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END OF SECTION

26 01 00.00 Operating and Maintenance Instructions

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 03.00 – RECORD DRAWINGS.

1.1.3. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.4. Section 26 08 00.00 – COMMISSIONING.

2. Products

2.1. NOT USED

3. Execution

3.1. REQUIREMENTS FOR MANUALS

3.1.1. A minimum of three copies of complete and approved operating and maintenance instructions for all electrical equipment and systems shall be supplied before substantial completion. Provide additional copies if required under the General Requirements. In addition to the three copies of manuals, the contractor to provide a manual in a searchable PDF format on CD or DVD or sent via electronic transfer. As-Built Drawings to be included on the CD or DVD or sent via electronic transfer.

3.1.2. The contractor to identify the cost of Record Drawings and the Operation and Maintenance Manuals as a separate line item on their progress draw. The values to be broken out can be found in Section 26 05 03.00 – Record Drawings. The project will remain incomplete and no money will be released until the final versions, both hard and electronic, of the drawings and manuals are received and reviewed without comments.

3.1.3. Binders shall be three-ring, hard-cover, loose-leaf type and identified on the binding edges as "Maintenance Instructions and Data Book", for "NEW SAYERS FOOD STORE".

3.1.4. Terminology used in all the sections shall be consistent.

3.1.5. Volume One shall contain the master index of all systems, the name of the Contractor, Electrical Subcontractors and the date of substantial performance for the Contract.

3.1.6. Volume One shall contain a section with all necessary warranty information.

3.1.7. Each binder shall have a complete index for all volumes.

3.1.8. Each binder shall be no more than half filled.

3.1.9. There shall be a separate section for all materials used on the project which fall under the WHMIS legislation. There shall be Material Safety Data Sheet (MSDS), hazard data sheet, for each of the materials.

3.1.10. There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.

3.1.11. All relevant information relating to a system or product shall be contained within one binder.

3.1.12. The manual sections shall follow the specification sections.

3.1.13. Any diagrams, installation drawings, single line diagrams charts, etc. shall be mechanically reduced while maintaining full legibility to standard page size. If this cannot be achieved they shall be carefully folded and contained within a clear plastic wallet within the manual.

3.2. DATA FOR MANUALS

3.2.1. Equipment data shall contain:

- .1 Operating instructions.
- .2 Operating conditions such as temperature and pressure.
- .3 Location of equipment.
- .4 Maintenance instructions and schedules for one year routine.
- .5 Recommended list of spare parts.
- .6 Maintenance schedule.
- .7 A trouble shooting table showing where to look for problems under various conditions of malfunction.
- .8 All wiring diagrams.
- .9 Equipment operating curves.
- .10 Equipment nameplate data and serial numbers.

3.2.2. System data shall contain:

- .1 A listing of all systems.
- .2 All panel, mcc and fire alarm schedules and locations.
- .3 Equipment name tags.
- .4 Cleaning, maintaining and preserving instructions for all material, products and surfaces. Include warnings of harmful cleaning, maintaining and preserving practices.

3.2.3. Sub-Contractor manuals are required for:

- .1 Switchboards and power distribution systems.
- .2 Lighting systems.
- .3 Emergency power systems.
- .4 Fire alarm systems.

3.2.4. As-Built documentation shall contain:

- .1 Reviewed As-Built Shop Drawings.
- .2 As-Built Construction Drawings.
- .3 Originals of test forms.
- .4 Originals of test certificates.

3.3. OPERATING INSTRUCTIONS

3.3.1. Instruct the Owner's representative in all aspects of the operation and maintenance of systems and equipment.

3.3.2. Where commissioning is a requirement of the project, the Contractor shall comply with all requirements of Section 26 08 00.00 – COMMISSIONING, for duration of tests.

3.3.3. Instruct the Owner for a minimum of five (5) working days.

3.3.4. All instruction sessions to be video-taped and copy must be provided to the Engineer's Representative/owner.

- 3.3.5. Arrange for and pay for the services of engineers and other manufacturers' representatives required for instruction on the systems and the equipment as requested by the Engineer's Representative and/or the Owner.
- 3.3.6. At the time of final review, provide a sheet for each system and piece of equipment showing the date instructions were given. Each sheet shall show the duration of instruction, name of persons receiving instruction, other persons present (manufacturer's representative, Engineer's Representative, etc.), system or equipment involved and signature of the Owner's staff stating that they understood the system installation, operating and maintenance requirements. This information shall be inserted in the manuals after all instructions have been completed.
- 3.3.7. Review information with the Owner's representative to ensure that all information required has been provided.
- 3.3.8. Electrical equipment and systems included in the instruction requirements, include but not limited to the following:
- .1 Switchboards and related power distribution equipment.
 - .2 Emergency generator.
 - .3 Automatic transfer switches.
 - .4 Fire alarm systems.
- 3.4. TRIAL USAGE
- 3.4.1. The Owner shall be permitted trial usage of systems or parts of systems for the purpose of testing and learning operational procedures. Trial usage shall not affect the warranties nor be construed as acceptance, and no claim for damage shall be made against the Owner for any damage or breakage to any part or parts due to the tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or workmanship of any kind.

END OF SECTION

26 05 01.00 General Instructions for Electrical Sections

1. General

1.1. WORK INCLUDED

1.1.1. Conform to the requirements of Division 1, which applies to and forms part of all sections of the work.

1.2. DESCRIPTION OF SECTION

1.2.1. The specification is divided into sections of work and a section may consist of the work of more than one subcontractor. The responsibility as to which electrical subcontractor provides labour, materials, equipment and services required to complete the work rests solely with the Electrical Contractor.

1.3. SECTIONS AFFECTED

1.3.1. These instructions apply to and form a part of all electrical sections.

1.4. SCOPE

1.4.1. Provide all labour, materials, equipment and services to complete the work of the electrical division as further specified and as shown on the drawings.

1.4.2. Should any discrepancy appear between any parts of the specifications and/or the drawings to cause doubt as to the true meaning and intent of the drawings and specifications, a ruling shall be obtained from the Engineer's Representative before submitting the tender. If this is not done the following will be assumed:

- .1 Where a discrepancy occurs between the specification and the drawings, the more expensive/onerous alternative will be deemed as included in the contract.
- .2 Where a discrepancy occurs in the drawings the more expensive/onerous alternative will be deemed as included in the contract.
- .3 Where a discrepancy occurs in the specifications the more expensive/onerous alternative will be deemed as included in the contract.

1.4.3. For any equipment/device where circuit numbers and/or panel designation labels are missing and not indicated on the drawings or specifications, a clarification shall be obtained from the Engineer's Representative before submitting the tender. If this is not done the Contractor shall power the equipment/device from the respective 120V/208V or 600V electrical panel serving the equipment in that area at no additional cost to the Owner.

1.5. REGULATIONS

1.5.1. All work shall be performed in accordance with the latest codes, rules, regulations, by-laws and requirements of all authorities having jurisdiction except where the requirements of the drawings and specifications exceed the codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.

1.5.2. These specifications are supplementary to the requirements above.

1.5.3. Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the contractor shall notify the Engineer's Representative.

1.6. PERMITS, FEES, AND REVIEWS

- 1.6.1. Make submissions to obtain all permits. Include for and pay for all fees and arrange for all reviews required for the work of this division.
- 1.6.2. If required by code, plans and specifications have been previously submitted to the Authority Having Jurisdiction.
- 1.6.3. Furnish certificates of Acceptance from the Authority Having Jurisdiction and include them in the Operation and Maintenance manual.

1.7. VOLTAGE RATINGS

- 1.7.1. Operating voltages are as specified in CAN3-C235-(latest edition).
- 1.7.2. Motors, electric heating, control and distribution devices and equipment are to operate satisfactorily at 60 Hz within operating limits established by the above standard.

1.8. COORDINATION WITH MECHANICAL DIVISIONS.

- 1.8.1. Unless indicated otherwise on the Electrical Drawings, Electrical Contractor will be responsible for the supply and installation of the following:
 - .1 Starters.
 - .2 Line and load side wiring for starters.
 - .3 Reduced voltage starters including "Soft Start" starters.
 - .4 Line and load side wiring to variable speed drives, including but not limited to wiring of associated harmonic filters, AC line input reactors, dV/dT filters, and output filters.
 - .5 Provisions of disconnects to all mechanical equipment.
 - .6 All power wiring (120V & above) to all mechanical equipment.
 - .7 Electrical ramp heating cables and controls.
 - .8 All motorized damper power connections (120V & above).
 - .9 Fire alarm devices.
 - .10 Wiring to electric space heaters.
- 1.8.2. Mechanical Divisions will be responsible for the supply and installation of the following:
 - .1 All variable speed drives and control wiring to starters.
 - .2 Pipe tracing and related controls.
 - .3 Electric hot water heaters.
 - .4 All electrical heaters including baseboard heaters, cabinet heaters, force flow heaters and radiant heaters.
 - .5 All interposing relays, relays, contactors and 120V control devices.
 - .6 All 120V and low voltage control wiring and conduits.
- 1.8.3. Determine exact location of starters, motors and line voltage controls based on the mechanical drawings to coordinate with the locations of all equipment to ensure the required clearances are maintained. If no wall location is suitable for the motor starters then mount the starters on a plywood backboard on unistrut supports near the respective equipment to meet the applicable code requirements for motor isolation switches. If a motor or piece of equipment is listed on one of the starter schedules but is not shown on the floor plans, the contractor is to reference the mechanical drawings for the location of the respective piece of equipment. No additional costs will be entertained.

- 1.8.4. Should the mechanical contractor change any of the motor or equipment sizes from those identified on the mechanical schedules and drawings at any stage of the project to aide their installation, the mechanical contractor will incur all extra electrical costs to revise the electrical feeders, breakers, starters and equipment to supply power to the revised piece of equipment.
- 1.9. PLYWOOD BACKBOARDS, EQUIPMENT MOUNTING, & HOUSEKEEPING PADS
- 1.9.1. Provide fire rated plywood backboards as shown on the drawings and mount where all communication equipment is to be wall mounted. Plywood is to be 21 mm, urea-formaldehyde (UF) free and shall be either, Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI) or CSA Z809-(latest edition) certified. Plywood to be either fire rated with the appropriate label displayed once installed or coated with fire retardant paint. Do not paint over plywood fire rating certification stamp. All Certification not to be painted. Submit documentation as a shop drawing for review by the LEED Representative prior to ordering.
- 1.9.2. Surface mounted electrical equipment boxes are to be installed on galvanized unistrut stand-offs. Electrical equipment boxes shall include, but not be limited to electrical panels, LV lighting control, fire alarm, security, communication, electrical sub-metering, etc. Panels are to be grouped on common base wherever practical.
- 1.9.3. Provide steel re-enforced concrete housekeeping pads under all floor mounted electrical equipment and where noted on the drawings. All housekeeping pads to be a minimum of 100mm high above finished floor and shall not extend beyond 50mm beyond the electrical equipment unless shown otherwise on the drawings.
- 1.10. FINISHES
- 1.10.1. Metal enclosure surfaces are to be finished by the application of rust resistant primer on both the inside and outside, with at least two coats of enamel.
- 1.10.2. Clean and touch up all surfaces of equipment scratched or marred during shipment or installation. Match the original paint.
- 1.10.3. Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
- 1.10.4. All paints, coatings, sealants and adhesives shall meet the VOC limits in accordance with the LEED Specification sections. Submit documentation as a shop drawing for review by the LEED Representative prior to ordering.
- 1.11. SAFETY
- 1.11.1. Protect exposed live equipment during construction for personnel safety.
- 1.11.2. Shield and mark all live parts "LIVE 120 VOLTS", or with appropriate voltage in English.
- 1.11.3. Arrange for the installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of an electrician.
- 1.12. FIRE STOPS
- 1.12.1. Provide fire stops in accordance with front end, and Division 1 documents and as described herein. Contractor to coordinate fire stops with General Contractor. All paints, coatings, sealants and adhesives shall meet the VOC limits in accordance with the LEED Specification sections. Submit documentation as a shop drawing for review by the LEED Representative prior to ordering
- 1.12.2. Fire stops and smoke seal systems: in accordance with CAN/ULC-S115 (latest edition).

- .1 Asbestos free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of CAN/ULC-S115 (latest edition) and not to exceed opening sizes for which they are intended.
 - .2 Fire stop system rating for service penetrations: to suit the latest edition of the National Building Code of Canada with local amendments or the Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.
 - .3 Fire stop system rating for sealing junction of rated walls to rated floors and ceilings: to suit the National Building Code of Canada with local amendments or the Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.
- 1.12.3. Service penetration assemblies: certified by ULC in accordance with CAN/ULC-S115 (latest edition) and listed in ULC Guide No. 40 U19.
- 1.12.4. Service penetration fire stop components: certified by ULC in accordance with CAN/ULC-S115 (latest edition) and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC.
- 1.12.5. Fire resistance rating of installed fire stop assembly not less than the fire resistance rating of surrounding floor and wall assembly, and in accordance with the National Building Code of Canada with local amendments or the Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.
- 1.12.6. Fire stops and smoke seals at openings intended for ease of re-entry, such as cables: elastomeric seal; do not use cementitious or rigid seal at such locations.
- 1.12.7. Fire stops and smoke seal all electrical penetrations through rated assemblies as per ULC Standards.
- 1.12.8. Where sound and vibration control is required, use an elastomeric seal; do not use a cementitious or rigid seal at such locations.
- 1.12.9. Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- 1.12.10. Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- 1.12.11. Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- 1.12.12. Sealants for vertical joints: non-sagging.
- 1.12.13. Colour: if range available to Engineer's Representative's choice of standard colours, generally to match background colour where visible in finished spaces.
- 1.12.14. Through non-fire or non-smoke separations or where waterproof membrane is field applied, where pipes are insulated, sleeves shall be sized to accommodate the insulation and vapour barrier.
- 1.12.15. Where-holes are core drilled in existing structures, sleeves shall be provided as specified complete with fire stopping as noted above.
- 1.12.16. Submit a complete fire stop system shop drawing package, identifying the products that may be used on the project. Prior to submitting data, review with Authority having Jurisdiction to confirm acceptability of proposed materials and assemblies.
- 1.12.17. Installation
- .1 Install fire stops and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.

- .2 Seal-holes or voids made by through penetrations, poke through termination devices, and un-penetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .4 Tool or trowel exposed surfaces to a neat finish.
- .5 Remove excess compound promptly as work progresses and upon completion.

1.13. ACOUSTIC TREATMENT

- 1.13.1. Electrical Contractor will be responsible for coordinating the electrical installation with the recommendations of the acoustic consultant and their report where one has been included in the contract documents.
- 1.13.2. Refer to the recommendations of the acoustic report where provided, and provide and install acoustic treatments as necessary. This may include separation of receptacles in stud bays, sealing of junction boxes, application of sound insulating materials etc. Coordinate the installation of these materials with the General Contractor and Drywall/Partition Subtrade.
- 1.13.3. Do not install back to back receptacles/back boxes within the same stud bay wherever possible. Where it is not possible to stagger receptacles, provide acoustic seal around receptacle/back box to provide acoustic isolation/separation of spaces.

1.14. HOISTING

- 1.14.1. Electrical Contractor will be responsible for the hoisting of all the equipment in the contract. Contractor to coordinate with General Contractor for use of the general hoisting facilities. If hoist facilities are inadequate then subcontractors must provide their own. Subcontractors must inform general contractors in writing of requirements before tender closing date. Any hoisting required in addition to that provided by the General, will be included in the bid price.
- 1.14.2. Electrical Contractor to include for the qualified millwrights to move and place all equipment over 1000lbs. Contractor to provide proof of millwright certification.

1.15. CLEANING AND WASTE REMOVAL

- 1.15.1. Clean all electrical equipment that has been exposed to construction dust and dirt.
- 1.15.2. Contractor to clean all electrical equipment, inside and out, prior to turn over to Owner. Equipment is subject to review by Engineer's Representative and/or Owner.
- 1.15.3. Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.

1.16. SPRINKLERS

- 1.16.1. All electrical equipment shall be suitable for installation in a sprinklered environment and enclosures are to be CSA Type 1 with drip hood, sprinkler proof enclosure unless otherwise noted.

1.17. TEMPORARY LIGHT AND POWER

- 1.17.1. Temporary light and power for construction shall be provided, metered, and maintained by the electrical trade, as directed by the General Contractor; but each trade shall provide all extension cords, lamps, etc., required to complete their work.
- 1.17.2. All temporary light to be fluorescent or LED. Provide adequate lighting to meet all health and safety standards.

