monitored, including but not limited to pumps, lighting, metering systems, photovoltaics, UPS, generators, gas detection, and other miscellaneous systems shall be provided as per Contract Documents;
- k) Temporary lighting, where required, shall be provided by Contract Documents;
- l) Temporary power, where required, shall be provided by Contract Documents;
- m) Confirm existing site conditions as they apply to electrical systems and adjust work to suit site requirements. Advise Metrolinx of any discrepancies to Contract Documents prior to making any adjustments;
- n) Coordinate work with other Divisions prior to and during construction to avoid interference with equipment and services;
- o) Cut, patch, and make good all holes made due to electrical system installation to match existing condition;
- p) Correct and complete all construction deficiencies before scheduling commissioning;
- q) Complete inspection, start-up, testing and commissioning of installed equipment to manufacturer's recommendations and Contract Documents; and
- r) Services of manufacturer's technical representative for commissioning shall be provided at no additional cost to Metrolinx.

1.2. DESIGN REQUIREMENTS

- a) Design Electrical equipment and systems to all applicable standards of CSA, ULC, IEEE, and ESA;
- b) Design electrical equipment and systems to the latest version of the GO DRM, Metrolinx standard specifications and Metrolinx standard drawings;
- c) Design electrical equipment and systems to standards and codes to the latest editions adopted by and enforced by local Authorities Having Jurisdiction (AHJ);
- d) Equipment installed outdoors in the Greater Toronto Hamilton region shall be designed to withstand the following environmental conditions without damage or degradation of operating characteristics. Where electrical equipment has specific requirements, these are provided in the related Section. Where the AHJ has different requirements from Metrolinx requirements, the most stringent requirement shall apply.
 - 1) Altitude: 0 m to 1000 m (AMSL);

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- 2) Relative humidity: 0 to 95% non-condensing;
 - 3) Ambient Temperature: -40 °C to 40 °C;
 - 4) Full solar exposure;
 - 5) Wind: Peak Recorded Gust: 108 km/h;
 - 6) Rainfall: Normal Annual: 786.9 mm Rainfall, Maximum in 24-hour period: 126 mm; and
 - 7) Snowfall: Normal Annual: 125 cm, Maximum monthly: 100 cm, Maximum daily: 50 cm.
- e) Equipment installed in a controlled environment shall be able to withstand the controlled environmental conditions without damage or degradation of operating characteristics.
 - f) All designs shall minimize EMF effects and do everything needed to reduce EMI on the site. The design shall include the selection and specification of equipment that will reduce or eliminate the EMI effects. Power and communication wiring shall be separated in all cases or by using metal enclosures and separate raceways throughout the system. The only exception is Power-over-Ethernet (PoE) wiring.
 - g) The grounding system shall be designed to Metrolinx grounding requirements, including rail electrification grounding. The grounding system shall accommodate future rail electrification in accordance with Metrolinx standards MX-ELEC TRAC EW-SPEC, MX-ELEC TRAC EW-DW, MX-ELEC STR-SPEC, and MX-ELEC EM. In case of any conflicts, the more stringent requirement shall apply. The grounding design shall also address interconnection of different grounding systems, including lightning, rail electrification, Metrolinx-specific grounding and utility OESA grounding requirements.
 - h) The grounding system shall accommodate at each site grounding inspection wells for ground rods. There shall be at least two grounding test wells per site.
 - i) The electrical utility service and associated utility service transformer shall be sized to accommodate known present and known future loads plus an additional 50% capacity for unknown future loads. The main service panel/board/switchgear and the feeder to the utility service transformer shall also match the utility service capacity. In all cases, equipment ratings shall be selected from industry standard ratings only.
 - j) System protective devices (relays, fuses, breaker trip units, etc.) shall be selected and coordinated to ensure that the interrupter nearest the point of short circuit or high overload will open first and minimize disturbances on the rest of the system.

k) Brownfields sites and systems design shall be accommodated as follows:

- 1) Option 1 - Complete System Replacement
 - i) Where the electrical system is to be completely replaced, the design shall allow for complete removal of all existing equipment. The design shall also allow for the complete removal without incurring damage or loss of function to any remaining equipment.
 - ii) The new equipment shall be installed, tested and commissioned in the same manner as a greenfields installation.
- 2) Option 2 - Partial System Replacement
 - i) Where only a partial section of an existing electrical system is to be replaced, the design shall allow any new section to harmoniously interface with the existing section. The design shall also allow for the partial removal without incurring damage or loss of function to remaining equipment.
 - ii) The new equipment in the system shall be installed, tested and commissioned. Only interfaces between the new equipment and existing equipment in the system shall be tested and commissioned.
- 3) Option 3 - System Extension
 - i) Where an existing electrical system is to be extended, the design shall allow any new section to harmoniously interface with the existing section.
 - ii) The new equipment in the system shall be installed, tested and commissioned. Only interfaces between the new equipment and existing equipment in the system shall be tested and commissioned.
- 4) Existing supervisory systems, such as BAS, SCADA, or CHUBB security, shall interface with new electrical equipment. The design of the new equipment shall allow for a harmonious interface to the existing supervisory system. Where equipment is needed to interface and link the new equipment to the existing supervisory system, this shall be included in the electrical scope of work. All supervisory system interfaces to new equipment shall be installed, tested and commissioned.

1.3. RELATED WORKS

- 1.3.1. Section 26 05 01 - Technical Review Checklists
- 1.3.2. Section 26 05 21 - Electrical Conductors and Cables.
- 1.3.3. Section 26 05 53 - Electrical Identification and Nomenclature
- 1.3.4. Section 26 05 31 - Splitter Boxes, Junction Boxes, Pullboxes and Cabinets.
- 1.3.5. Section 26 05 34 - Raceway for Electrical Systems.
- 1.3.6. Section 26 09 23 - Occupancy Sensors.
- 1.3.7. Section 26 12 13 - Liquid Filled Transformer.
- 1.3.8. Section 26 12 16 - Dry Type Transformer.
- 1.3.9. Section 26 13 26 - Metal-Clad Switchgears.
- 1.3.10. Section 26 23 00 - Low-Voltage Switchgears.
- 1.3.11. Section 26 24 13 - Switchboards and Panelboards.
- 1.3.12. Section 26 24 19 - Motor Control Centres.
- 1.3.13. Section 26 27 26 - Receptacles and Plugs.
- 1.3.14. Section 26 28 00 - Circuit Breakers and Fuses.
- 1.3.15. Section 26 28 23 - Disconnect Switches.
- 1.3.16. Section 26 29 10 - Motor Starters and Contactors.
- 1.3.17. Section 26 32 00 - Backup Power Supply Generator.
- 1.3.18. Section 26 33 33 - Inverter Rectifier and Charger.
- 1.3.19. Section 26 33 53 - Uninterruptible Power Supply.
- 1.3.20. Section 26 36 23 - Transfer Switch.
- 1.3.21. Section 26 37 00 - Outdoor Load Bank.
- 1.3.22. Section 26 50 00 - Lighting and Controls.

1.4. REFERENCE STANDARDS

- 1.4.1. Ontario Electrical Safety Code (OESC).
- 1.4.2. Ontario Building Code (OBC).
- 1.4.3. Metrolinx Standards, Drawings and Specifications.
- 1.4.4. GO Design Requirement Manual (DRM).
- 1.4.5. Interim Standards for the Selection of New Electronic Devices and Cables in Metrolinx Facilities to Mitigate Potential EMI Effects Generated by the RER Electric Traction System MX-ELEC EMI-SPEC.
- 1.4.6. Metrolinx Electrical Safety Document.
- 1.4.7. CSA Z462, Workplace Electrical Safety.
- 1.4.8. CAN3 C235, Preferred Voltage Levels for AC Systems, 0 to 50,000V.
- 1.4.9. CAN3-Z299.4, Quality Assurance Program - Category 4.
- 1.4.10. CSA, Certification Standards and Electrical Bulletins.
- 1.4.11. CFAA, Canadian Fire Alarm Association.
- 1.4.12. CEMA, Canadian Electrical Manufacturers Association.
- 1.4.13. ESA, Electrical Safety Authority and Bulletins.
- 1.4.14. EEMAC, Electrical and Electronic Manufacturers Association of Canada.
- 1.4.15. IESNA, Illumination Engineering Society of North America.
- 1.4.16. IEEE, Institute of Electrical and Electronics Engineers.
- 1.4.17. NEMA, National Electronic Manufacturers Association.
- 1.4.18. OPS, Ontario Provincial Standards.
- 1.4.19. ULC, Underwriters Laboratories of Canada.
- 1.4.20. SSPC, Surface Preparation Standards.

1.5. SPARE PARTS

- 1.5.1. See Contract Documents and related Sections.

1.6. TRAINING

- 1.6.1. See Contract Documents and related Sections.

1.7. WARRANTY

- 1.7.1. A manufacturer warranty shall be provided for all electrical products with a minimum warranty period of two years, if not defined by other specifications for a longer period.