1.18. EXAMINATION AND PROTECTION OF SITE

- 1.18.1. Before submitting Bid, each trade shall examine the site to determine the conditions which may affect the proposed work. No claims for extra payment will be considered because of failure to fulfil this condition.
- 1.18.2. Contractor to document any existing conditions on site and submit a pre-condition survey including pictures. Contractor will be responsible to return the site back to its original form, which includes but is not limited to ground repair including grading and new sod and repair of damaged walls, doors and/or floors.
- 1.18.3. Contractor is to protect trees and plants on site and on adjacent properties. Plants to be protect with burlap. Trees and roots within construction area to be protected by the erection of temporary 2m high plywood hoarding at the drip line of the tree. Contractor to avoid unnecessary traffic, dumping and storage of materials at or near trees or plants.
- 1.18.4. When requested by the Owner and/or Engineer's Representative, the Contractor is to provide digital pictures of the site, including but not limited to progress of work and installed equipment, via e-mail to the Owner and/or Engineer's Representative.

1.19. DRAWINGS AND INSTALLATION

- 1.19.1. The drawings are intended to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operative installation.
- 1.19.2. The location, arrangement and connection of equipment and materials shown on the drawings represent a close approximation to the intent and requirements of the contract. The right is reserved by the Engineer's Representative to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.
- 1.19.3. Certain details indicated on the drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence on the drawings.
- 1.19.4. The actual location of switches, outlets and luminaries, etc. shall be reviewed by the Engineer's Representative before installation.
- 1.19.5. The location and size of existing services shown on the drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced. Particular attention shall be paid to buried services.
- 1.19.6. Changes and modifications necessary to ensure co-ordination and avoid interference and conflicts with other trades or to accommodate existing conditions, shall be made at no extra cost to the Owner.
- 1.19.7. Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades.
- 1.19.8. Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
- 1.19.9. Where equipment is shown to be 'roughed-in only' obtain accurate information from the Engineer's Representative before proceeding with the work.
- 1.19.10. Contractor is to review Architect's specifications, drawings and details to confirm locations of devices and equipment.
- 1.19.11. This Contractor is responsible to mark-out his work, fully co-ordinated with all other trades, in sufficient time for review by Architectural Consultant prior to rough-in. Prepare dimensioned layouts of each room prior to rough-in for review by Architectural Consultant. Do not proceed with any work until the Architectural Consultant has reviewed the layout drawings.

- 1.19.12. The Contractor will reimburse the Engineer's Representative for their time spent on answering any written questions or requests for information where the answer is clearly identified on the drawings or in the specifications.
- 1.20. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS
- 1.20.1. The Contractor is to complete installation, interference and setting drawings, dimensioned and to scale for all systems. They shall be made available for review by the Engineer's Representative, if requested. The drawings are required to make clear the work intended or to show its relation to adjacent work or to the work of other trades. When an alternative piece of equipment is to be substituted for equipment shown, drawings of the area involved shall be prepared by this division.
- 1.20.2. Slab layout drawings are to be submitted for review by the Structural Engineer's Representative. These slab layout drawings are to be included in the as-built drawings. Refer to Section 26 05 03.00 – RECORD DRAWINGS.
- 1.20.3. Interference drawings are required for shafts, ceiling spaces, basement areas, typical floors and wherever there is possible conflict in the positioning of electrical equipment, piping, ductwork sub-trades or architectural features.
- 1.20.4. This Division shall prepare sleeving drawings indicating the size and locations of openings required in concrete floor slabs, roof slabs/decks and walls for conduit, bus ducts and equipment for review by the Structural Engineer and Architect. In case of failure to provide information in time (i.e. before the concrete is poured) any extras incurred shall be at the expense of this Division.
- 1.21. APPROVED MANUFACTURERS
- 1.21.1. Where only one name appears in the specification, the bid shall include for the specified equipment.
- 1.21.2. Where two or more names are shown in the specifications as alternates or equal to, this division can select which manufacturer is to be carried.
- 1.21.3. The Contractor is to list substitute equipment as a price deduction to the Bid Price on the Bid Form or as a separate appended page. Acceptance of substitute equipment shall be at the discretion of the Owner and/or Engineer's Representative. Any substitutes not listed on the Bid Form will not be entertained.
- .1 The proposed substitution shall show product name and complete description and also what difference, if any, will be made in the amount of the Bid Price for each substitution, should it be accepted.
 - .2 Materials and products specified by the name of the manufacturer, the brand or trade name, or catalogue reference, shall be the basis of the Bid Price.
 - .3 Any alternate and/or substitute equipment listed shall be equal in performance and quality to that specified. If space, power, structural or any other requirements are different from the equipment specified, the cost of any changes shall be included for in the price shown on the Bid Form.
 - .4 The Owner reserves the right to accept or reject any substitution without question.
- 1.22. PRODUCTS AND MATERIALS
- 1.22.1. Make and quality of materials used in the construction of this project shall be subject to the approval of the Engineer's Representative.

- 1.22.2. All equipment and material are to be CSA certified or approved by an accredited organization. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Authorities.
- 1.22.3. Factory assemble control panels and component assemblies.
- 1.22.4. Materials and equipment supplied by this division shall be new and free from defects and shall be equivalent in physical characteristics and performance to that specified by the manufacturer's name and catalogue reference.
- 1.22.5. Where a certain manufacturer's equipment has been specified by name or model number, the contractor shall be responsible for ensuring that the performance and quality meets the specified equipment and that the same access or maintenance space is available for an alternative manufacturer's equipment that is used and that interfacing connections with other trades can be made at no extra cost.
- 1.22.6. Within 30days of the award of contract, the Contractor is to submit a complete list of the manufacturers for all equipment being supplied on the project.
- 1.22.7. Availability
- .1 In submitting Bid, Contractor warrants that all materials are available in suitable time to meet Contract dates.
 - .2 Subject to sentence .3 below, where the Contractor advises that the Contractor cannot supply materials in suitable time to meet Contract dates, and should it subsequently appear that Work may be delayed for such reason, the Engineer's Representative reserves the right to substitute more readily available products of similar character, even if more costly to the Contractor, at no increase in Contract Price.
 - .3 Where the Contractor can show that the Contractor promptly ordered the originally specified materials the Owner will pay the differential in cost between the originally specified material and the substitute material without any mark-ups applicable by the Contractor, subcontractors, sub-subcontractors or suppliers. For greater certainty, the Contractor's failure to submit shop drawings or other submittals or seek direction in those instances where the Contract Documents so require in sufficient time to permit ordering materials is not cause for the Owner to pay the cost differential in sentence .2 above.
- 1.23. CO-OPERATION WITH CONSULTANTS
- 1.23.1. To assist in the successful execution of the project, the Contractor shall receive a job report that summarizes the expectations of the Consultant and the Contractor. This document covers topics such as progress billings breakdowns, shop drawing requirements, change order pricing breakdowns, the commissioning process, installation drawings, the specifications, as-built drawings and O+M manuals, along with a number of other items. This job report is intended to reiterate and elaborate on key items of the Contract Documents and is not intended to impose new requirements.
- 1.23.2. At the appropriate time during construction the Contractor shall submit the applicable documentation listed in the "Mechanical/Electrical Unfinished Building Occupancy Checklist". The list shall be issued by the Consultant during the course of the project; however, a sample checklist can be provided at any time upon request. The checklist shall be completed by the Contractor when the information required for occupancy is submitted. The Consultant shall review the information and checklist and shall identify when the information is complete. The Consultant's general review letter (required for building occupancy) shall only be issued when all the information requested in the checklist is submitted by the Contractor and deemed to be complete by the Consultant.

1.24. CO-OPERATION WITH OTHER DIVISIONS

- 1.24.1. Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.
- 1.24.2. Electrical conduits shall not touch or be supported on pipe or duct walls.
- 1.24.3. Each section shall confine itself to installing all materials in the spaces shown without encroaching upon space for materials installed under other sections or divisions. Where the space allocated to another section or division is encroached upon, the materials shall be relocated to their proper space allocation in such a manner to complete the work using space allocated to the various sections and divisions. Relocation of materials and work involved shall be paid for by the section responsible for the encroachment at no extra cost to the Owner.
- 1.24.4. The supply of all items is to have built-in to the delivery schedule, ample time for rapid progress of work. Proceed with work determined by the construction schedule.
- 1.24.5. The Electrical Contractor shall coordinate the exact breaker/fuse sizes with all mechanical equipment shop drawings prior to rough-in and ordering of the electrical distribution equipment. Size of breakers/fuses shown on drawings are based on generic equipment manufacturers and sizes may change depending on successful equipment manufacturer. No additional costs shall be allowed for non-coordinated mechanical shop drawing reviews by the Electrical Contractor.

1.25. TEMPORARY USE OF EQUIPMENT

- 1.25.1. Where the electrical systems are operated during construction, the Electrical Contractor shall maintain the system and equipment in proper operating condition.
- 1.25.2. Before any area of the building is turned over to the Owner for acceptance and for beginning of the guarantee/warranty period, the systems and equipment shall be returned to the initial new condition.
- 1.25.3. Permanent electrical equipment is only to be used upon permission of Owner and Engineer's Representative and is only to be used on a limited basis. All equipment must be cleaned prior to turnover.

1.26. TESTING

- 1.26.1. General
 - .1 Refer to the testing requirements outlined in each individual specification section and provide all required staffing, materials, tools and expertise to perform the required testing. Where specification section 26 08 01.00 Technical Services Division Startup Service has been included, ensure all testing is performed accordingly by the Technical Services Division trade.
 - .2 This specification is intended to capture the requirements for factory testing, factory witness testing, site startups, site testing and training of electrical equipment. This specification represents a minimum requirement and does not absolve the equipment manufacturers from performing any tests required by the standards referenced in the individual specification sections.
 - .3 The testing process for the Electrical Systems shall include:
 - .1 Verification that the installation meets the requirements of the contract documents.
 - .2 Verification that the systems performance meets the design intent.
 - .3 Building operator training.

- .4 As-Built documentation, operating and maintenance manuals, and systems operating manuals.
 - .4 The Contractor, Engineer's Representative, Technical Division Startup Services (where called for in the specification) and Commissioning Agent (where identified as part of the project) shall provide the services to complete the process. See further explanation below defining the areas of responsibility.
 - .5 Provide labour, equipment and material to conduct the testing process as outlined in this Section.
- 1.26.2. Factory testing
- .1 All equipment is to have factory testing performed by the equipment manufacturer. These tests are to include the manufacturers standard factory testing, and any required testing to conform to the standards, and any additional testing referenced in the individual specification sections.
 - .2 The manufacturer is to perform the required testing and submit test reports recording the results of all tests to the Electrical Contractor for review and if found acceptable submit to Engineer's Representative for shop drawing review and the final copy included in the O&M Manuals. Test reports are to be submitted and reviewed to the Electrical Contractor and Engineer's Representative prior to shipment to site.
 - .3 Any deficiencies noted in the factory testing are to be corrected prior to shipment of electrical equipment unless otherwise agreed to by the Electrical Contractor.
- 1.26.3. Site Startup
- .1 Manufacturer to include for the costs of technician(s) to perform initial system startup on site as required by the specifications and Electrical Contractor. Extent of technician(s) involvement to be coordinated with the needs of the specifications and the Electrical Contractor.
- 1.26.4. Site tests
- .1 Manufacturer to include for the costs of technician(s) to perform site tests as required by the specifications and Electrical Contractor. Refer to tests identified in the individual specification sections and include all personnel and equipment to perform testing.
- 1.26.5. Materials
- .1 The Contractor and Manufacturer shall provide all instrumentation and equipment necessary to conduct the tests as specified in the specifications. The Contractor shall ensure the instrumentation to be used are properly and adequately calibrated and if required by the Engineer's Representative or Commissioning Agent to provide the dates the instrumentation was last calibrated.
- 1.27. TRAINING
- 1.27.1. The Manufacturer is to include for qualified technician(s) with project specific knowledge to perform in depth training for facility management team members.
- 1.27.2. Training may include up to ten (10) attendees and may be video recorded by others.
- 1.27.3. Training program to include:
- .1 One site 'in class' introduction session covering the basics of system operation.
 - .1 Manufacturer to submit a course outline before training commences.
 - .2 Manufacturer to provide course training documentation (if required) for attendees.

- .2 On site 'hands on' session covering the specific equipment design and operation details, including:
 - .1 All operating procedures including automatic and manual intervention procedures.
 - .2 All regular maintenance procedures.
 - .3 Troubleshooting procedures.
 - .4 Spare parts required.
- 1.27.4. Timing of training to be coordinated with Electrical Contractor and Owner/Facility Management staff and is to be provided in advance of systems supporting critical loads to allow for full ability to operate the systems. The Electrical Contractor/Manufacturer to notify the Owner/Facility Management team a minimum two (2) weeks prior to the date of training.
- 1.28. STATEMENT OF PRICES
- 1.28.1. To form a basis for progress payments the successful bidder shall submit a sample progress draw for the various portions of the work. The format of the sample progress draw shall be as shown in the example progress draw below. The sample progress draw shall include a breakdown which illustrates all categories shown on the example progress draw which are relevant to the project. The categories shall be broken down to clearly illustrate the value of the material being supplied as the first subcategory and the value of the labour being supplied as the second subcategory, as shown on the example progress draw. The electrical Engineer's Representative reserves the right to request that additional categories be added to the progress draw if the Engineer's Representative feels that doing so will aid in assessing the contractor's progress on site, thereby expediting contractor payment. Progress draws not including the categories shown on the example progress draw where relevant to the project and / or not providing separate labour value and separate material value subcategories will be rejected.
- 1.28.2. The total price of all portions of the work shall equal the total price of the work covered under the electrical division. Cost for as-built drawings and manuals to be carried as a separate line item.
- 1.28.3. Contractor to list and track all fixed per unit cost luminaires as part of Light Fixtures - Materials on the progress draw.
- 1.28.4. Contractor to list and track each of the approved changes on separate lines on the progress draw.
- 1.28.5. Costs of temporary facilities and utilities shall be amortized over the duration of the Work. Claims for 'mobilization', 'bidding costs', or similar lump sums at or before start of work are not acceptable.

EXAMPLE PROGRESS DRAW

Electrical Contractor Name
 Billing Application Electrical Division
 Project Name

	Application Number – xx	Date – xxxx to xxxx						
<u>Description</u>	<u>Contract Value</u>	<u>%</u>	<u>Billed To Date</u>	<u>%</u>	<u>Prev. Billed</u>	<u>%</u>	<u>This Billing</u>	<u>Balance to Complete</u>
Permits / Mobilization	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demolition & Removals	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Duct Banks – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Duct Banks – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx

Feeder Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Wire – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Wire – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Ltg. Branch Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Ltg. Branch Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Lighting Branch Wire – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Lighting Branch Wire – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Cable – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Cable – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Cable – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Cable – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Distribution Equipment – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Distribution Equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Generator / Inverter – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Generator / Inverter – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Light Fixtures – Material†	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Light Fixtures – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Lighting Controls – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Lighting Controls – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Equipment – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Wiring Devices – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Wiring Devices – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Hand Dryers – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Hand Dryers – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Commissioning / Training	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demobilization / Clean-up	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Manuals / As-Built Drawings	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Subtotal	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Additions to Contract								
CO # / PC # / CCN #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
Cash Allowance #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx

Subtotal	----- xx,xxx.xx -----	xxx	----- xx,xxx.xx -----	xxx	----- xx,xxx.xx -----	xxx	----- xx,xxx.xx -----	----- xx,xxx.xx -----
Total Contract	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Less Holdback			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	
Total			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	

[†] Inclusive of fixed per unit cost luminaires. Refer to luminaire schedule and/or electrical supplementary bid form for luminaire fixed unit costs.

1.29. METRIC CONVERSIONS

1.29.1. Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, but not limited to, equipment, conduit and site services in both new and existing installations.

1.30. INTERRUPTION OF SERVICES

1.30.1. Any interruption of the electrical services to any part of the building shall come at a time agreeable to the Engineer's Representative. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.

1.30.2. Testing and operation of major equipment shall be approved by the Engineer's Representative to avoid excessive electrical utility charges. Such testing to be generally carried out after normal working hours or on weekends.

1.30.3. All such overtime work shall be carried out without additional cost to the Owners.

1.30.4. Modifications to existing electrical equipment, which will require shutdown, must be coordinated with the Owner and will only be permitted on weekdays from 10:00 pm to 6:00 am and on weekends from Friday at 7:00 pm to Sunday 6:00 pm. Exact weekends to be co-ordinated with the Owner. Consecutive weekends of shutdowns will not be allowed. Contractor to pay for all utility costs associated with shutdowns. Any work not associated with live equipment can be done during normal working hours. Work considered disruptive to the normal operation of the building will be done after normal business hours. Exact times to be co-ordinated with Owner.

1.30.5. Contractor to provide a minimum of 5 days written notice of a requirement for a shutdown. Contractor to include for separate meetings with the Owner and Engineer's Representative to discuss the shutdown in detail and to coordinate all the work being performed.

1.30.6. The Contractor is responsible for co-ordination and isolating of all existing services at all voltage levels required for the disconnections and connections to existing buildings. This includes shutting down and isolating existing low and medium voltage services. The owner will not perform any isolations for the contractor but will be present during the work. The contractor is to use qualified personnel for these shutdowns ensuring compliance with all applicable safety requirements.

1.30.7. The Contractor is responsible for any damages caused to existing systems when making connections.

1.30.8. The Contractor is to keep shutdowns of existing buildings to a minimum by scheduling the work and providing the required number of personnel to keep the shutdown to a minimum. This Contractor is to include for as many multiple teams of electricians as is feasible to keep the shutdown work to a minimum.

1.31. VALUATION OF CHANGES

- 1.31.1. Further to contract requirements, the method to be used in determining the value of a change to the Work, by either Change Order or Change Directive, shall be:
- .1 Estimate and acceptance in a lump sum, unless the Engineer's Representative otherwise determines that the method shall be unit prices set out in the Contract.
- 1.31.2. Contractor shall provide the Engineer's Representative with a detailed cost analysis of the contemplated change indicating:
- .1 Quantity of each material.
 - .2 Unit cost of each material.
 - .3 Time involved.
 - .4 Sub-trade quotations including a complete analysis of costs.
 - .5 Mark-ups, if applicable.
 - .6 Value of GST or HST, as applicable.
 - .7 Proposed change in Contract Time.
- 1.31.3. The detailed cost breakdown is to list material and labour separately for each item on the proposed change. The breakdown for contemplated change is to follow the format of the attached document.
- 1.31.4. The following shall not be included in the cost of the work but are covered by the hourly labour rate:
- .1 The Contractor's payroll, administrative, head office and site office expenses, including stationary, postage and other office supplies.
 - .2 The costs of the Contractor's Project Manager, clerical and administrative personnel, and executive personnel.
 - .3 Use of temporary offices, sheds, small/hand tools, storage, and site office consumables, etc., including but not limited to the cost of telephone, light, power, water and heat used therein.
 - .4 Transportation and overnight room expenses for out of town labour, if local labour is unavailable.
 - .5 Insurance premiums, all government payroll burdens, variable labour factors and union or association funds.
 - .6 Licenses and permits, except when these are special for a particular item of work.
 - .7 Printing charges for Proposed Changes, Change Orders and Drawings for Contractor's and Subcontractors' use in the work. Engineer's Representative will provide a PDF electronic copy of change notice documentation.
 - .8 The cost of preparing record, layout and working drawings and shop drawings.
 - .9 The cost of clean-up and disposal of waste material.
 - .10 Parking, travel, coffee break/rest periods, warranties, safety training, WHMIS and health and safety committee, and non-productivity time.
 - .11 Rentals, additional bonding, project financing.
- 1.31.5. The Contractor shall not be entitled to any additional compensation arising out of changes to the Work other than the amounts determined and agreed to under CCDC2-2008 GC 6.2.
- 1.31.6. In computing accounts for extras and credits for any Proposed Change, all credits shall be deducted from the total sum of the extras before mark-ups or charges for overhead and profit are added.

- 1.31.7. The Contractor shall inform the Surety Company or Companies who have issued any bonds for this Contract, and any Insurers who have insured any part of the work or operations or who have an interest in this Contract, of all changes in the Contract. Pay all costs of any changes in bonds or insurances required to maintain bonds or insurances in conformance with the requirements of the Contract Documents. Provide Owner immediately with any revised bonds or insurances.
- 1.31.8. Special equipment rental rates will be charged at cost. The Contractor shall provide an official quotation of the equipment rental with the Proposed Change quotation as backup, otherwise special equipment rentals will not be accepted by the Owner/Consultant.
- 1.31.9. The maximum percentage fee for mark-ups shall be as stated in the Division 0/1 specifications.
- 1.31.10. Where a proposed change order includes both credits and extras, overhead and permitted mark-ups apply to the net extra or credits, if any, of the entire change.
- 1.31.11. All changes, change notices, revisions to contract, site instructions, change directives or any additional costs or deletes to the stipulated lump sum contract price are subject to review and scrutiny by a qualified third party or individual.
- 1.31.12. The material costs used shall be a discount to nationally available pricing guides (i.e. Trade Service, Allpricer, etc.) to reflect a value with a fair and reasonable markup to the actual cost of the materials purchased from distributors. The Owner and/or Engineer's Representative reserve the right to negotiate material pricing to a value that is fair and reasonable to the Owner.
- 1.31.13. Labour Rate
- .1 During the duration of the electrical contract, extra work hourly labour units are to be based on the latest edition of the National Electrical Contractors Association (NECA) labour units column 1(one). No additional factors will be accepted.
 - .2 The hourly labour rate for all changes will be based on a Journeyman Electrician rate as listed on the Bid Form and/or Electrical Supplementary Bid Form. The Owner and/or Engineer's Representative reserve the right to renegotiate the labour rate. The hourly labour rate will be inclusive of overhead, markup and profit. The labour rate will be inclusive of all labour burden charges as stated in this 'Valuation of Changes' section above.
 - .3 The following labour burdens are not part of the hourly labour cost, but are covered under the NECA labour unit rates: safety measures and regulations; drawing and specification study; layout, measuring and marking the installation location; material unloading, jobsite storage and delivery to the installation area; inspection, uncrating and shipping support removal; tool acquisition and return to storage; clean-up of excess material; and testing circuits for continuity.
 - .4 At the request of the Owner or the Engineer's Representative, the Contractor is to submit a detailed labour cost breakdown showing a breakdown of all adders to the base wage rate to show how the Contractor has come to the proposed hourly rate. The Owner and the Engineer's Representative reserve the right to negotiate the hourly labour rate with the Contractor.
- 1.31.14. When pricing additional work for Proposed Changes, the Electrical Contractor shall only price new materials that are required for the Proposed Change. Where existing materials and/or infrastructure (i.e. homerun conduits back to electrical panels) can be re-used for the Proposed Change, the Electrical Contractor shall utilize these items in the valuation of the Change at no extra cost.

PROPOSED CHANGE ORDER

Company Name:	CCN #
Address:	Date:
City, Prov.:	Project Name:
Postal Code:	Project Number:
Telephone:	Page Number:
Fax:	Change Order #:
E-Mail address:	

Client Address:

Work Description

We reserve the right to correct this quote for errors and omissions.
 This quote covers direct costs only.
 This price is good for acceptance within 30 days from the date of receipt.

Itemized Breakdown

<u>Description</u>	<u>Qty</u>	<u>Net Price U</u>	<u>Total Mat(\$)</u>	<u>Labor U</u>	<u>Total Hours</u>
3/4' EMT		150.39 C		5.00 C	
3/4' EMT STL SS CONN		65.97 C		10.00C	
3/4' EMT STL SS CPLG		70.60 C		5.00 C	
3/4' EMT STRAO 1-H		11.24 C		4.00 C	
#10 x 1" SELF TAPPING SCREW		5.50 C		5.50 C	

TOTALS

Description

Material

General Materials		
Permitted Mark-up	(@ 10.000 %)	
Material Total		

Labour

Journeyman	(xx Hrs. @ \$xx.00)	
Foreman @ 10%	(xx Hrs. @ \$xx.00)	
Labour Total		

Material and Labour Total

Final Amount

- 2. Products
 - 2.1. NOT USED
 - 3. Execution
 - 3.1. NOT USED
- END OF SECTION

26 05 03.00 Record Drawings

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Refer to Record and/or As-built Drawings in Section 01 70 00 (01 72 29.00) – CLOSEOUT SUBMITTALS.

1.3. RECORD OF REVISIONS ON SITE

1.3.1. Print and maintain two complete sets of white prints to mark the project progress, changes and deviations.

1.3.2. Maintain an updated copy of plans and schematics in the digital format for which the project is provided (i.e. AutoCAD or Autodesk Revit MEP) and be capable to produce documents in Adobe PDF upon request.

2. Products

2.1. RECORD DRAWINGS

2.1.1. The Electrical Contractor shall request in writing from the Engineer's Representative all electrical AutoCAD drawings. Contractor to complete attached form and pay the Engineer's Representative directly the costs identified within the form prior to receiving the drawings. After the final as-built drawings have been reviewed, provide multiple copies of the drawings on CD or DVD or sent via electronic transfer. One copy is to be returned to the Engineer's Representative via CD or DVD or electronic transfer for their records and a minimum of one copy on CD or DVD with each set of maintenance manuals. Provide additional copies if required under the General Conditions. The Contractor is to use latest release of AutoCAD software, and provide electronic files saved in a version acceptable to the end user and engineer.

2.1.2. The contractor is to identify the cost of Record Drawings and the Operation and Maintenance Manuals as a separate line item on their progress draw. The following values are to be broken out:

\$5,000	For Electrical Contracts up to \$250,000
2% of Electrical Contract	For Electrical Contracts from \$250,000 to \$1,500,000
\$30,000	For Electrical Contracts over \$1,500,000

2.1.3. The project will remain incomplete and no money will be released until the final versions, both hard and electronic, of the drawings and manuals are received.

2.1.4. Final as-built prints/plots shall not contain markings or corrections by hand (i.e. marker, pen, pencil, etc.). References to the Architect and Engineer must be deleted from the drawings.

- 2.1.5. Final as-built drawings to include all revisions made to the drawings during construction, including all approved changes. The as-built drawings are to also include the routing of all feeders except for branch circuits, all junction boxes to be shown, drawing legend to be updated to include all symbols and lines used to show as-built conditions, quantity of wires in each conduit, and circuit numbers of wires in each conduit. Include slab layout drawings in as-built drawing package.
- 2.1.6. CADD Requirements.
- .1 A complete list of layer names and brief description of each layer's use shall accompany all files.
 - .2 Fonts for text shall be AutoCAD standard. Custom fonts, shape files, etc., are not to be used.
 - .3 Final as-built drawings shall be returned on CD ROM or DVD.
 - .4 Each CD ROM or DVD shall be clearly labelled with Engineer's Representative and Owner, Contract number, file names and Drawing number. If a complete listing exceeds the label size provide a "readme.txt" file in ASCII format with each CD ROM or DVD. A printed copy of the readme file shall accompany each CD ROM or DVD
 - .5 All drawings shall be in the same units as issued on Bid Documents.
 - .6 Provide a complete list of symbol (block) names with a description of each symbol.
 - .7 Special effort shall be made to ensure that drafting is accurate: i.e. appropriate lines are indeed horizontal and vertical; lines that should intersect do but not over-intersect and ensure that entities are placed on correct layers.
- 2.1.7. The Electrical Contractor will maintain two sets of white prints on site on which the Electrical Contractor shall clearly mark, as the job progresses, all changes and deviations from that shown on Contract Drawings. After review and approval of service lines in trenches, the Electrical Contractor shall take 'as-built' measurements, including all depths, prior to commencement of backfilling operations. The location of buried electrical ducts and conductors shall be shown on the drawings and dimensioned from fixed points. Drawings shall be kept up-to-date during construction and in addition to field measurements shall include variation orders, field instructions and all other changes.
- 2.1.8. On completion of the building, the Electrical Contractor shall forward to the Engineer's Representative the two sets of final drawings indicating all such changes and deviations for review by the Engineer's Representative. Each set shall include full size hard copy of the drawings, and electronic copy of the drawings on CD ROM or DVD.
- 2.1.9. If required, the Engineer's Representative will provide a quotation to this Contractor to transfer "As-Built" information from the mark-up documentation to the acceptable software.
- .1 Include a cost of \$400.00 per sheet for the transfer of marked up 'As Built' information to AutoCAD and forwarding of the electrical information by the Engineer's Representative to the Owner
- 2.1.10. The Electrical Contractor may request from the Engineer's Representative the most current electrical drawings in AutoCAD sent via electronic transfer (at a nominal charge of \$500.00).
- 2.1.11. The AutoCAD as-built documents shall meet all the Owner's and Engineer's Representative's requirements.

3. Execution

3.1. NOT USED

END OF SECTION

26 05 04.00 Submittals – Shop Drawings

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - 1.2. RELATED WORK
 - 1.2.1. Comply with Div. 00 for submittal requirements and as amended below.
2. Products
 - 2.1. SHOP DRAWINGS
 - 2.1.1. Shop Drawings shall be organized by Specification Section. Do not combine more than one section into one submission. Incorrect submissions will be returned without review.
 - 2.1.2. Submittals/Shop Drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each Shop Drawing shall give the identifying number of the specific assembly for which it was prepared (e.g. SWBD-1A).
 - 2.1.3. Submit shop drawings electronically, by email, in PDF format. Submissions that are not electronic without prior approval from the Engineer's Representative shall be returned as not reviewed. Provide the following information in the email submission:
 - .1 S+A project number and Contractor Shop Drawing Identifier in Subject Line
 - .2 Attachments shall be limited to 10MB
 - .3 Provide FTP hyperlink for all attachments in excess of 10MB with appropriate information for downloading the file (as required)
 - .4 Shop Drawing Submission to the following email address:
 - .1 ContractAdmin.Toronto@smithandandersen.com
 - 2.1.4. Shop drawings submitted directly to Smith + Andersen personnel (and not copied to the email address provided above) without advanced permission will not be processed nor considered as received.
 - 2.1.5. Each Shop Drawing for non-catalogue items shall be prepared specifically for this project. Shop Drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.
 - 2.1.6. When requested, Shop Drawings shall be supplemented by data explaining the theory of operation – for example: lighting control sequence of operation – the Engineer's Representative may also request that this information be added to the maintenance and operating manual.
 - 2.1.7. Provide a cover sheet with the project name, issue date, issue number, specification section number, and title of section with space for Shop Drawing review stamps for the Contractor and Engineer's Representative.

3. Execution

3.1. SUBMISSION

- 3.1.1. Each Shop Drawing or catalogue sheet shall be in original PDF format stamped and signed by the Contractor to indicate that he has checked the drawing for conformance with all requirements of the Drawings and Specifications, that he has co-ordinated this equipment with other equipment to which it is attached and/or connected and that he has verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that electrical and mechanical co-ordination is complete before submitting drawings for review.
- 3.1.2. Scanned PDF versions are not acceptable.
- 3.1.3. Equipment shall not be released for manufacture until the shop drawing has been reviewed by Engineer's Representative. Contractor shall assume responsibility and cost for field changes. Installation of any equipment shall not start until after final review of Shop Drawings by the Engineer's Representative has been obtained.
- 3.1.4. As part of the electrical Engineer's Representative's scope of the work, shop drawings shall be reviewed no more than twice. Should three or more reviews be required due to reasons of Contractor omissions causing resubmission requests, the Contractor shall reimburse the electrical Engineer's Representative for time expended in these extra reviews.

END OF SECTION

26 05 05.00 Mounting Heights

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. NOT USED

3. Execution

3.1. MOUNTING HEIGHTS

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

3.1.2. If mounting height of equipment is not specified or indicated, verify with the Consultant before proceeding with installation.

3.1.3. Unless indicated otherwise on the drawings or within the specifications, install electrical equipment at following heights.

.1 Local switches: 1050 mm.

.2 Wall receptacles:

.1 General: 450 mm.

.2 Above top of continuous baseboard heater: 200 mm.

.3 Above top of counters or counter splash backs: 175 mm.

.4 In mechanical rooms: 1200 mm.

.5 In equipment storage rooms: 900mm.

.3 Panelboards: 2000 mm to top of panel.

.4 Telephone and interphone outlets: 450 mm.

.5 Wall mounted telephone and interphone outlets: 1050 mm.

.6 Fire alarm stations: 1200 mm.

.7 Wall Mounted Fire alarm audible devices: 2300 mm.

.8 Television outlets not mounted behind a wall mounted television: 450 mm.

.9 Wall mounted speakers: 2100 mm.

.10 Clocks: 2100 mm.

.11 Power Door Operator push buttons: 1050 mm.

.12 Wall mounted Exit Signs

.1 For 2400 mm to 2500 mm ceiling heights: 2100 mm.

.2 For all ceilings heights greater than 2500 mm: 2400 mm.

- .13 Wall mounted Battery Packs and Emergency Heads
 - .1 For 2400 mm to 2500 mm ceiling heights: 2100 mm.
 - .2 For all ceilings heights greater than 2500 mm: 2400 mm.
- .14 Wall mounted occupancy sensors: 1050 mm.
- .15 Wall mounted visible signal devices: entire lens shall be no less than 2000 mm and no more than 2400 mm.
- .16 Top of remote annunciator and passive graphic panels shall be no more than 1800mm above finished floor.
- .17 Wall mounted emergency telephone (Fireman's Handset): 1350 to 1500mm.