1.8. DELIVERY, STORAGE AND HANDLING

- 1.8.1. Not applicable

1.9. SUBMITTALS

- 1.9.1. Product Data and Shop Drawings Package

a) Submit manufacturer's Product Data indicating:

- 1) Performance criteria, compliance with appropriate reference standard, characteristics, limitations and troubleshooting protocol;
- 2) Product transportation, storage, handling and installation requirements;
- 3) Technical data, Product data, supplemented by bulletins, component illustrations, detailed views, technical descriptions of items and parts lists; and
- 4) Product identification in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 53.

b) Submit Shop Drawings indicating:

- 1) Materials or equipment being supplied. Include thicknesses and finishes;
- 2) Details of construction, accurate dimensions. Include mounting and installation details;
- 3) Capacity, operating characteristics and performance;
- 4) Identifying number of specific equipment in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 53;
- 5) Non-catalogue items, prepared specifically for this project;
- 6) Supplementary data, with database explaining theory of operation;
- 7) Total weight;

- 8) Shipping sections;
- 9) Bill of Materials;
- 10) Connections, calculations, test results and loads;
- 11) Termination and interconnection lists;
- 12) Equipment nameplate schedule;
- 13) Nameplate drawings;
- 14) Interconnection lists, schematic diagrams with cross-referenced component lists and sequence of operations;
- 15) Equipment and components performance curves;
- 16) Names and addresses of local suppliers and service representatives; and
- 17) Identification table complete with details of conduit size, wire or cable size, junction boxes, pull boxes and feeder panels/breaker identification. Complete as part of Shop Drawing submission.

1.9.2. Protection Coordination

- a) Submit the following:
 - 1) Complete schedule of all main protective relays, fuses and other protective devices listing device locations, function number, manufacturer, model number, size, range and setting; and
 - 2) Protection Coordination and Load Flow study:
 - i) Study to include time current curves of protective devices in the system with corresponding short level levels, damage curves and single line diagram. All main protective devices, transformers, all large motors and main feeder cables shown be included on time current curves;
 - ii) Study to illustrate prospective fault currents and shall verify equipment short circuit withstand ratings specified for electrical equipment provided under the Contract;
 - iii) Study to illustrate protective device settings and ensure that the settings and sizes of all protective devices for each voltage level has been chosen to ensure maximum or optimum protection and coordination during electrical fault or overload conditions;

- iv) Study to illustrate arc flash hazard classification analysis with calculations for electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centres. Equipment shall be labelled with potential electric shock and arc flash hazards classification per CSA Z462. Labels shall be located so that it is clearly visible to persons before examination, adjustment or maintenance of equipment; and
- v) Study shall include all the assumptions and all the data.

1.9.3. Single Line and Riser Diagrams

- a) Submit and mount a single line diagram (863 mm x 562 mm), printed on non-fading and non-acid paper and mounted in non-combustible frame, protected by tempered glass fitted on wall in each electrical room or substation. Reviewed single line diagram shall include complete facility distribution system, starting with incoming service of Local Utility Authority and proceeding through all the downstream distribution system. Diagram shall be complete with symbols, legends, overcurrent-protective devices, revenue metering, Metrolinx metering, interlocking and transfer schemes;
- b) Submit riser diagrams for, but not limited to, the following systems: BAS system, PA system, Intercom system, CCTV, network, per Contract documents and requirements. Reviewed riser diagram shall be placed in pouch inside cabinet panel door; and
- c) Submit fire alarm riser and shut down diagram within central alarm and control facility cabinet, including plan and zoning diagram of building, mounted in metal pouch in fire alarm cabinet.

1.9.4. Quality Assurance Package

- a) Submit construction inspection and acceptance sign-off checklists during construction as the work is completed. The checklists shall be complete with signatures and dates from the contractor and the owner's on-site representative. These checklists shall be completed and reviewed by the commissioning team at the time of commissioning. Contractor shall utilize Metrolinx standard checklists to create the Contract-specific checklists; and
- b) Submit test report for each test performed. Tests shall be signed by testing engineer and witnessed by Metrolinx or its representatives. Report shall include: records of tests performed, methods of calculation, date and time of test, ambient conditions, names of testing company, test engineer and witnesses if required.

1.9.5. Commissioning Package

- a) Submit the following:
 - 1) Commissioning plan and procedures (submit prior to scheduling commissioning);
 - 2) Deficiency Report;
 - 3) Commissioning Closeout Report; and
 - 4) Certificate of Readiness. Certifying electrical installation ready and fit for service.
- b) Submit the following for incorporation into Operation and Maintenance Manuals:
 - 1) Complete set of reviewed Shop Drawings of equipment;
 - 2) Complete bills of materials and spare parts showing manufacturer's names, addresses, local replacement sources and telephone numbers;
 - 3) Stock list of recommended spare parts and quantity of each item;
 - 4) Manufacturer's warranties;
 - 5) Manufacturer's certified reports;
 - 6) Installation instructions;
 - 7) Appropriate servicing, troubleshooting, and preventative maintenance schedule and instructions for equipment and systems. Equipment and components performance curves;
 - 8) Field testing and commissioning reports;
 - 9) Factory test reports;
 - 10) Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of portion or feature of installation; and
 - 11) Final ESA and/or local Hydro Certificates.

1.9.6. Regulatory Requirements Package

- a) Submit Shop Drawings to AHJ and obtain approval that equipment or complete system meets their requirements before submission of drawings to Metrolinx.
- b) Complete ESA inspection and approval of new installation.