END OF SECTION

26 05 21.00 Wires and Cables 1000V

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables, latest edition.

1.2.2. CSA C22.2 No. 38, Thermoset-Insulated Wires and Cables, latest edition.

1.2.3. CSA C22.2 No. 51, Armoured Cables, latest edition.

1.2.4. CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables, latest edition.

1.2.5. CSA C22.2 No. 96, Portable Power Cables, latest edition.

1.2.6. CSA C22.2 No. 123, Metal Sheathed Cables, latest edition.

1.2.7. CSA C22.2 No. 124, Mineral-Insulated Cable, latest edition.

1.2.8. CSA C22.2 No. 131, Type TECK 90 Cable, latest edition.

1.2.9. CSA C22.2 No. 174, Cables and Cable Glands for Use in Hazardous Locations, latest edition.

1.2.10. CAN/ULC S139 / UL 2196 (Binational Standard), Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables, latest edition.

1.2.11. ASTM B800 - Standard Specification for 8000 Series Aluminium Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

2. Products

2.1. BUILDING WIRES

2.1.1. Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

2.1.2. Contractor to provide copper conductors on conductors sizes up to and including #8 AWG. Contractor to provide copper conductors for sizes larger than #8 AWG unless identified as aluminium or NUAL on the drawings.

2.1.3. All conductors to have size as indicated, with insulation of chemically cross-linked thermosetting polyethylene material rated RW90 or RWU90 to CSA C22.2 No. 38 rated as follows:

- .1 Insulation rated at 1000V for 600V systems that are ungrounded or have a neutral grounding resistor to limit ground fault current
- .2 Insulation rated at 600V for the other 600V and 347/600V distribution systems not covered under item #1 above.
- .3 Insulation rated at 600V for all systems rated at 480V and less.

- 2.1.4. All aluminium or NUAL conductors to be an aluminium alloy with CSA certified as an Aluminium conductor material (ACM) and meet the requirements of the Aluminium Association Inc. AA8030 and ASTM B800 standards. Provide an anti-oxidant compound, Ideal NOALOX, on all aluminum conductor terminations.
- 2.1.5. RWU90 wiring is to be used for underground installations.
- 2.2. TECK CABLE
- 2.2.1. Cables to CSA C22.2 No.131.
- 2.2.2. Conductors:
- .1 Bonding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
- 2.2.3. Insulation:
- .1 Chemically cross-linked thermosetting polyethylene type RW90, rated 1000 V.
- 2.2.4. Inner jacket: polyvinyl chloride material.
- 2.2.5. Armour: interlocking aluminum.
- 2.2.6. Overall covering: thermoplastic polyvinyl chloride material rated at a minimum of FT-4. Provide FT-6 jacket when TECK cables are run in return air plenum.
- 2.3. VARIABLE FREQUENCY DRIVE CABLES
- 2.3.1. Variable frequency drives are also known as variable speed drives.
- 2.3.2. Cables to CSA C22.2 No. 123 and CSA C22.2 No. 174.
- 2.3.3. Conductors:
- .1 Three (3) bare bonding conductor coppers sized to Table #16 of the electrical code.
 - .2 Circuit conductors: copper, size as indicated.
- 2.3.4. Insulation:
- .1 Chemically cross-linked thermosetting polyethylene type RW90, rated 1000 V.
- 2.3.5. Inner jacket: polyvinyl chloride material.
- 2.3.6. Armour: interlocking aluminum.
- 2.3.7. Overall covering: thermoplastic polyvinyl chloride (PVC) material rated at a minimum of FT-4.
- 2.4. ARMOURED CABLES
- 2.4.1. Cables to: CSA C22.2 No. 51.
- 2.4.2. Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
- 2.4.3. Type: AC90 (BX).
- 2.4.4. Armour: interlocking type fabricated from aluminium strip.
- 2.4.5. Type: ACWU90 - PVC flame retardant jacket over armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No. 0.3 with maximum flame travel of 1.2 m.

2.5. ALUMINUM SHEATHED CABLE

- 2.5.1. Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
- 2.5.2. Insulation: type RA90 rated 1000 V.
- 2.5.3. Sheath: aluminium applied to form continuous corrugated seamless sheath.
- 2.5.4. Outer jacket of PVC applied over sheath for direct burial or wet locations.

2.6. WIRING TERMINATION

- 2.6.1. Lugs, terminals, screws used for termination of wiring to be to be dual rated for Copper/Aluminum (Cu/Al)..
- 2.6.2. Lugs, terminals, and screws used for termination of multiple wires must be rated for their intended use.

3. Execution

3.1. GENERAL

- 3.1.1. Provide a minimum of one bonding conductor for each three ungrounded conductors on all conduit and cable runs. Provide separate bonding conductors for each ground fault circuit interrupter circuits. All bonding conductors to be copper and insulated with a green coloured insulation.
- 3.1.2. Size bonding conductor to applicable tables of the:
 - .1 Ontario Electrical Safety Code.
- 3.1.3. All equipment, junction boxes, pull boxes, liquid tight flex, etc. to be bonded to ground through bonding conductors.
- 3.1.4. Provide separate neutral conductor for each 120 volt circuit for all circuits feeding receptacles and power outlets.
- 3.1.5. Provide a variable frequency drive (VFD) cable from each VFD unit to each motor. Wiring to be installed in accordance with the VFD and motor manufacturer instructions.
- 3.1.6. All cable terminations to be compression type fittings for wire sizes greater than #8 AWG. All compression type fittings to be two-hole long barrel type with inspection / viewing window. Where mechanical screw type lugs are allowed by the Engineer's Representative, they will be suitable for quantity of parallel runs of wire that are to be terminated under.
- 3.1.7. Armoured Cable Type AC90 (BX) may only be used for individual drops from slab mounted junction box to recessed mounted light fixtures or where noted on the drawings where wiring is required to be installed within an existing wall. The maximum allowable distance of armoured cable is 3 m. Contractor to receive written approval from the Engineer's Representative to run armoured cable further than 3 m from junction box. Daisy chaining of fixtures is only acceptable in dry wall ceilings. Wiring in conduit is to be brought to a junction box to allow for the transition to armoured cable. Armoured cable is not to be installed directly into electrical panels or run in walls for receptacles.
- 3.1.8. Branch circuit wiring to be upsized as follows to address voltage drop when:
 - .1 The entire length of the circuit wiring exceeds 25 m – branch wiring to be a minimum of No. 10 AWG.
 - .2 The entire length of the circuit wiring exceeds 40 m – branch wiring to be a minimum of No. 8 AWG.

- .3 The entire length of the circuit wiring exceeds 60 m – branch wiring to be a minimum of No. 6 AWG.
- 3.1.9. Where feeders or branch circuits are run underground, upsize conductors to comply with the requirements of electrical code Rule 4-004, Ampacity of wires and cables, using Diagrams D8 to D11 and Tables D8A to D11B of the electrical code. Where conductors are upsized due to Tables D8A to D11B, upsize conduits to comply with the requirements of electrical code Rule 12-910, Conductors and cables in conduit and tubing.
- 3.1.10. Wire Splicing
 - .1 Splice up to and including No. 6 AWG with nylon insulated expandable spring type connectors.
 - .2 Splice larger conductors using compression type connectors wrapped in PVC insulation rated at the respective voltage.
- 3.2. INSTALLATION OF BUILDING WIRES
 - 3.2.1. Install all building wiring in conduit unless otherwise noted. Conduit to be sized to the electrical code unless noted on the drawings or in the specifications.
 - 3.2.2. All conductors are to be colour coded. Provide colour tape at all terminations to identify all conductors in each run.
- 3.3. INSTALLATION OF TECK 90 CABLE, VARIABLE FREQUENCY DRIVE CABLE, ARMOURED CABLE OR ALUMINUM SHEATHED CABLE
 - 3.3.1. Group cables wherever possible on channels.
 - 3.3.2. Terminate cables in accordance with manufacturer's instructions.
 - 3.3.3. Fastenings:
 - .1 One-hole steel straps to secure surface cables 50 mm and smaller. Two-hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables.
 - .3 Galvanized threaded rods: 6 mm diameter minimum to support suspended channels.
 - 3.3.4. Connectors:
 - .1 Watertight, approved for respective cables.
 - 3.3.5. For single conductor cables, ground the sheath at the upstream (source) panel and provide insulated fibre plate at the load end, so as to prevent circulating sheath currents.
- 3.4. FIELD QUALITY CONTROL
 - 3.4.1. Prior to energizing wires/cables, measure insulation resistance of each wire/cable. Ensure readings are acceptable per installation recommendations. Tabulate and submit for approval as a submittal.
- 3.5. INSTALLATION OF CONTROL CABLES
 - 3.5.1. Install control cables in conduit.
 - 3.5.2. Ground control cable shield.

END OF SECTION

26 05 26.00 Grounding + Bonding

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. CSA C22.2 No. 41– Grounding and Bonding of Equipment, latest edition.

1.2.2. Ontario Building Code, latest edition.

1.2.3. CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.2.4. IEEE Standard 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, latest edition.

1.3. DESCRIPTION

1.3.1. Provide system grounding to meet requirements of current applicable codes.

1.4. SHOP DRAWINGS AND PRODUCT DATA

1.4.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4.2. Submit shop drawings for ground bars and ground rod inspection wells for engineer's review prior to manufacture.

1.4.3. Submit main system ground test report as a shop drawing for engineer's review. Include final reviewed report in the project O&M manuals.

2. Products

2.1. GROUNDING & BONDING EQUIPMENT

2.1.1. Meet standard of CSA C22.2 No. 41 – Grounding and Bonding of Equipment, latest edition.

2.2. CONDUCTORS

2.2.1. Bare or insulated, stranded, soft drawn annealed copper wire, for: ground bus, electrode interconnections, metal structures, ground connections, telephone ground.

2.3. LUGS

2.3.1. All grounding connections to be made with compression type fittings and lugs with inspection / viewing window.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install complete permanent, continuous, system and circuit, equipment, grounding and bonding systems including, conductors, connectors, and accessories, as indicated, to conform to requirements of local authority having jurisdiction over installation.
- 3.1.2. Supply and install a new ground bus system consisting of a length of copper bus, 25 mm thick ebony pad with chamfered edges as shown on the drawings. A minimum of two 1200 mm ground bars are to be provided in main electrical room(s).
- 3.1.3. For solidly grounded systems, transformer neutrals, switchboard neutrals and all similar bonding connections, the bonding conductors shall be sized in accordance with Table 16 of the Electrical Code.
- 3.1.4. Provide cable grips to receive all grounding conductors. Identify all grounding conductors at the ground pad using lamacoid nameplates. Ground bus system to be provided in rooms as shown.
- 3.1.5. Terminate the following conductors at the ground bus system:

- Service neutral -as indicated on drawings
- Telecommunications ground -as per EIA/TIA standard 607-A (latest edition)

TBB/GE linear length m (ft)	TBB/GE size (AWG)
less than 4 (13)	6
4 – 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8 – 10 (27 – 33)	2
10 – 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20 – 26 (67 – 84)	3/0
26 – 32 (85 – 105)	4/0
32 – 38 (106 – 125)	250 kcmil
38 – 46 (126 – 150)	300 kcmil
46 – 53 (151 – 175)	350 kcmil
53 – 76 (176 – 250)	500 kcmil
76 – 91 (251 – 300)	600 kcmil
Greater than 91 (301)	750 kcmil

where,
 TBB = Telecommunications Bonding Backbone

- Main system ground -#2/0 AWG or 2 x # 4/0 AWG for remote ground grids
- Bonding conductor -as per Table 16 of CSA C22.1

- 3.1.6. Ground all metallic water, gas, and waste systems with a minimum #2/0 AWG copper in accordance with code requirements.
- 3.1.7. Install bonding connections to typical equipment included in, but not necessarily limited to, following list: frames of motors, starters, control panels, building steel work, elevators, distribution panels and outdoor lighting.
- 3.1.8. Commission an approved certified testing Agency to perform a main system ground test. Submit the main system ground test report as a shop drawing for engineer’s review. Provide a copy of the report in the maintenance manual.

- 3.1.9. Install connectors in accordance with manufacturer's instructions.
- 3.1.10. Protect exposed grounding conductors from mechanical damage.
- 3.1.11. Install bonding conductor for flexible conduit and connect at both ends to grounding bushing with solderless lug, clamp or cup washer and screw. Neatly cleat bonding conductor to exterior of flexible conduit.
- 3.1.12. Provide separate, insulated bonding conductor within each feeder and branch circuit raceway.

END OF SECTION

26 05 29.00 Hangers and Supports

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. SHOP DRAWINGS AND PRODUCT DATA

1.2.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2.2. Conduit and equipment provided under the Electrical division shall be complete with all necessary supports and hangers required for a safe and workmanlike installation.

2. Products

2.1. MATERIALS

2.1.1. Provide “U” type support Strut as manufactured by Unistrut.

3. Execution

3.1. INSTALLATION

3.1.1. All drilling for hangers, rod inserts and work of similar nature shall be done by this Division.

3.1.2. Auxiliary structural members shall be provided under the electrical section concerned where conduits or equipment must be suspended between the joists or beams of the structure, or where required to replace individual hanger to allow for installation on new services. Submit details for review as requested.

3.1.3. Depending on type of structure, hangers shall be either clamped to steel beams or joists, or attached to approved concrete inserts.

3.1.4. Approved type expansion shields and bolts may be used for conduit up to 100 mm diameter where the pre-setting of concrete inserts is not practical. Submit Shop Drawings.

3.1.5. Suspension from metal deck shall not be allowed unless specifically accepted by the Engineer’s Representative. Drawings of the proposed method of suspension must be submitted for review.

3.1.6. Hangers, hanger rods and inserts in all parking and ramp areas shall meet the requirements of CAN/CSA-S413 – Parking Structures (latest edition) and shall be of corrosion-resistant material or have an effective, durable corrosion resistant coating. Submit samples for approval.

3.1.7. Suspending one hanger from another shall not be permitted.

3.1.8. All hangers, supports, brackets and other devices used outside the building wall shall be galvanized. If galvanized components cannot be used submit samples of proposed substituted for review before installation.

3.2. HORIZONTAL RUNS ON THE ROOF

- 3.2.1. Where conduit or cables are run horizontally across a roof, conduit or cable shall be supported from pre-manufactured UV resistant sleepers with closed cell foam base.
- 3.2.2. Sleepers shall be "E-Z Sleeper" product from Pipe-Ease Inc. or approved equivalent.
- 3.2.3. Wood Blocks are not acceptable.

END OF SECTION

26 05 31.00 Splitters, Junction, Pull Boxes and Cabinets

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 53.00 – IDENTIFICATION.

1.1.4. Section 26 05 63.00 – ACCESS DOORS AND ACCESSIBILITY.

1.2. REFERENCE

1.2.1. Ontario Electrical Safety Code, latest edition.

1.2.2. Ontario Building Code, latest edition.

1.2.3. CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit shop drawings and product data for cabinets in accordance with specification Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

2. Products

2.1. SPLITTERS

2.1.1. Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position. Provide CSA Type 1 enclosures in non-sprinklered environments and CSA Type 4/12 in sprinklered environments.

2.1.2. Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated. Lugs to be dual rated for Copper/Aluminum (Cu/Al).

2.1.3. At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2. JUNCTION AND PULL BOXES

2.2.1. Welded steel construction with screw-on flat covers for surface mounting.

2.2.2. Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.3. CABINETS

2.3.1. Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.

2.3.2. Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing 19 mm plywood backboard for surface or flush mounting. The plywood backboard is to have a fire-resistant coating on the front. Do not paint over plywood fire rating certification stamp.

3. Execution

3.1. SPLITTER INSTALLATION

- 3.1.1. Install splitters and mount plumb, true and square to the building lines.
- 3.1.2. Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2. JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- 3.2.1. Install pull boxes in inconspicuous but accessible locations.
- 3.2.2. Mount cabinets with top not higher than 2000 mm above finished floor.
- 3.2.3. Install terminal block as indicated in Type T cabinets.
- 3.2.4. Only main junction and pull boxes are indicated. Install pull boxes as follows:
 - .1 A conduit run exceeds 30 m and;
 - .2 360 degree of combined bends between pull boxes for power conduits or 180 degree of combined bends between pull boxes for communication and low voltage conduits.

3.3. IDENTIFICATION

- 3.3.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
- 3.3.2. Install identification labels indicating system name, voltage, and phase.

END OF SECTION

26 05 32.00 Outlet Boxes, Conduit Boxes and Fittings

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. REFERENCES

1.2.1. Ontario Electrical Safety Code, latest edition.

1.2.2. Ontario Building Code, latest edition.

1.2.3. CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

2. Products

2.1. OUTLET AND CONDUIT BOXES GENERAL

2.1.1. Size boxes in accordance with the electrical code.

2.1.2. Square or larger outlet boxes as required for special devices.

2.1.3. Gang boxes where wiring devices are grouped.

2.1.4. Blank cover plates for boxes without wiring devices.

2.1.5. 347V outlet boxes for 347 V switching devices.

2.1.6. Combination boxes with barriers where outlets for more than one system are grouped.

2.2. SHEET STEEL OUTLET BOXES

2.2.1. Electro-galvanized steel single and multi-gang flush device boxes for flush installation, minimum size 75 mm x 50 mm x 38 mm or as indicated. 100 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

2.2.2. Provide cast FS aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles connected to rigid conduit.

2.2.3. Provide electro-galvanized steel utility boxes for surface mounted boxes connected to surface-mounted EMT conduit, minimum size 100 mm x 54 mm x 48 mm.

2.2.4. Square or octagonal outlet boxes for lighting fixture outlets.

2.2.5. Square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.3. MASONRY BOXES

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

2.4. CONCRETE BOXES

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

2.5. FLOOR BOXES

- 2.5.1. Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 28 mm for receptacles; 73 mm for communication equipment.
- 2.5.2. Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12.7 mm and 19 mm conduit. Minimum size: 73 mm deep.

2.6. OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

- 2.6.1. Electro-galvanized, sectional, screw ganging steel boxes, minimum size 75 mm x 50 mm x 63.5 mm with two double clamps to take non-metallic sheathed cables.

2.7. FITTINGS - GENERAL

- 2.7.1. Bushing and connectors with nylon insulated throats.
- 2.7.2. Knock-out fillers to prevent entry of debris.
- 2.7.3. Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.
- 2.7.4. Double locknuts and insulated bushings on sheet metal boxes.

2.8. SERVICE FITTINGS

- 2.8.1. 'High tension' receptacle fitting made of 2 piece die-cast aluminum with brushed aluminum housing finish for duplex receptacles. Bottom plate with two knockouts for centered or offset installation.
- 2.8.2. Pedestal type 'low tension' fitting made of 2 piece die cast aluminum with brushed aluminum housing finish to accommodate Amphenol jack connectors.

3. Execution

3.1. INSTALLATION

- 3.1.1. Support boxes independently of connecting conduits.
- 3.1.2. Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- 3.1.3. For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- 3.1.4. Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- 3.1.5. Non-combustible electrical outlet boxes that penetrate a fire separation or a membrane forming part of an assembly required to have a fire-resistance rating, do not require fire stops provided,
 - .1 they do not exceed:
 - .1 100 cm² each in area, AND
 - .2 an aggregate area of 650 cm² in any 9.3 m² of surface area, AND
 - .2 The annular space between the membrane and the box does not exceed 3 mm.
- 3.1.6. Where the conditions of clause 3.1.5 are not met, provide fire stops for the outlet boxes.

- 3.1.7. Opposing outlets on non-fire rated partition walls shall have a minimum 150 mm horizontal separation. Outlets shall not be mounted back to back.
- 3.1.8. Conform to the fire stopping requirements of the building code: unless provided with a fire stop in accordance with CAN/ULC-S115, "Fire Tests of Fire Stop Systems", electrical outlet boxes on opposite sides of a vertical fire separation required to have a fire-resistance rating shall be separated by a horizontal distance of not less than 600 mm, or be installed in adjacent stud cavities.

END OF SECTION

26 05 34.00 Conduits, Conduit Fasteners and Fittings

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 31.00 – SPLITTERS, JUNCTION, PULL BOXES AND CABINETS
- 1.1.3. Section 26 05 32.00 – OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1.2. REFERENCES

- 1.2.1. CAN/CSA C22.2 No.18- Outlet Boxes, Conduit Boxes, and Fittings, latest edition.
- 1.2.2. CSA C22.2 No.45.1- Electrical Rigid Metal Conduit - Steel, latest edition.
- 1.2.3. CSA C22.2 No.56- Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit, latest edition.
- 1.2.4. CSA C22.2 No.83- Electrical Metallic Tubing, latest edition.
- 1.2.5. CSA C22.2 No.211.2- Rigid PVC (Unplasticized) Conduit, latest edition.
- 1.2.6. CAN/CSA C22.2 No.227.3- Flexible Non-metallic Tubing, latest edition.
- 1.2.7. CSA C22.2 No.227.1 - Electrical Non-Metallic Tubing, latest edition.

2. Products

2.1. CONDUITS

- 2.1.1. Electrical rigid metal conduit: to CSA C22.2 No.45.1, galvanized steel or aluminum threaded.
- 2.1.2. Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- 2.1.3. Electrical metallic tubing (EMT): to CSA C22.2 No.83, with couplings.
- 2.1.4. Rigid PVC conduit: to CSA C22.2 No.211.2.
- 2.1.5. Flexible metal conduit: to CSA C22.2 No.56, steel or liquid-tight flexible metal.
- 2.1.6. Electrical non-metallic tubing (ENT): to CSA C22.2 No. 227, with couplings.

2.2. CONDUIT FASTENINGS

- 2.2.1. One-hole steel straps to secure surface conduits NPS 2 and smaller. Two-hole steel straps for conduits larger than NPS 2.
- 2.2.2. Beam clamps to secure conduits to exposed steel work.
- 2.2.3. Channel type supports for two or more conduits at 1 m oc.
- 2.2.4. Hot dipped galvanized threaded rods, 6 mm dia. minimum, to support suspended channels.

2.3. CONDUIT FITTINGS

- 2.3.1. Fittings: manufactured for use with conduit specified. Coating: same as conduit.

- 2.3.2. Factory 90 degree elbow where 90 bends are required for 1” and larger conduits when a hydraulic bender is not used.
- 2.3.3. Connectors, and couplings for EMT conduit are to be set-screw steel type. Below the level of suspended ceilings, in a sprinklered environment, provide watertight fittings and “O” rings on all conduit runs and when conduit is terminated at any piece of electrical equipment.
- 2.3.4. Provide plastic bushings for all connectors, rigid nipples and rigid conduit 32mm or larger.
- 2.4. EXPANSION FITTINGS FOR RIGID CONDUIT
 - 2.4.1. Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- 2.5. FISH CORD
 - 2.5.1. Fish cord to be made of polypropylene.
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. All conduits on project to be surface mounted. No conduits in cast in-place concrete or in slab conduits will be allowed unless written consent is received from the Engineer’s Representative and Owner. Only once approved by the Engineer’s Representative and Owner do the clauses contained within this section and the respective sections relating to conduits in cast in-place concrete or in slab conduits apply.
 - 3.1.2. Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
 - 3.1.3. Conceal conduits except in mechanical and electrical service rooms or in unfinished areas. Conduits to have their own support system and are to be supported independently of the ceiling grid or ceiling support system.
 - 3.1.4. Where vertically run conduit passes through a slab, Contractor to provide a 100mm high concrete pad with the pad extending 100mm on all sides of the conduit.
 - 3.1.5. Use electrical metallic tubing (EMT) conduit except where specified otherwise.
 - 3.1.6. Use epoxy coated conduit in corrosive areas.
 - 3.1.7. Use rigid galvanized steel threaded conduit where conduit is subject to mechanical damage.
 - 3.1.8. Use rigid PVC conduit underground or in corrosive areas and where indicated.
 - 3.1.9. Use flexible metal conduit for connection to motors or vibrating equipment in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.
 - 3.1.10. Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations. Use only liquid tight fittings when using liquid tight flexible metal conduit. Liquid tight flexible metal conduit to have a jacket with an FT6 rating when used in plenums otherwise provide a minimum FT4 rating.
 - 3.1.11. Use explosion proof flexible connection for connection to explosion proof motors.
 - 3.1.12. Install conduit sealing fittings in hazardous areas. Fill with compound.
 - 3.1.13. Minimum conduit size for lighting and power circuits: NPS 21mm, unless otherwise noted on the drawings.

- 3.1.14. Install EMT conduit from a raised floor branch circuit panel to outlet boxes located in sub floor.
- 3.1.15. Install EMT conduit from a raised floor branch circuit panel to junction box in sub-floor. Run flexible metal conduit from junction box to outlet boxes for equipment connections in sub-floor.
- 3.1.16. Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- 3.1.17. Mechanically bend steel conduit over 19 mm diameter.
- 3.1.18. Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- 3.1.19. Install fish cord in empty conduits.
- 3.1.20. Run two 27mm spare conduits up to ceiling space and two 27mm spare conduits down to sub-floor space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm junction boxes or in case of an exposed concrete slab, terminate each conduit in flush concrete or surface type box.
- 3.1.21. Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- 3.1.22. Dry conduits out before installing wire.
- 3.1.23. All cutting and patching of masonry/concrete floors, walls, and roof for electrical services shall be by this Division. Obtain approval from the Landlord and/or structural Engineer's Representative before cutting any structural walls or floors. Cutting and drilling shall only be at times allowed by the Landlord. Check and verify the location of existing mechanical and electrical services in walls and below the floor slab in all areas requiring core drilling and cutting. Protect all tenant areas where core drilling occurs. Carefully chip top and bottom of slab to expose rebar to minimize cutting of rebar when core drilling. Provide x-ray study before drilling or cutting where required by the Landlord and/or structural Engineer's Representative.
- 3.1.24. Provide sleeves for all new conduit passing through floor and roof slabs, beams, concrete walls and slab to slab partitions, etc.
- 3.1.25. Where cables and conduits pass through partitions and through floors that are not fire rated, provide an air-tight seal around the cables and conduits.
- 3.1.26. Where cables and conduits pass through floors and fire rated walls, pack space between conduit (or cable) and sleeve with an approved fire stop as specified in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 3.1.27. Prior to installation of any wire or cable in the ducts, pull through each duct a flexible mandrel not less than 300 mm long and size for the internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Notify the engineer's representative no less than 48 hours prior to the event, so that the engineer's representative may witness.
- 3.2. SURFACE CONDUITS
 - 3.2.1. Run parallel or perpendicular to building lines.
 - 3.2.2. Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
 - 3.2.3. Run conduits in flanged portion of structural steel.
 - 3.2.4. Group conduits wherever possible on suspended or surface mounted channels.
 - 3.2.5. Do not pass conduits through structural members, except as indicated.
 - 3.2.6. Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
 - 3.2.7. Conduits must not be used to support other conduits.

3.3. CONCEALED CONDUITS

- 3.3.1. Run parallel or perpendicular to building lines.
- 3.3.2. Do not install horizontal runs in masonry walls.
- 3.3.3. Do not install conduits in terrazzo or concrete toppings.

3.4. CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

- 3.4.1. Run conduits 25 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.

3.5. CONDUITS UNDERGROUND

- 3.5.1. Slope conduits to provide drainage.
- 3.5.2. For all non-PVC conduits run underground, provide waterproof joints with heavy coat of bituminous paint.

END OF SECTION

26 05 44.00 Installation of Cables in Trenches and in Ducts

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 33 71 19.00 - CONCRETE ENCASED DUCT BANKS AND MAINTENANCE CHAMBERS.

2. Products

2.1. CABLE PROTECTION

2.1.1. Protect existing cables in manholes and trenches with 38 mm x 140 mm planks pressure treated with 5% pentachlorophenol solution, water repellent preservative.

2.2. MARKERS

2.2.1. Concrete type cable markers: 600 x 600 x 100 mm with words: cable, joint or conduit impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

3. Execution

3.1. CABLE INSTALLATION IN DUCTS

3.1.1. Install cables as indicated in ducts.

3.1.2. Pull a steel mandrel through each duct less than 300 mm long and of a diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling-in cables.

3.1.3. Install a polypropylene pull string in each duct if one does not exist. Pull string to remain after cable has been installed.

3.1.4. Do not pull spliced cables inside ducts.

3.1.5. Install multiple cables in duct simultaneously.

3.1.6. Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

3.1.7. To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.

3.1.8. Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.

3.1.9. After installation of cables, seal duct ends with duct sealing compound.

3.2. MARKERS

3.2.1. Mark cable every 150 m along cable or duct runs and changes in direction.

3.2.2. Mark underground splices.

3.2.3. Where markers are removed to permit installation of additional cables, reinstall existing markers.

3.2.4. Lay concrete markers flat and centered over cable with top flush with finish grade.

END OF SECTION

26 05 53.00 Identification

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. Ontario Electrical Safety Code.

1.2.2. Ontario Building Code.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

2. Products

2.1. EQUIPMENT IDENTIFICATION

2.1.1. Identify electrical equipment with nameplates as follows:

- .1 Lamacoid 3 mm thick plastic engraved sheet, black or red face, white core, mechanically attached with self-tapping screws or rivets.
- .2 White letters 12 mm high for major switchboards, panelboards and power transformers.
- .3 White letters 12 mm high for terminal boxes, junction boxes, grid boxes, splitter boxes, disconnect switches starters and contactors.
- .4 Allow for an average of fifty (50) to one hundred (100) letters per nameplate.
- .5 Identification to be in English.
- .6 Black nameplates for normal power.
- .7 Sample:

<p>SWITCHBOARD AA 3000A, 600/347V, 3 PH, 4W, 50kA FED FROM SWITCHBOARD AAA MANUFACTURED IN MM/YYYY; SERIAL NUMBER ##-####</p>

- .8 Wording on nameplates to be approved by Engineer's Representative prior to manufacture.
- .9 Nameplates for splitters, terminal cabinets, grid boxes, pull boxes, and junction boxes are to indicate the system and/or voltage characteristics.
- .10 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

- .11 Transformers: indicate capacity, primary and secondary voltages, and upstream source where Transformer is fed from.
 - .12 Mechanical equipment: indicate equipment name and full circuit number including panel board identification.
 - .13 Switchboards, Distribution Panels, and Panelboards: Name designation, rated ampacity, voltage, number of phases, and number of wires, if neutral is rated for 200%, interrupting capacity in units of kA, upstream source from which panelboard is fed, month and year manufactured, and serial number.
 - .14 Provide nameplates on all electrical equipment including:
 - .1 Splitters, terminal cabinets, grid boxes, pull boxes, and junction boxes
 - .2 Disconnects, starters and contactors, and Mechanical equipment
 - .3 Transformers
 - .4 Switchgear, Switchboards, Distribution Panels, and Panelboards
 - .5 Automatic Transfer Switches
 - .6 Generators
 - .7 UPS equipment
 - .8 Lighting control systems
- 2.1.2. Labels:
- .1 A printed label, similar to a Brady label 6 mm high letters unless specified otherwise, for internal components, such as relays, fuses, terminal blocks.
- 2.2. WIRING IDENTIFICATION
- 2.2.1. Identify wiring with permanent legible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
 - 2.2.2. Maintain phase sequence and colour coding throughout.
 - 2.2.3. Colour code: in conformance with the electrical code.
 - 2.2.4. Use colour coded wires in communication cables and control wiring, matched throughout system.
- 2.3. CONDUIT AND CABLE IDENTIFICATION
- 2.3.1. Colour code conduits, boxes and metallic sheathed cables.
 - 2.3.2. Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
 - 2.3.3. Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour:
 - .1 up to 250 V Normal Power = Green
 - .2 up to 600 V Normal Power = Blue
 - .3 up to 250 V Emergency Power = Black
 - .4 up to 600 V Emergency Power = Orange
 - .5 High Voltage, greater than 750 V = Large independent label clearly identifying the voltage
 - .6 Telephone/Data = White
 - .7 Fire alarm = Red
 - .8 Other security systems = Yellow

.9 Controls = Purple

2.4. RECEPTACLE IDENTIFICATION

2.4.1. All receptacles including systems furniture receptacles and whip connections are to be labelled with the respective circuit numbers with a printed label, similar to a Brady label, with 12mm characters. Circuit number to include full circuit number including panel board identification.

2.4.2. Label to be placed on wall above cover plate or on cover plate. Location of label to be consistent throughout project.

2.5. MANUFACTURERS AND CSA LABELS

2.5.1. Visible and legible after equipment is installed.

2.6. WARNING SIGNS

2.6.1. Provide warning signs, as specified, and/or to meet the requirements of the Inspection Authorities.

2.7. FUSE SIZE LABELLING

2.7.1. Contractor to install a label on all equipment with fuses to identify the fuse sizes and class that are installed in the respective equipment.

2.7.2. Contractor to also install a label on all equipment with fuses to identify the maximum allowable fuse size based on the size of the respective feeders.