1.9.7. As-Built and Record Drawings

- a) Submit As-Built or Record Drawings indicating:
 - 1) Accurately maintained, dimensioned record of cable, conduit, bus duct and equipment locations in tunnels, shafts, mechanical rooms, electrical rooms, switchgear rooms, ceiling spaces and other critical locations to avoid conflict with other trades. Show deviations and changes in Work from Contract Drawings;
 - 2) Actual locations of conduits and ducts, piping, maintenance holes and related items located below or outside of structure;
 - 3) Dimensions with respect to structural column lines or walls and elevations with respect to finished floor levels or grades, referenced to centre line of conduit, duct, or raceway for the following: conduits, ducts or raceways underground, underfloor, or in inaccessible locations; and
 - 4) On each drawing in lower right-hand corner, in letters minimum 13 mm high, as follows: AS-BUILT (or Record Drawing): THIS DRAWING HAS BEEN REVISED TO SHOW ELECTRICAL SYSTEMS AS INSTALLED, followed by signature of Contractor and date.

1.10. QUALITY ASSURANCE

- 1.10.1. All Quality Assurance submittals listed in this specification shall be provided.
- 1.10.2. All electrical work shall be carried out by licensed electricians with experience and training in the equipment and systems (certified or manufacturer-approved) being installed in Ontario.
- 1.10.3. All electrical work shall be inspected and approved by Metrolinx or its representative for acceptance. Interim and final inspections shall be performed with Metrolinx or its representative present.

1.11. REGULATORY REQUIREMENTS

- 1.11.1. Obtain and pay for permits required by the AHJ and arrange and pay for inspection and testing.
- 1.11.2. Comply with Authorities Having Jurisdiction (AHJ). Include for changes or alterations required by AHJ. Where a conflict is observed in the Contract Documents and AHJ requirements, the more stringent requirement shall apply.
- 1.11.3. Submit required documentation and drawings to AHJ to obtain approval for the Work. Submit any additional information, details and related items that AHJ requests.
- 1.11.4. Supply and install warning signs, labels, nameplates and glass-covered diagrams as required by AHJ.

- 1.11.5. Where materials require special inspection and approval of CSA or AHJ, obtain such approval for that installation. If CSA-certified equipment unavailable, obtain special approval for equipment from CSA and/or ESA.
- 1.11.6. Carry out all changes and alterations required by the authorized inspector of any AHJ without delay to the progress of the work and without extra cost.

2. PRODUCTS

2.1. GENERAL

- 2.1.1. Equipment and materials shall be in accordance with requirements of related Sections and the Contract Documents.
- 2.1.2. Provide equipment suitable for its intended use for the environmental conditions experienced in the location without damage or degradation of operating characteristics.
- 2.1.3. Provide equipment for electrically noisy environments (EMI) that shall be able to withstand the EMI conditions without damage or degradation of operating characteristics.
- 2.1.4. Equipment shall be CSA certified as a system. Where CSA-certified equipment is unavailable, obtain special approval for equipment from CSA, ESA, or its designated representative. Where CSA-certified individual components are used/assembled to provide a complete system on site, obtain special approval for the complete system/assembly from CSA, ESA, or its designated representative.
- 2.1.5. Equipment shall be factory-made where possible and not cost-prohibitive. Site fabrication shall be minimized.
- 2.1.6. All manholes, handwells or handholes shall be drained and not store water.
- 2.1.7. All manholes, handwells, or handholes shall have secured covers (bolted) and shall have the collars grounded.
- 2.1.8. All manhole, handwell or handhole covers shall be heavy-duty, capable of having vehicles driving over them.
- 2.1.9. Operating voltages: shall follow the latest edition of CAN3-C235.
- 2.1.10. Motors, electrical heating, control and distribution devices and equipment shall operate satisfactorily at 60 Hz within normal operating limits established by above standard.
- 2.1.11. Maximum voltage in public access areas shall be 240 VAC.
- 2.1.12. Maximum voltage in communication rooms or mini hub rooms shall be 208 VAC.
- 2.1.13. All equipment shall be provided by reputable manufacturers of the specified equipment. The reputable manufacturers shall have a minimum of ten (10) years of experience manufacturing the products specified, and the Contractor shall provide documents from the manufacturers demonstrating this experience during the shop drawing review stage.

2.1.14. Equipment Enclosures:

- a) Sprinkler-proof enclosures shall be provided for equipment enclosures in all areas;
- b) Equipment enclosures for indoor, dry, conditioned, HVAC-controlled spaces shall be EEMAC sprinkler-proof Type 2 or Type 12 as applicable, except as noted in other Division 26, 27 and 28 Specification Sections;
- c) Enclosures for all exterior areas and indoor areas that are damp, wet and unconditioned, non-HVAC controlled areas, including shall be EEMAC Type 4X;
- d) Enclosures for equipment in elevator and escalator hoistways and pits shall be EEMAC Type 4X; and
- e) Where installed in public areas, all enclosures, cover-plates, outlets, plates, access panels, and handwells shall be provided with method of securing doors and covers. All enclosures and panels shall have a common key and in an enclosed, protected area, where possible.