3. Execution

3.1. NOT USED

END OF SECTION

26 05 63.00 Access Doors and Accessibility

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. SHOP DRAWINGS AND PRODUCT DATA

1.2.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2.2. Submit drawings showing size, type and location of all access doors, for review, before installation.

2. Products

2.1. MATERIALS

2.1.1. Access doors shall be Acudor, or LeHage or Mifab. Coordinate with other trades on site. All access doors on site shall be from the same manufacturer.

2.1.2. Doors in solid walls shall be equal to Acudor Model UF5000 with 14 U.S. gauge, prime painted steel door panel, rust resistant concealed hinges and screwdriver operated lock.

2.1.3. Doors in plaster partitions or ceiling shall be equal to Acudor model AP5010 16 US gauge, prime painted steel, concealed hinges and screwdriver operated lock.

2.1.4. Doors in drywall partitions or ceiling shall be equal to Acudor model DW 5040, 20 US gauge, prime painted steel, concealed hinges and screwdriver operated lock.

2.1.5. Access doors in fire rated walls or ceilings shall be equal to Acudor Model FW 5050 and ULC labeled with insulated door panel, concealed hinge, self-closing, self-latching, and prime painted. Provide master key operated catch in areas accessible to the public.

2.1.6. All doors in tiled walls shall be 16 US gauge, stainless steel, type 304 with #4 satin finish, concealed hinges, wall frame and screw driver operated lock.

2.1.7. Minimum size of doors shall be 300 mm x 450 mm. Wherever possible 600 mm x 600 mm doors shall be used.

3. Execution

3.1. INSTALLATION

3.1.1. All parts of the installation requiring periodic maintenance shall be accessible. Wherever pull boxes, junction boxes and other appurtenances are concealed by building construction, access doors shall be furnished by this section and installed under the respective Trade Sections (i.e. masonry, plaster, drywall, tile, etc.). This section is responsible for the proper location of the access doors.

3.1.2. Wherever possible, items requiring access shall be located in easily accessible areas (i.e. exposed or T-bar ceilings).

- 3.1.3. Group items in order to minimize the number of access doors required.
- 3.1.4. Each access door shall be installed to provide complete access to equipment for maintenance and servicing.
- 3.1.5. Make any changes to locations of access doors as directed by the Engineer's Representative.
- 3.1.6. The final installed locations of all access doors shall be shown on the As-Built Record Drawings.

END OF SECTION

26 05 73.00 Electrical Power System Studies

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
 - 1.2. REFERENCES
 - 1.2.1. CSA Z462 – Workplace Electrical Safety, latest edition.
 - 1.2.2. IEEE 1584 – IEEE Guide for Performing Arc Flash Hazard Calculations, latest edition.
 - 1.2.3. NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition.
 - 1.3. SUMMARY
 - 1.3.1. The electrical power system studies for the project shall be performed by an approved electrical power systems contractor. The type and content of each study is specified in the following articles.
 - 1.3.2. The extent of the power systems studies shall include from the main utility connection down to the branch circuit panels. All relays and fuse sizes to be included to ensure the best operation of the entire system. The studies shall also be performed to include the operation of the emergency power generation system.
 - 1.3.3. Contractor to label and re-label with the appropriate Client approved label all equipment that is new or the calculated values have changed from what is currently shown.
 - 1.4. SHOP DRAWINGS AND PRODUCT DATA
 - 1.4.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
 - 1.4.2. Completed electrical power system studies shall be bound and submitted to the Engineer. Submit initial version(s) of the power system studies during the project shop drawing stage. Submit another “final” version of the power system studies at the end of the project utilizing the final/installed values. The study must be stamped and signed by a professional engineer in the applicable jurisdiction of the project for all submissions.
 - 1.4.3. Contractor providing electrical power systems study to allow for revisions/adjustments based on review comments and actual transformer impedances.
 - 1.4.4. Provide a minimum of three (3) bound coloured copies of all submissions to Owner and Engineer for review. Modify studies based on comments received and continue to re-issue until an accepted version is agreed upon.
 - 1.4.5. Provide a copy of the working electronic file in native program format along with each of the final copies of the studies. Identify what software was used to complete the studies. The information contained within the project file remains the property of the owner and can be used by the Owner for future system modifications.
 - 1.4.6. Provide samples of the proposed arc flash labels. All labels to match the Owners standard labels.

1.4.7. Contractor shall submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, contractor shall submit at a minimum a preliminary short circuit study for review.

2. Product

2.1. ELECTRICAL POWER SYSTEM STUDIES

2.1.1. Short-Circuit Analysis

- .1 Calculation of maximum RMS symmetrical three-phase short-circuit and single line to ground fault current at each significant location in the electrical system shall be made using a digital computer.
- .2 Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.
- .3 A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
- .4 The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
- .5 Include a computer printout identifying the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.
- .6 The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.
- .7 A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for the improvements to the system.
- .8 The contractor shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.
- .9 Any inadequacies shall be called to the attention of the engineer (architect) and recommendations made for improvements as soon as they are identified.

2.1.2. Protective Device Time-Current Coordination Analysis

- .1 The time-current coordination analysis shall be performed with the aid of a digital computer and will include the determination of settings, ratings, or types for the over-current protective devices supplied.
- .2 A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected over-current devices and other pertinent system parameters.

- .3 Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
- .4 The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable over-current protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.
- .5 A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
- .6 A discussion section which evaluates the degree of system protection and service continuity with over-current devices, along with recommendations as required for increasing system protection or device coordination.
- .7 Significant deficiencies in protection and/or coordination shall be called to the attention of the engineer (architect) and recommendations made for improvements as soon as they are identified.

2.1.3. Arc Flash/Incident Energy Study

- .1 An Arc Flash/Incident Energy Study shall be performed to determine the incident energy and arc flash protection boundary at each piece of electrical equipment and to identify the level of PPE required by people working on that respective equipment.
- .2 All equipment rated at 208V fed from a transformer less than 125kVA are not required to be included in the study. Equipment not included in the study is to receive a common arc-flash label that does not include equipment specific data.
- .3 The study shall take into account all the information set forth in the short circuit study and the coordination study. Contractor to use the minimum and maximum fault currents provided by the utility to determine the worst incident energy levels. Provide two columns in your arc flash summary sheet identifying the current at both fault levels. Contractor to revisit the coordination study and revise coordination to provide the minimum incident energy levels as possible. Provide recommendations to reduce the incident energy levels even further at the risk of affecting the coordination to allow Owner and Engineer's Representative to review options and provide feedback.
- .4 Calculate the arc flash hazard, incident energy level and the flash protection boundary as per IEEE 1584. PPE level recommendations as per NFPA 70E / CSA Z462.
- .5 All electrical equipment to be identified with the incident energy, flash protection boundary and level of PPE required.
- .6 Purpose made labels to be provided on all electrical equipment. All equipment where levels were not calculated are to be provided with a standard warning label. Label samples to be submitted for review by Owner and Engineer's Representative.

2.2. APPROVED ELECTRICAL POWER SYSTEMS CONTRACTORS

2.2.1. The power system studies shall be completed by qualified and experienced personnel.

2.2.2. The specified electrical power system studies shall be performed by:

- .1 G.T. Wood.
- .2 K-Line – K-Tek.
- .3 Schneider-Electric Services.
- .4 Eaton - Cutler-Hammer Service Group.

- .5 Pelikan Inc.
- .6 General Electric (GE).
- .7 Eastenghouse.
- .8 AC Tesla.
- .9 Brosz Technical Services.
- .10 Enkompass Power and Energy Corp.

3. Execution

3.1. GENERAL

- 3.1.1. Contractor to include for all on site surveys and investigations in order to obtain all the relevant information to complete all the studies.
- 3.1.2. The relays and equipment will be set up on site by the Technical Start-Up Services Contractor. Coordinate with this Contractor to ensure information is relayed accordingly.
- 3.1.3. Review work on site to ensure equipment has been set up as per the coordination study. Have the Technical Services Start-up Contractor test systems at random to ensure the coordination study has been adhered to.
- 3.1.4. Submit a report and a letter reporting to the Engineer and Owner that the coordination study information has been followed.
- 3.1.5. Contractor to revise fuse sizes as identified in the report and modify the drawings to represent as-built conditions.

3.2. LABELLING

- 3.2.1. Install arc flash labels on all equipment. Coordinate with the electrical contractor.

3.3. TRAINING

- 3.3.1. Provide one day of in-depth training on arc-flash safety detailing the industry and code requirements including the details of the specific project for the Owner and the Owner's representatives.

END OF SECTION

26 05 83.00 Sleeves

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Sleeves passing through stud partitions shall be 0.75 mm 22 US Gauge steel.

2.1.2. Sleeves passing through masonry walls shall be Schedule 40 steel pipe.

2.1.3. Sleeves passing through floors in finished areas and concealed spaces may be sheet metal or factory fabricated reusable type.

2.1.4. Where a housekeeping pad cannot be installed, sleeves passing through floors with waterproof membrane shall have a flashing collar, 50 mm wide at the membrane level. Flashing collar shall be continuously welded to sleeve. Sleeves shall extend 50 mm above the finished floor and shall be Schedule 40 steel pipe.

2.1.5. Where conduits pass through exterior foundation walls 6 mm thick steel sleeve of inside diameter not less the 75 mm greater than the outside diameter of the pipe shall be used and shall be complete with anchor collar. Thunderline Link-Seal wall seal or approved equal shall be used for the annular space between the sleeve and the conduit. A reinforced concrete bridge shall be installed between the wall and the adjacent undisturbed soil.

2.1.6. Provide adequate bracing for support of sleeves during concrete and masonry work.

2.1.7. Unless otherwise specified on the drawings, sleeves passing through the roof shall be liquid tight flexible conduit flashing consisting of a gooseneck shaped aluminum flashing sleeve with an integral deck flange, EPDM end cap seal and EPDM base seal.

3. Execution

3.1. INSTALLATION

3.1.1. Arrange for all chases and formed openings in walls and floors as required by the Electrical Division for the Electrical services. These chases and openings shall not be larger than necessary to accommodate the equipment and services. Advise on these requirements well in advance, before the concrete is poured and the walls are built. All necessary sleeves and inserts shall be supplied by this Division.

3.1.2. Chases and openings not located in accordance with the above provisions shall be made at the expense of this Division. Cutting of structural members shall not be permitted without specified written acceptance of the Engineer's Representative.

3.1.3. Provide sleeves for all service penetrations through walls, partitions, floor slabs, plenums and similar barriers. At non-rated barriers fill the annular space between the service and the sleeve with fire rated insulation as specified for rated separations and caulk around the edges with a minimum 12 mm thick of fire rated compound or acoustic non-setting mastic.

- 3.1.4. Through all fire or smoke separations, after testing, the annular space between conduit sleeves shall be fire stopped.
- 3.1.5. Where-holes are to be installed in existing structure, contractor is to core drill the-holes required. Contractor is required to scan all areas prior to coring and confirm layout with structural engineer prior to completing work. When installing sleeves in existing structures, sleeves shall be provided as specified complete with a combination puddle/anchor flange bolted to the floor. Seal watertight between the flange and the floor.
- 3.1.6. All sleeves are to extend 150mm above finished floor to accommodate a 100mm concrete pad. Contractor to pour the concrete pad with the pad extending 100mm on all sides of the sleeve.

END OF SECTION

26 24 13.00 Switchboards

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 53.00 – IDENTIFICATION.

1.1.4. Section 26 28 21.00 – MOULDED CASE CIRCUIT BREAKERS.

1.1.5. Section 26 28 14.00 – FUSES LOW VOLTAGE.

1.2. REFERENCE

1.2.1. CAN/CSA C22.2 No. 31 – Switchgear Assemblies, latest edition.

1.2.2. Seismic compliance: International Building Code (IBC) and California Building Code (CBC), latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.3.2. Indicate on Shop Drawings:

.1 Floor or wall anchoring method and foundation template.

.2 Dimensioned cable entry and exit locations.

.3 Dimensioned position and size of bus.

.4 Overall length, height and depth.

.5 Dimensioned layout of internal and front panel mounted components.

1.3.3. Include time-current characteristic curves for circuit breakers and fuses.

1.3.4. Provide certificates of compliance with the requirements as stated within the IBC and CBC and demonstrated the ability to function after the test.

1.4. MAINTENANCE DATA

1.4.1. Submit 3 copies of the maintenance data for the complete assembly including components, and include in the project operating and maintenance manuals.

1.5. MAINTENANCE MATERIALS

1.5.1. Include:

.1 Fuse or breaker types.

1.6. SOURCE QUALITY CONTROL

1.6.1. Submit 3 copies of certified test results, and include in the project operating and maintenance manuals.

-
- 2. Products
 - 2.1. SWITCHBOARD
 - 2.1.1. Ratings as identified on the drawings and/or schedules.
 - 2.1.2. Switchboard breakers to have a minimum short circuit current rating as indicated on the drawings.
 - 2.1.3. Enclosures to be dead-front, CSA Type 1 with drip hood, sprinkler proof enclosure, size as indicated.
 - 2.1.4. Hinged access panels with captive knurled thumb screws.
 - 2.1.5. Bus bars and main connections: copper.
 - 2.1.6. Bus from load terminals of main breaker via metering section to main lugs of distribution section.
 - 2.1.7. Identify phases with colour coding.
 - 2.1.8. Provide two-hole long barrel compression lugs with inspection / viewing window for the main feeder terminations. All lugs to be dual rated for Copper/Aluminum (Cu/Al). Size as per the drawings.
 - 2.1.9. Breakers and/or fuse sections shall be bolt-on.
 - 2.1.10. Make provisions to extend the main bus to future cubicles on each end of the switchboard.
 - 2.2. CIRCUIT BREAKERS
 - 2.2.1. Circuit breakers to be supplied as per Section 26 28 21.00 – MOULDED CASE CIRCUIT BREAKERS.
 - 2.2.2. All breakers to be factory installed and tested.
 - 2.2.3. Circuit breaker conductor terminations to be dual rated for Copper/Aluminum (Cu/Al).
 - 2.3. GROUNDING
 - 2.3.1. Copper ground bus extending full width of cubicles and located at bottom.
 - 2.3.2. Provide two-hole long barrel compression lugs with inspection / viewing window for the ground cable terminations. Size as per the drawings.
 - 2.4. FINISHES
 - 2.4.1. Apply finishes in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - 2.4.2. Switchboard to be painted: baked grey enamel.
 - 2.5. EQUIPMENT IDENTIFICATION
 - 2.5.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
 - 2.5.2. Label all branch feeders with names as indicated on drawings.
 - 2.6. MANUFACTURERS
 - 2.6.1. The switchboards shall be manufactured by:
 - .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.

.3 Siemens.

3. Execution

3.1. INSTALLATION

3.1.1. Locate switchboard and secure in position. Install floor mounted switchboards on a 100 mm concrete housekeeping pad.

3.1.2. Connect main incoming feeder to line terminals of main breaker, if applicable.

3.1.3. Connect load terminals of distribution switches or breakers to feeders.

3.1.4. Check factory made connections for mechanical security and electrical continuity.

3.1.5. Check trip unit settings and fuse sizes against co-ordination study to ensure proper working and protection of components.

3.2. TESTING

3.2.1. Contractor to review and test that all wiring has been connected as per the manufacturer drawings.

END OF SECTION

26 24 17.00 Panelboards – Breaker Type

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
 - 1.1.3. Section 26 05 05.00 – MOUNTING HEIGHTS.
 - 1.1.4. Section 26 05 53.00 – IDENTIFICATION.
 - 1.2. REFERENCES
 - 1.2.1. CSA C22.2 No. 29 – Panelboards and Enclosed Panelboards, latest edition.
 - 1.2.2. CSA C22.2 No. 5 – Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures, latest edition.
 - 1.3. SHOP DRAWINGS AND PRODUCT DATA
 - 1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
 - 1.3.2. Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
2. Products
 - 2.1. PANELBOARDS
 - 2.1.1. Panelboards: product of one manufacturer.
 - 2.1.2. Install circuit breakers in panelboards before shipment.
 - 2.1.3. In addition to CSA requirements manufacturer's nameplate must show fault current that the panel including all breakers have been built to withstand.
 - 2.1.4. Panelboards to have the following minimum ratings for interrupting capacity or as indicated on the drawings or panel schedules.
 - .1 120/208V panelboards – 22kA
 - 2.1.5. Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
 - 2.1.6. Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated. Provide an additional 20% of space within each panelboard in addition to what is shown on the drawings when a separate panel schedule is not provided for a specific panelboard.
 - 2.1.7. Two keys for each panelboard and key panelboards alike.
 - 2.1.8. Panelboards to be copper bus unless identified otherwise.
 - 2.1.9. Where identified on the drawings or schedules, provide a copper neutral bus sized to 200% of the mains rating for panels.
 - 2.1.10. Mains: suitable for bolt-on breakers.