2.1.15. All floor-mounted equipment shall be mounted on 100mm high concrete housekeeping pads.

2.1.16. Fire Barriers

- a) Fire barriers of multi-transit type shall be provided at firewalls and fire separations, and shall be in accordance with the OBC and CAN4-S115-M.

2.1.17. Handholes and Manholes

- 1) Canadian Standards Association (CSA):
 - i) CAN/CSA-A5, Portland Cement;
 - ii) CSA-A23.1, Concrete Materials and Methods of Concrete Construction;
 - iii) CSA G30.3, Cold-Drawn Steel Wire for Concrete Reinforcement;
 - iv) CSA G30.5, Welded Steel Wire Fabric for Concrete Reinforcement; and
 - v) CSA G30.18, Billet-Steel Bars for Concrete Reinforcement.
- 2) American Society for Testing and Materials (ASTM):
 - i) ASTM D1056, Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.

- b) Precast concrete handholes and manholes and auxiliary sections shall be fabricated in steel forms;
- c) Aggregates: to CSA-A23.1;
- d) Cement: to CAN/CSA-A5, Type-30;
- e) Steel welded wire fabric mesh reinforcing: to CSA G30.3;
- f) Pulling inserts and bolts for racks integrally cast in concrete;
- g) Neoprene gasket seals between maintenance chamber sections: to ASTM D1056;
- h) Precast concrete handholes and manholes shall come complete with a well in the bottom of the maintenance chamber with a breakout section in the bottom to allow for natural drainage;
- i) Refer to Contract Drawings for size, selection and locations of handwells and manholes;
- j) Precast concrete maintenance chambers shall come complete with concrete knockout duct sections in each wall of the duct bank. Provide a minimum quantity of knockouts at the factory in accordance with the Contract Drawings. Provide additional knockouts as required to suit the quantity of ducts shown on the Contract Drawings. Rebar shall only encircle all the duct knockouts, and no rebar shall be run in the duct knockout openings;
- k) The minimum opening in the top of the handhole shall be no smaller than 460 mm;
- l) The lip of the handhole and manholes shall be identified as to the type of service within by means of grooves cut into the collar of the handhole or manhole;
- m) These markings on the collar shall be 2 grooves; 3 mm deep for communications in the direction of conduit in and out and 1 groove; 3 mm deep in the direction of conduit in and out for electrical; and
- n) Provide ground rod at each handwell for grounding of handwells. Provide grounding jumper wire connection or braid with slack to maintain connection to ground while handwell cover is removed.

3. EXECUTION

3.1. GENERAL

- 3.1.1. Perform electrical work to Ontario Building Code, Ontario Electrical Safety Code and to Canadian Standards Association.
- 3.1.2. Provide regulatory requirements as provided in Paragraph 1.11 of this specification.
- 3.1.3. Do not manufacture or install electrical equipment or systems until Shop Drawing review and acceptance by Metrolinx or its representative and the AHJ.

3.2. ELECTRICAL SAFETY

- 3.2.1. Protect personnel during construction from physical danger from exposed energized equipment such as panelboard mains and outlet wiring. Shield and mark live parts "LIVE - XXX VOLTS" (label voltage as required, 600 V, 208 V, 120 V, etc.).
- 3.2.2. Protect personnel during construction from physical danger from arc-flash hazards by assessment of hazards and provision of arc-flash labels.
- 3.2.3. Arrange for installation of temporary doors, barriers and signage for rooms containing electrical equipment. Keep doors locked except when under direct supervision.
- 3.2.4. Minimum 1.5-hour fire-rated temporary doors and barriers shall be provided for rooms containing electrical equipment.

3.3. INSTALLATION

- 3.3.1. Protect, support and maintain existing active services as required for execution of Work without disturbing these services.
- 3.3.2. Do not disrupt existing lighting, power or communications systems unless approved by Metrolinx or its representative.
- 3.3.3. Notify and obtain written permission from Metrolinx before working on or accessing any existing panel or electrical equipment.
- 3.3.4. Install electrical equipment in locations shown on Contract Drawings. Where conflicts or site conditions require deviation from work as specified or indicated in the Contract Documents, notify Metrolinx and provide required documentation for acceptance before proceeding. Commencement of Work means acceptance of existing conditions.
- 3.3.5. Quantities or lengths indicated in Contract Documents are approximate and do not gauge or limit Work. No adjustment to Contract Price allowed to complete Work.
- 3.3.6. Verify equipment access and coordinate with equipment supplier to ensure equipment can physically transport to installation location.

- 3.3.7. Metrolinx reserves the right to relocate electrical items during construction, but prior to installation, without cost, if the relocation per item does not exceed 3 m from the original location. No credits shall be anticipated where relocation, per item, of up to and including 3 m reduces materials, products, and labour.
- 3.3.8. Metrolinx reserves the right for reconstruction of electrical items without cost, due to lack of timely submissions or approvals before commencing work. Remove, relocate or replace work to the acceptance of Metrolinx.
- 3.3.9. No change to Contract price is allowed for relocation of equipment incorrectly installed because of failure to check and coordinate details, Contract Drawings and interferences, prior to installation.
- 3.3.10. If temporary connections are required to maintain services during construction period, supply and install necessary material, equipment and labour to electrical safety codes and standards.
- 3.3.11. Notify other trades concerned of openings, anchors, hangers or other provisions necessary for installation of electrical Work for installation in structure, walls, floors and similar locations or may affect other Work. Coordinate electrical installation with other trades. Install electrical items in a timely manner to avoid cutting or patching of Work.
- 3.3.12. Protect electrical equipment from elements and damage by other construction activities in area. Install protective materials around and over services as required. Be present during excavation and backfilling to supervise installation.
- 3.3.13. Protect finished and unfinished work of other trades until completed work has been accepted.
- 3.3.14. Identify embedded, concealed, or recessed equipment before construction. Before penetrating any surface, scan proposed work areas using Ground Penetrating Radar (GPR), pipe and cable locators, X-ray, or similar approved technology as necessary to find reinforcements, electrical cables and conduit, pipe, utilities, and other items that may be concealed.
- 3.3.15. Perform testing of packages of work and promptly make any changes necessary.
- 3.3.16. After completion of a package of work, notify Metrolinx to perform a final inspection for acceptance purposes. Any deficiencies identified by Metrolinx or its representative shall be rectified, and the inspection repeated for those deficiencies.
- 3.3.17. Obtain Metrolinx written approval prior to any final connections to existing operational electrical panels and equipment. Metrolinx will present and agree to any connection to existing electrical panels and equipment.
- 3.3.18. Place packages of work into service at such time, and in such order, as Metrolinx may direct.

- 3.3.19. Unless otherwise specified, Contract Documents intended to cover ancillary items necessary for work. Supply and install all ancillary omitted items essential for complete and operational installation.
- 3.3.20. Unless otherwise specified, Contract Documents intended to result in completely operational electrical systems and equipment. Supply, install, connect, configure and test to achieve a complete and operational installation.
- 3.3.21. Space noted on the Contract Documents as reserved for future equipment supplied by other trades or by Metrolinx shall be left clean. At no point shall the spare space be utilized or blocked in any manner.
- 3.3.22. Floor-mounted electrical equipment shall be mounted on 100 mm high concrete housekeeping pads in service rooms. There shall be a minimum of 50 mm of pad beyond the edge of the equipment.
- 3.3.23. In electrical rooms, no equipment shall be mounted directly to the walls. The panels and equipment shall be mounted on U-channel standoffs or on fire-rated plywood, complete with two coats of fire-retardant paint.
- 3.3.24. Identify all equipment provided under the Contract in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 53. For an existing facility, there shall be no duplication of identification, including but not limited to electrical rooms, communication rooms, switchgear, switchboards, panelboards, distribution boards, receptacles, lights, etc.
- 3.3.25. If the existing identification is modified (i.e., room name is changed, panel name is changed, etc.), all existing equipment impacted by the change shall be provided with new identification in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 53.
- 3.3.26. Install wiring and connections to equipment supplied by other trades, such as wiring and interlocks of equipment and control devices specified in other Divisions.
- 3.3.27. Flexible conduits to connect devices may be mounted on removable panels, provided the conduit length permits panel removal without dislodging connected device.
- 3.3.28. Circuit designations on existing panelboards may not agree with field installation. In such cases, trace and verify such circuits, and update the circuit designations.

3.4. EXISTING EQUIPMENT

- 3.4.1. Electrical equipment requiring temporary or permanent relocation or power due to construction shall be made as required. Coordinate any relocation with Metrolinx.
- 3.4.2. All new and existing electrical equipment shall be connected to or disconnected from existing distribution system (e.g., switchgear, switchboards, panelboards, control panels, etc.) after approval by Metrolinx.

3.4.3. Include and provide additional items and accessories or connections obviously required to provide complete working system for relocated equipment but omitted from Specifications or not shown on Contract Drawings.

3.4.4. Assume all existing conduits in Work area contain live circuits.

3.4.5. Trace conduits and circuits feeding existing equipment in Work area obstructing and interfering with Contract Work. Maintain circuits live, and if required, in use.

3.5. FACTORY FABRICATION

3.5.1. Factory assemble all equipment except for shipping splits.

3.5.2. Factory fabricate steel components such as supports, plates and hardware. Any hot-dip galvanizing shall also be performed in the factory,

3.5.3. Field welding of fabricated components is not permitted; bolting or clamping shall be used instead. Touch-up any cut sections with cold galvanizing zinc coating on site.