- 2.1.11. Trim with concealed front bolts and hinges.
- 2.1.12. Trim and door finish: baked grey enamel.
- 2.1.13. Enclosure to be CSA Type 1 with drip hood with the exception of recessed panel enclosures which are to be CSA Type 1.
- 2.1.14. Surge Protection Device as required.
- 2.1.15. Series ratings may be acceptable. Panels to be labeled as such. Manufacturing to supply supporting data.
- 2.1.16. All lugs to be dual rated for Copper/Aluminum (Cu/Al).

- 2.2. MOULDED CASE CIRCUIT BREAKERS
 - 2.2.1. Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. C. ambient.
 - 2.2.2. Common-trip breakers: with single handle for multi-pole applications.
 - 2.2.3. Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.
 - 2.2.4. Main breaker, where indicated: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
 - 2.2.5. Lock-on devices for 10 % of 15 to 30 A breakers installed. Turn over unused lock-on devices to Owner.
 - 2.2.6. Where breakers are identified to feed high intensity discharge (HID) lighting, provide breakers that are rated and designed for use with HID lighting.
 - 2.2.7. Provide one breaker per designated breaker space. Multiple breakers contained in one housing or twin breakers are not acceptable.
 - 2.2.8. Breaker terminals to be dual rated for Copper/Aluminum (Cu/Al).

- 2.3. EQUIPMENT IDENTIFICATION
 - 2.3.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
 - 2.3.2. Complete circuit directory with typewritten legend showing location and load of each circuit.

- 2.4. MANUFACTURERS
 - 2.4.1. The following are acceptable manufacturers:
 - .1 Schneider Electric
 - .2 Eaton Cutler-Hammer
 - .3 Siemens

- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

- 3.1.2. Install surface mounted panelboards on galvanized unistrut stand-offs or on fire rated plywood backboards. The plywood backboards are to be as per Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 3.1.3. Mount panelboards at height specified in Section 26 05 05.00 – MOUNTING HEIGHTS.
- 3.1.4. Connect loads to circuits.
- 3.1.5. Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

26 27 26.00 Wiring Devices

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 05 05.00 – MOUNTING HEIGHTS.
- 1.1.4. Section 26 05 53.00 – IDENTIFICATION.
- 1.1.5. Section 26 51 13.00 – LIGHTING EQUIPMENT.

1.2. SHOP DRAWINGS AND PRODUCT DATA

- 1.2.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

2. Products

2.1. SWITCHES

- 2.1.1. 20 A, single pole, double pole, three-way, or four-way specification grade switches. Voltage rating of the switch to be as per the contract documents.
- 2.1.2. Manually-operated general purpose switches with following features:
 - .1 Terminal-holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 Decora Style specification grade Rocker switch.
 - .6 Colour to be selected by Architect/Engineer's Representative.
- 2.1.3. Toggle operated locking fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

2.2. RECEPTACLES

- 2.2.1. All receptacles to be specification grade.
- 2.2.2. Duplex specification receptacles, Decora style CSA type 5-15 R, 125 V, 15 A, U ground, with following features:
 - .1 Thermoplastic with impact-resistant nylon face moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Eight back wired entrances, four side wiring screws.
 - .4 Triple wipe contacts and riveted grounding contacts.
- 2.2.3. Hospital grade receptacles:

- .1 Hospital grade with green dot symbol, tamper-resistant, extra heavy duty, modular plug-in type, 15 ampere, 125 V, 2-pole, 3-wire U-ground duplex receptacles complete with front circuit identification area.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Eight back wired entrances, four side wiring screws.
 - .4 Triple wipe contacts and riveted grounding contact.
- 2.2.4. Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
- .1 Thermoplastic moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
- 2.2.5. Other receptacles with ampacity and voltage as indicated.
- 2.2.6. Receptacles to be coloured as follows:
- .1 Normal Power – Colour to be selected by Architect/Engineer's Representative.
 - .2 Emergency/Essential Power – Red.
 - .3 Isolated Ground – Orange.
 - .4 Switched – Gray.
 - .5 UPS – Blue.
- 2.2.7. Electrical Contractor shall coordinate with furniture supplier to identify switched circuits prior to installation.
- 2.3. MANUFACTURERS
- 2.3.1. The switches and wiring devices shall be of one manufacturer throughout the project.
- 2.3.2. The following are acceptable manufacturers:
- .1 Legrand.
 - .2 Hubbell.
 - .3 Cooper.
 - .4 Leviton.
- 2.4. DIMMERS
- 2.4.1. Dimmers shall be 600W, 1500W, 2000W.
- .1 Full range, continuously variable control of light intensity.
 - .2 Vertical slider allowing the light level to be set by the user.
 - .3 Slide to Off.
 - .4 Capable of operating at rated capacity.
 - .5 Power failure memory.
 - .6 Dimmers shall be available for direct control of incandescent, magnetic low voltage, electronic low voltage, fluorescent, and LED.
- 2.4.2. Electronic (solid-state) Low Voltage (ELV) transformer dimmers (incandescent).
- .1 Circuitry designed to control the input of Electronic (solid state) Low Voltage transformers.
 - .2 Control up to 600W of Electronic Low Voltage load.

- .3 Reset-able overload protection when capacity is exceeded.
- 2.4.3. Magnetic Low-Voltage (MLV) transformer dimmers.
 - .1 Designed to control and provide a symmetrical AC wave form to input of magnetic low voltage transformers per UL 1972 section 5.11.
 - .2 Direct control of up to 1500VA of Magnetic Low Voltage load.
 - .3 Dimmer shall be suitable to control dimming ballast as specified in Section 26 51 13.00 – LIGHTING EQUIPMENT.
- 2.4.4. LED dimmers.
 - .1 Slide to Off only. Must match driver and LED requirements.
- 2.4.5. Manufacturers
 - .1 Lutron Maestro Series.
 - .2 Leviton True Touch Series.
- 2.5. SPECIAL WIRING DEVICES
- 2.5.1. Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic lens flush type.
- 2.6. COVER PLATES
- 2.6.1. Cover plates for wiring devices.
- 2.6.2. Cover plates from one manufacturer throughout project.
- 2.6.3. Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- 2.6.4. Provide stainless steel cover plates, suitable for the respective device, for all devices mounted in flush-mounted outlet boxes located in finished areas.
- 2.6.5. Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- 2.6.6. Weatherproof rain tight while-in-use metal cover, complete with gaskets for duplex receptacles located outside or as indicated.
- 2.6.7. Weatherproof rain tight while-in-use metal cover, complete with gaskets for single receptacles or switches located outside or as indicated.
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Where line voltage controls are used, install an identified conductor at each location of a manual or automatic control device in accordance with electrical code requirements.
 - .4 Mount toggle switches at height specified in Section 26 05 05.00 – MOUNTING HEIGHTS or as indicated.
- 3.1.2. Receptacles:

- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
- .2 Mount receptacles at height specified in Section 26 05 05.00 – MOUNTING HEIGHTS or as indicated.
- .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .4 Install hospital grade receptacles in all patient care areas in healthcare applications.

3.1.3. Dimmers:

- .1 Install dimmers as indicated. Provide suitable clearances in multi-gang boxes as recommended by the manufacturer to maintain the dimmer rating.
- .2 Coordinate the dimmer selection with the ballast/driver to be controlled, to ensure compatibility.
- .3 Where line voltage controls are used, install an identified conductor at each location of a manual or automatic control device in accordance with electrical code requirements.

3.1.4. Cover plates:

- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .2 Install suitable common cover plates where wiring devices are grouped.
- .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.1.5. Labelling

- .1 Provide labels with panel name and circuit number on all receptacles in conformance with Section 26 05 53.00 – IDENTIFICATION.

END OF SECTION

26 28 14.00 Fuses Low Voltage

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. CSA C22.2 No. 248, Low Voltage Fuses, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.3.2. Submit fuse performance data characteristics for each fuse type and size above 100 A. Performance data to include: average melting time-current characteristics, I₂t (for fuse coordination), and peak let-through current.

1.4. MAINTENANCE MATERIALS

1.4.1. Three spare fuses of each type and size installed 600 A. and above.

1.4.2. Six spare fuses of each type and size installed up to and including 400 A.

1.5. DELIVERY AND STORAGE

1.5.1. Ship fuses in original containers.

1.5.2. Do not ship fuses installed in switchboard.

1.5.3. Store fuses in original containers in moisture free location.

2. Products

2.1. FUSES GENERAL Fuses: product of one manufacturer.

2.1.2. Fuses to have an indicating window to identify when the fuse has been blown.

2.2. FUSE TYPES

2.2.1. Class L fuses.

.1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.2 Type L2, fast acting.

2.2.2. Class J fuses.

.1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.2 Type J2, fast acting.

2.2.3. Class R fuses. For UL Class RK1 fuses, peak let-through current and I₂t values not to exceed limits of CSA C22.2 No. 248.

- .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
 - .2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.
- 2.2.4. Class C fuses.
- 2.2.5. Fuses for Motors:
- .1 All fuses for motor loads are to be time-delay type.
- 2.3. FUSE STORAGE CABINET
- 2.3.1. Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door, B-LINE model 243012 + 2 shelves FCS2412, finished in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 2.4. FUSE PULLER
- 2.4.1. Provide a fuse puller for each size of fuse to be located in the fuse storage cabinet. Fuse puller to be clearly labelled for the appropriate building and fuse cabinet. Fuse puller to be equal to the Ideal Safe-T-Grip Fuse Puller.
- 2.5. MANUFACTURERS
- 2.5.1. The following are acceptable manufacturers:
- .1 Mersen
 - .2 Cooper-Bussman
 - .3 Littelfuse
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Install fuses in mounting devices immediately before energizing circuit.
- 3.1.2. Ensure correct fuses fitted to physically match mounting devices.
- .1 Install Class R rejection clips for Class R fuses.
- 3.1.3. Ensure correct fuses fitted to assigned electrical circuit.
- 3.1.4. Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

END OF SECTION

26 28 21.00 Moulded Case Circuit Breakers

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. CSA C22.2 No. 5 – Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS

1.3.2. Include time-current characteristic curves for breakers with ampacity of 400 A and over or with interrupting capacity of 22,000 A symmetrical (RMS) and over at system voltage.

2. Products

2.1. BREAKERS GENERAL

2.1.1. Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. C. ambient.

2.1.2. Common-trip breakers: with single handle for multi-pole applications.

2.1.3. Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

2.1.4. Circuit breakers with interchangeable trips as indicated.

2.2. THERMAL MAGNETIC BREAKERS

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

2.3. MAGNETIC BREAKERS

2.3.1. Moulded case circuit breakers to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4. FUSED THERMAL MAGNETIC BREAKERS

2.4.1. Fused thermal magnetic breakers with current limiting fuses internally mounted. Time current limiting characteristics of fuses coordinated with time current tripping characteristics of circuit breaker. Coordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker. Fuses individually removable and interlocked with breaker. The removal of fuse cover, blowing of a fuse or removal of a fuse, shall trip the breaker.

2.5. SOLID STATE TRIP BREAKERS

2.5.1. Moulded case circuit breaker to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition and long time, short time, instantaneous tripping for phase and ground fault short circuit protection.

2.6. ACCESSORIES

2.6.1. Include:

- .1 shunt trip, when electrically operated or when indicated.
- .2 auxiliary switches, when electrically operated or when indicated.
- .3 motor-operated mechanism, when electrical operation indicated.
- .4 on-off locking device.
- .5 handle mechanism.
- .6 Where a breaker serves a fire pump, the breaker is to come complete with auxiliary contacts that are to be monitored by the fire alarm system.

2.7. MANUFACTURERS

2.7.1. The following are acceptable manufacturers:

- .1 Schneider Electric
- .2 Eaton Cutler-Hammer
- .3 Siemens

3. Execution

3.1. INSTALLATION

3.1.1. Install circuit breakers as indicated.

3.1.2. Contractor to wire any neutral CT's to the breaker trip unit where required by the breaker ground fault detection system or as otherwise required by the manufacturers instructions.

END OF SECTION

26 28 23.00 Disconnect Switches – Fused and Non-Fused

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 05 53.00 – IDENTIFICATION.

1.2. REFERENCE

- 1.2.1. CSA C22.2 No. 4 – Enclosed Switches, latest edition.
- 1.2.2. CSA C22.2 No. 39 – Fuse-holder Assemblies, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

2. Products

2.1. DISCONNECT SWITCHES

- 2.1.1. Fusible or non-fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, size as indicated.
- 2.1.2. Provision for padlocking in on-off switch position by three locks.
- 2.1.3. Mechanically interlocked door to prevent opening when handle in ON position.
- 2.1.4. Fuses: size as indicated, class J, current limiting, in accordance with Section 26 28 14.00 – FUSES - LOW VOLTAGE.
- 2.1.5. Fuse-holders: suitable without adaptors, for type and size of fuse indicated.
- 2.1.6. Quick-make, quick-break action.
- 2.1.7. ON-OFF switch position indication on switch enclosure cover.

2.2. EQUIPMENT IDENTIFICATION

- 2.2.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
- 2.2.2. Indicate name of load controlled on nameplate.
- 2.2.3. Provide a Lamacoid nameplate that indicates the replacement fuse size as well as the maximum allowable fuse size for that disconnect based upon the sizing of the feeder.

2.3. MANUFACTURERS

- 2.3.1. The following are acceptable manufacturers:
 - .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.
 - .3 Siemens.

3. Execution

3.1. INSTALLATION

3.1.1. Install disconnect switches complete with fuses if applicable.

END OF SECTION

26 29 00.00 Motor Starters

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 53.00 – IDENTIFICATION.

1.2. REFERENCES

1.2.1. IEC 947-4-1, Part 4: Contactors and motor-starters, latest edition. Select IEC or NEMA rated devices depending on the project requirements

1.2.2. CSA C22.2 No. 60947-4-1 – Low-voltage switchgear and control gear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters, latest edition.

1.2.3. Attachment – Loose Starter Schedule

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

.1 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.

1.4. OPERATION AND MAINTENANCE DATA

1.4.1. Provide operation and maintenance data for motor starters for incorporation into manual.

1.4.2. Include operation and maintenance data for each type and style of starter.

1.5. MAINTENANCE MATERIALS

1.5.1. Provide listed spare parts for each different size and type of starter:

.1 Stationary contacts.

.2 Movable contacts.

.3 Auxiliary contacts.

.4 Control transformer.

.5 Operating coil.

.6 Fuses.

.7 Indicating lamp bulbs used.

2. Products

2.1. MATERIALS

2.1.1. Starters: to IEC 947-4 with AC4 utilization category.

2.2. EQUIPMENT

2.2.1. All starters (with the exception of manual motor starters) are to be combination starters with fusible disconnect switches.

.1 All fusible disconnects are:

- .1 To be of the quick make and quick break type.
- .2 To have an operating handle on the outside of the enclosure.
- .3 To have fuse clips suitable for HRC type J fuses.

.2 The operating handle of the fusible disconnect switch must be:

- .1 Capable of being locked in the "OFF" position.
- .2 Have provisions of accepting 3 pad locks.
- .3 Have provision for preventing switching to "ON" position while enclosure door is open.

2.2.2. All starters, with the exception of manual motor starters, are to be provided with a single phase, dry type control circuit transformer with:

- .1 A fused primary.
- .2 Primary voltage as indicated.
- .3 120V secondary.
- .4 Secondary fusing.

2.2.3. Size the control transformer for control circuit load plus 20% spare capacity, minimum capacity 150 VA.

2.2.4. All starters shall be equipped with indicating lamps that are long life cluster LED style or long life (10000 hour) incandescent type.

2.2.5. All starters shall be provided with 3 phase bimetallic overload relays which are adjustable and are ambient temperature compensated. Manual resets for the overload relays are to be mounted on the enclosure door such that they can be reset from outside of the enclosure and have externally visible trip indication.

2.2.6. All starters shall have identification for each wire and terminal for external connection, within starter, with permanent number marking identical to diagram.

2.3. MANUAL MOTOR STARTERS

2.3.1. Single or three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

- .1 Switching mechanism, quick make and break.
- .2 One overload heater per phase, manual reset, trip indicating handle.

2.3.2. Accessories:

- .1 Toggle switch: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating light: oil tight type and colour as indicated on the Starter Schedule.
- .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.4. FULL VOLTAGE MAGNETIC STARTERS

2.4.1. Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

- .1 Contactor solenoid operated rapid action type.
- .2 Motor overload bimetallic protective relay.
- .3 Wiring and schematic diagram inside starter enclosure in a visible location.