3.6. NEUTRAL CONDUCTOR AND PHASING

3.6.1. Install individually grounded neutral conductors for one-pole, two-pole or three-pole branch breakers of balanced, 3-phase 4-wire circuits unless noted otherwise.

3.6.2. For each single-phase 347 V or 120 V circuit powering an end device, the circuit shall have its own neutral conductor. Sharing or common neutral installations are not allowed in end devices using polyphase circuits. For example, a light pole with 3 light fittings on 3 circuits shall have 3 neutral conductors between the light fittings and the associated feeder panel.

3.6.3. Current carrying capacity of neutral conductors shall be equal to or greater than the phase conductor to suit load conditions.

3.6.4. Balance single-phase loads to minimize unbalance of three-phase supply.

3.7. NOISE AND VIBRATION

3.7.1. If equipment operates with excessive noise or vibration due to incorrect installation or support, eliminate noise or vibration to acceptance by Metrolinx.

3.7.2. Make connections to noise-producing and vibrating equipment with flexible conduit.

3.7.3. Install vibration isolators where indicated. Isolate transformers from structure with spring or rubber isolators when suspended and appropriate sandwich pads when floor-mounted. Isolate diesel generator sets from structure with vibration isolators.

3.8. LOCATION OF OUTLETS

- 3.8.1. Location of outlets is subject to change at Metrolinx request, if information is given prior to installation.
- 3.8.2. Relocate outlets up to 3000 mm from original location at no extra cost or credit.
- 3.8.3. Relocations over 3000 mm reviewed and negotiated on individual basis.
- 3.8.4. Make relocations required as result of insufficient coordination, at no cost to Metrolinx. Relocations subject to acceptance by Metrolinx.

3.9. MOUNTING HEIGHTS

- 3.9.1. Mounting heights of equipment shall be measured from finished floor to vertical centerline of equipment unless specified or indicated otherwise.
- 3.9.2. If mounting height of equipment not indicated, verify with Metrolinx before proceeding with installation.
- 3.9.3. Install electrical equipment at following heights above finished floors, unless indicated otherwise:
 - a) Local switches: 1,200 mm;
 - b) Wall receptacles: Vertical orientation, generally 400 mm; 1,000 mm in Electrical, UPS, LAN, MCC and Mechanical rooms; 850 mm in office areas;
 - c) Telephone outlets: 850 mm;
 - d) Data outlets: 850 mm;
 - e) Fire alarm stations and handsets: 1,050 to 1150 mm;
 - f) Intercom stations: 1,500 mm;
 - g) Wall-mounted speakers: 300 mm to top below finished ceiling; and
 - h) Locate receptacles above kitchen counter backsplash to underside of kitchen cabinet. Verify site condition before installation.

3.10. CONDUIT AND CABLE INSTALLATION

- 3.10.1. Assume existing conduits in Work area contain live circuits. Coordinate any Work on existing equipment with Metrolinx.
- 3.10.2. Relocate temporary or permanent electrical equipment and conduits as required.
- 3.10.3. Install 50 mm high raised concrete curb at floor openings for bus ducts through floor slabs.

3.11. LOAD BALANCING

- 3.11.1. Measure phase current to panelboards with normal loads operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record current readings. Submit recorded data to Metrolinx for review.
- 3.11.2. Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment. Measure phase voltages to reflect utility voltage fluctuations and set accordingly.

3.12. CARE, OPERATION AND START UP

- 3.12.1. Instruct Metrolinx's staff in operation, care and maintenance of installation at times arranged by Metrolinx and detailed in other Sections at no extra cost to Metrolinx.
- 3.12.2. Services of Contractor's staff shall be provided to supervise startup of installation, check, adjust, balance and calibrate components at no extra cost to Metrolinx.
- 3.12.3. These services shall be provided for such period and for as many visits as necessary to put installation in working order and to ensure Metrolinx's staff conversant with all aspects of its care and operation at no extra cost to Metrolinx.

3.13. FINISH

- 3.13.1. Painting Procedure
 - a) Prepare and clean surfaces of electrical equipment requiring painting to SSPC SP3 for rust and SSPC SP1 for oil, grease, dirt, and other contaminants;
 - b) Apply one coat of primer;
 - c) Apply two coats of finish paint. Colour of manufacturer's standard ANSI 61 grey except as specified otherwise. Paint all electrical equipment to EEMAC standard; and
 - d) Apply paint in accordance with manufacturer's instructions regarding application methods, coating thicknesses, equipment, temperature and humidity conditions.
- 3.13.2. Surfaces scratched or marred during shipment and installation shall be cleaned and touched up to match original paint finish.
- 3.13.3. Exposed hangers, racks and fasteners shall be cleaned, primed and painted to prevent rust.
- 3.13.4. Provide touch-up paint.

3.14. FIELD QUALITY CONTROL AND COMMISSIONING

3.14.1. General

- a) Field quality control and commissioning shall be performed in accordance with related Sections. Field quality-control test reports shall be submitted to Metrolinx;
- b) Commissioning shall verify electrical and mechanical operation is in accordance with Standards and recommendations of manufacturers;
- c) A 3rd party commissioning agent shall be engaged to perform commissioning work and provide all required commissioning submittals;
- d) Factory authorized and trained personnel shall be provided to perform commissioning and start-up testing, including checkout, adjustments, balancing and calibration of components and systems, as required;
- e) These services shall be provided as required to ensure installation is in proper working order and to ensure the Metrolinx's staff conversant with all aspects of its care and operation at no extra cost to Metrolinx;
- f) Inspections by jurisdictional authorities shall include all appropriate local and provincial authorities, including but not limited to:
 - 1) Building Inspection Department;
 - 2) Local Utility Companies (Local Utility Authority);
 - 3) Fire Services Inspection Department
 - 4) Ministry of Labour; and
 - 5) Electrical Safety Authority.

3.14.2. Tests

- a) Field testing shall be performed on all systems included in the Contract, including but not limited to:
 - 1) Water supply pumps and controls;
 - 2) Sanitary waste pumps and controls;
 - 3) High Voltage and or Low Voltage electrical distribution and control system;
 - 4) Storm Drainage System;

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- 5) Heating, Ventilating, and Air Conditioning Systems (HVAC);
 - 6) Fire Protection and Alarm Systems;
 - 7) Miscellaneous Mechanical Systems;
 - 8) Emergency Lighting;
 - 9) UPS System;
 - 10) ATS and Generators;
 - 11) BAS System; and
 - 12) Communications systems (PA, data, intercom system, and CCTV).
- b) Test wiring systems with switchboards, panelboards, fuseholders, switches and overcurrent devices in place and connected, as follows:
- 1) Dielectric Test on equipment and wiring:
 - i) For 120/208V equipment and cables, apply 500 VAC, 60 Hz for three minutes between phase conductors and between each phase conductor and ground; and
 - ii) Ensure test voltages for 600 V equipment and cables are as recommended by manufacturers of equipment and cables.
 - 2) Insulation Resistance Test:
 - i) After completion of Dielectric test, measure insulation resistance by means of approved resistance measuring instrument; and
 - ii) Minimum value of insulation resistance between connected system and ground: Minimum values prescribed under Insulation Resistance in Ontario Electrical Safety Code, ESA or manufacturer's recommendations.
 - 3) Remove and replace shorted, grounded and defective conductors.
- c) Test lighting system as follows:
- 1) Illumination: Test lighting illumination levels meet design requirements; and
 - 2) Control and Switching: Test circuits for correct operation of devices, switches and controls.
- d) Polarity Test: Test sockets for correct polarity;

- e) Voltage Drop Test: Perform voltage test at last outlet in each circuit, one on each circuit, with circuit loaded to its maximum capacity. If excessive drop in potential, locate cause and correct condition. Replace defective parts, materials, conductors, insulation or splices;
- f) Phase Balance: Measure load on each phase at each distribution panelboard and at main switchboard. Report results to Metrolinx. Make necessary rearrangement of phase connections to balance load on each phase. Make rearrangement as instructed by Metrolinx and restrict to exchanging connections at panelboards or at main switchboard. After making changes, submit to Metrolinx drawings or marked prints showing modified connections;
- g) Supply Voltage: Measure and report to Metrolinx line voltage of each phase at load terminals of main breakers. Make test with majority of electrical equipment in use;
- h) Motor Rotation: Check and report to Metrolinx that the phase rotation for each motor is correct. If rotation is incorrect, make required adjustments and recheck;
- i) Motor Loadings: Measure and report to Metrolinx line currents of each phase of each motor under load. Upon indication of imbalance or overload, thoroughly examine electrical connections and rectify any defective parts or wiring. If electrical connections correct, report overloads and phase unbalances to Metrolinx;
- j) General Operation: Energize and put into operation each electrical circuit and item. Make necessary repairs, alterations, replacements, tests and adjustments required for complete and operating electrical system;
- k) Make tests in presence of Metrolinx. Perform General-Operation testing at time of acceptance of Work; and
- l) All testing shall be conducted in accordance with the latest edition of ANSI/NETA ATS - Standard for Acceptance Testing for Electrical Power Equipment and Systems.

3.14.3. Cleaning

- a) Perform final cleaning in accordance with Contract documents;
- b) Where equipment shows corrosion, or damage to finish of panels, panelboards, fixtures or devices, touch-up surfaces to the acceptance of Metrolinx;
- c) Polish plated work and glass. Replace burned-out lamps; and
- d) Repair, adjust and lubricate mechanisms and leave in operating condition.

3.14.4. Training

- a) Provide training, video instructions if appropriate and documentation in accordance with the Contract documents and as indicated within related Sections.

3.14.5. Maintenance

- a) Maintain all equipment and systems installed until Substantial Performance, in accordance with the Contract documents.

END OF SECTION