2.4.2. Accessories:

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: oil tight type and color as indicated on the Starter Schedule.
- .3 2-N/C and 2 N/O spare auxiliary contacts unless otherwise indicated on the Starter Schedule.

2.5. ENCLOSURE

2.5.1. Starter to come in a CSA Type 3R enclosure, size as indicated.

2.5.2. Equipment to be painted: baked grey enamel.

3. Execution

3.1. INSTALLATION

3.1.1. Install starters, connect power to starter and control and provide wiring from starter to motor through a manual disconnecting device if required by code.

3.1.2. Coordinate with Mechanical Division Contractor to ensure correct fuses and overload devices elements installed.

3.2. FIELD QUALITY CONTROL

3.2.1. Operate switches, contactors to verify correct functioning.

3.2.2. Perform starting and stopping sequences of contactors and relays.

3.2.3. Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

26 51 13.00 Lighting Equipment

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- 1.1.2. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.3. Section 26 05 04.00 – SUBMITTALS – SHOP DRAWINGS.
- 1.1.4. Section 26 05 21.00 – WIRES AND CABLES 1000V.
- 1.1.5. Section 26 06 05.16 – LUMINAIRE SCHEDULE.

1.2. REFERENCES

- 1.2.1. CSA C22.2 No. 74 – Equipment for Use with Electric Discharge Lamps, latest edition.
- 1.2.2. The Consortium of Energy Efficiency (CEE) guidelines, latest edition.
- 1.2.3. IESNA LM-79 – Approved Method: Electric and Photometric Measurements of Solid-State Lighting Products, latest edition.
- 1.2.4. IESNA LM-80 – Approved Method: Measuring Lumen Maintenance of LED Light Sources, latest edition.
- 1.2.5. The Certified Ballast Manufacturers Association (CBM) standards, latest edition.
- 1.2.6. NEMA 410 – Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts, latest edition.

1.3. SUBSTITUTION

- 1.3.1. The lighting equipment for this project and specified herein has been carefully selected for its ability to meet the project's luminous environment requirements. Manual and computer calculations have been performed to ensure that the lighting equipment that has been specified complies with established criteria. The Engineer's Representative reserves the right not to accept any alternates or substitutions. If alternates or substitutions are entertained, then it is the responsibility of the Contractor/Supplier to provide all information required herein and detailed layouts and lighting calculations demonstrating that the performance of the alternate luminaire meets or exceeds the original lighting design while not consuming any additional energy. The Contractor/Supplier is responsible to ensure the light levels provided in the alternate submittal package will achieve the design light levels. Where the light levels are not achieved, the Contractor is responsible to replace the luminaire with a luminaire that will meet the required levels with no increase in energy use at no cost to the Owner. Rather than replacing the luminaires, the Engineer's Representative may accept the installation of additional luminaires by the Contractor at no cost to the Owner in order to achieve the required light levels.
- 1.3.2. Accompanying the request for a luminaire or lamp substitution, the contractor shall submit a complete lighting calculation report with photometric modeling of the space showing light levels including average, maximum, minimum and max to min values.

1.4. SHOP DRAWING AND PRODUCT DATA

- 1.4.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

- 1.4.2. Submit a shop drawing for each luminaire specified, including lamp.
- 1.4.3. Luminaire submittals are to consist of a physical description, manufacturer's specification sheets, dimensioned drawings, and complete photometric data from an independent test laboratory in the form of IES computer files of the equipment being submitted and hard copy of the photometric report. Coordinate ceiling types to ensure proper supports and luminaire framing.
- 1.4.4. Lamp submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, rated life, colour temperature, base type, lamp shape, CRI, voltage and mercury content.
- 1.4.5. LED submittals are to consist of manufacturer's technical data for diodes and drivers with respective luminaire shop drawing. Submittal to include operating wattage, voltage, maximum distance from drivers, wiring diagrams and lumen output at time of delivery.
- 1.4.6. Ballast submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, input voltage, ballast efficiency, maximum distance for remote ballasts, power factor, and operating temperature.
- 1.4.7. Where samples are indicated on the luminaire schedule, they are to be provided with shop drawings at time of shop drawing submittals unless noted otherwise.
- 1.4.8. Where luminaires consist of multiple field assembled components, include manufacturer supplied installation manual detailing the assembly procedure.
- 1.5. OPERATION AND MAINTENANCE DATA
 - 1.5.1. Provide operation and maintenance data for lighting equipment in accordance with Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS for incorporation into the manual.
 - 1.5.2. Operation and maintenance instructions shall include documentation related to warranty claim process.
- 1.6. WARRANTY
 - 1.6.1. The manufacturer shall provide a warranty against defects in material and workmanship, starting at substantial completion. Parts warranty shall be 5 years and labour warranty shall be 1 year.
 - 1.6.2. LED's, Drivers, Lamps and ballasts showing signs of premature failure shall be replaced at no cost to the owner.
 - 1.6.3. LED Drivers must have a 5 year warranty.
2. Product
 - 2.1. GENERAL
 - 2.1.1. All products must be CSA or CUL approved.
 - 2.2. LAMPS AND LEDS
 - 2.2.1. All Lamps are to meet the standards of the Consortium of Energy Efficiency (CEE) guidelines.
 - 2.2.2. Refer to luminaire schedule for project specific details, and lamps required.

- 2.2.3. All lamps are to be new and are to be from the same manufacturing batch to avoid colour differences. Replace all lamps that exhibit colour shift, or exhibit premature lumen intensity decline, at no cost to the owner.
- 2.2.4. Light Emitting Diodes (LED)
- .1 LEDs shall meet the standards of IESNA LM-79 and LM-80.
 - .2 All LED drivers shall be tested and comply with the maximum in-rush current limits as stated in NEMA 410.
 - .3 LED's shall be manufactured by Luxeon or equal. Colour temperature shall be as indicated on the luminaire schedule. Lamps are to be binned with no visible colour variance (+/- 100K from specified colour temperature). Rated life for 1 watt white LED shall be 50,000 hours. Lumen output to be maximum based on latest technology at time of delivery.
 - .4 All LED luminaires that present signs of failure on site, within the warranty period, must be replaced at no cost to the owner. If temporary luminaires are required to replace any failed LED luminaires, during the waiting time for parts (i.e. drivers, boards, heat sinks, etc.), the labour cost including installation, temporary luminaire supply, temporary luminaire removal and reinstallation of the LED luminaire must be provided at no cost of the owner. Additional electrical costs, associated with higher Wattage temporary luminaires, must be reimbursed with interest to the owner by the manufacturer.
 - .5 In case of failure of an LED luminaire, complete or part thereof, an independent third party testing Laboratory (approved by Smith + Andersen) shall be commissioned by the manufacturer or vendor to perform tests on samples taken from the failed luminaires installed on corresponding site. All reporting including the test results must be submitted to Smith + Andersen for evaluation and final approval.
 - .6 Any additional time involved by Smith + Andersen will be billed at our hourly rates to the manufacturer or vendor.
- 2.3. DRIVERS
- 2.3.1. All drivers are to be tested and comply with maximum in-rush current limits within NEMA 410 standards. This is to be clearly indicated on shop drawing submittal.
- 2.3.2. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
- 2.3.3. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
- 2.3.4. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
- 2.3.5. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
- 2.3.6. Total Harmonic Distortion less than 20% percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
- 2.3.7. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
- .1 Adjustment of forward LED voltage, supporting 3V through 55V.

- .2 Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
 - .3 Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.
- 2.3.8. Driver must be able to operate for a (+/- 10%) supply voltage of 120V through 277VAC at 60Hz.
- 2.3.9. Driver must be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
- 2.3.10. Driver shall include ability to provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.
- 2.3.11. Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0% relative light output, or 100 – 1% light output and step to 0% where indicated. Driver shall respond similarly when raising from 0% to 100%
- .1 Driver must be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.
- 2.3.12. Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
- 2.3.13. Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.
- 2.3.14. Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have:
- .1 LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.
 - .2 Base specification: Flicker index shall less than 5% at all frequencies below 1000 Hz.
 - .3 Preferred specification: Flicker index shall be equal to incandescent, less than 1% at all frequencies below 1000 Hz.
- 2.3.15. Control Input
- .1 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
 - .1 Must meet IEC 60929 Annex E for General White Lighting LED drivers
 - .2 Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
- 2.3.16. Must meet ESTA E1.3 for RGBW LED drivers
- 2.4. LUMINAIRES
- 2.4.1. All luminaires are to be complete with mounting brackets, transformers, supports, trims, louvers, lenses and other accessories as required to make luminaire operational and allow it to be installed in the respective location.

- 2.4.2. Luminaires shall be suitable for the environment where installed, include seals and gaskets, and corrosion resistant baked-on finish as required and as specified.
- 2.4.3. Louvers, lenses and diffusers must be of suitable thickness to prevent sagging.
- 2.4.4. Where drawings show luminaires mounted end-to-end, luminaires shall be suitable for continuous, seamless and tandem mounting.
- 2.4.5. All poles are to come complete with internal vibration dampeners to accommodate wind conditions to avoid damage due to wind-induced vibrations.
- 2.4.6. All concrete bases for poles and bollards shall be designed to accommodate the height, weight, etc. of the pole/bollard and its accessories for the soil conditions for which it is installed. Engineered shop drawings shall be provided that is signed by a structural engineer registered in the local jurisdiction.
- 2.4.7. Where cameras are shown to be installed on poles, the poles shall be stiffened to reduce vibration and sway, and shall be rated for video recording cameras.
- 2.4.8. The following is a list of generic type designation for luminaires. The project specific luminaire schedule is to be referenced for the specific types and designations and the respective specifications.
- .1 Designations beginning with the letter 'L' denote LED type.
 - .2 Designations beginning with the letter 'X' denote exit sign.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. It is the responsibility of the contractor to obtain the information related to the luminaire and luminaire trim finishes/colours from the Interior Designer or Architects prior to the fabrication of luminaires. The Contractor shall provide adequate time for the design team to review and comment on luminaire and luminaire trim finishes
- 3.1.2. The contractor will provide, receive, unload, uncrate, store, protect and install lamps, luminaires, and other related lighting equipment as specified herein. Lamps for all equipment will be provided and installed by the contractor according to equipment manufacturer's instructions.
- 3.1.3. The Electrical Contractor shall be responsible for the supply and installation of all concrete bases for poles and bollards. Unless otherwise shown on the drawings, concrete bases to be ArtForm style or Approved Equal and shall extend a minimum 900mm above grade in parking lots and a minimum 150mm above grade in pedestrian walkways.
- 3.1.4. Poles and bollards are to be installed on independent concrete bases unless indicated otherwise on the drawings or schedules. Coordinate brackets for cameras and supports for banners with pole manufacturer.
- 3.1.5. Install remote ballasts in racks and wire luminaires to ballasts in conduit. Provide wiring as per manufacturer's recommendations.
- 3.1.6. Locate luminaires in accordance with the Architect's Drawings. Coordinate exact locations on site. Refer to Architect's drawings for dimensions of coves and valences.
- 3.1.7. Install in accordance with Manufacturer's Instructions, Local Codes, Electrical Division Drawings and Specifications.
- 3.1.8. All suspended luminaires shall have cables and support stems vertically aligned.

- 3.1.9. Suspend luminaires in mechanical rooms after all the mechanical equipment and ductwork are installed. Luminaires are not to be suspended from mechanical pipes, ductwork or other building services.
- 3.1.10. All luminaires shall be installed underneath other services located within ceiling space. Contractor is responsible for interference drawings to ensure all services in ceiling are coordinated.
- 3.1.11. Any dimensions provided in the drawings or schedules are intended as general guidelines. For exact dimensioning refer to the Architectural drawings. The detailed information shall be cross referenced with the electrical specifications and the Luminaire Schedule applying the most stringent requirement.
- 3.1.12. It is the responsibility of the Electrical Contractor to coordinate luminaire trims and mounting system with ceiling finishes. Luminaires delivered on site with the wrong ceiling mounting system shall be replaced without additional costs for the owner. Restocking fees will not be accepted.
- 3.1.13. For suspended ceiling installations support luminaires from structural slab in accordance with local inspection requirements.
- 3.1.14. Where luminaires are mounted in tandem, align luminaires mounted in continuous rows to form straight uninterrupted line.
- 3.1.15. Align luminaires mounted individually parallel or perpendicular to building grid lines.
- 3.1.16. Ensure light leakage does not occur from openings and trim rings. Contractor is responsible to repair the ceiling at no cost to the Owner if cut-out is too large.
- 3.1.17. Connect luminaires to lighting circuits.
- 3.1.18. Provide all wiring in conduit with junction boxes on a grid pattern to limit the run of flexible armoured cable drops from the ceiling mounted junction box to each luminaire to a maximum of 3 m in length unless approved otherwise in writing from the Engineer's Representative.
- 3.1.19. Modular wiring systems shall be employed only where indicated or with approval of the Engineer's Representative.
- 3.1.20. Luminaires are not to be used as temporary construction lighting. After being tested to ensure acceptable operation, luminaires will not be used until substantial completion unless permission is received from the owner, architect or Engineer's Representative.
- 3.1.21. Clean all luminaires, inside and out at time of substantial completion. Replace all scratched or damaged luminaires, lenses, louvers and diffusers at no cost to the owner.
- 3.1.22. Installation of exit signs
 - .1 Rough-in and installation of exit signs shall be carefully coordinated on site such that after installation of all equipment/services, including equipment/services from other trades (i.e. sprinkler lines, plumbing pipes, way-finding signs, etc.), shall not interfere with the line-of-sight visibility of the exit sign(s) from approach of the intended egress pathway(s).
 - .2 If exit sign(s) have been installed and do not meet the satisfaction of the Engineer's Representative/Architect, the Contractor shall lower, raise or relocate the exit sign(s) such that proper and adequate visibility of the exit sign(s) is achieved at no additional cost to the Owner.

END OF SECTION

26 52 01.00 Unit Equipment for Emergency Lighting

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 21.00 – WIRE AND CABLES 1000V.

1.1.4. Section 26 05 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.

1.2. REFERENCES

1.2.1. CSA Standard C22.2 No.141 – Emergency Lighting Equipment, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS

1.3.2. Submit shop drawings for equipment and accessories specified in this Section. Include photometric data for all luminaires not named as approved in this specification.

1.3.3. Data to indicate system components, mounting method, source of power and special attachments.

1.3.4. Manufacturer/Contractor to ensure runtime capacity of battery unit is sized accordingly to meet the runtimes specified within this section and/or drawings/schedules.

1.4. WARRANTY

1.4.1. For batteries, the warranty period shall be extended to 120 months, with a no-charge replacement during the first 5 years and a pro-rata charge on the second 5 years.

2. Products

2.1. EQUIPMENT

2.1.1. Supply voltage: 120 V, ac.

2.1.2. Output voltage: 24 V dc.

2.1.3. Operating time: 120 minutes, unless otherwise noted in schedules.

2.1.4. Battery: 10 year sealed, valve regulated, lead calcium.

2.1.5. Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations. Recharges battery within 24 hours in accordance with CSA.

2.1.6. Solid state transfer circuit.

2.1.7. Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

2.1.8. Signal lights: solid state, for 'AC Power ON' and 'High Charge'.

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- 2.1.9. Lamp heads: integral on unit and remote as indicated, 345 horizontal and 180 vertical adjustment. Lamp type: LED MR16, wattage to be 6W unless noted otherwise on drawings or in the "Battery Unit Schedule."
- 2.1.10. Directional remote head lamps to have narrow beam spread distribution.
- 2.1.11. Recessed remote head lamps to have flood beam spread distribution.
- 2.1.12. Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- 2.1.13. Finish: Baked white enamel.
- 2.1.14. Auxiliary equipment:
- .1 Ammeter.
 - .2 Voltmeter.
 - .3 Test switch.
 - .4 Time delay relay.
 - .5 Battery disconnect device.
 - .6 ac input and dc output terminal blocks inside cabinet.
 - .7 Bracket.
 - .8 Cord and single twist-lock plug connection for ac.
 - .9 RFI suppressors.
- 2.2. WIRING OF REMOTE HEADS AND EXIT SIGNS
- 2.2.1. Conduit: As per Section 26 05 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- 2.2.2. Conductors: As per Section 26 05 21.00 – WIRE AND CABLES 1000V, sized as per manufacturer's recommendation and compliant to the applicable electrical codes.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Install unit equipment and remote mounted fixtures. Interconnect all heads with central battery pack.
- 3.1.2. Direct heads to optimize illumination of egress pathways to minimum building code requirements.
- 3.1.3. Connect exit lights to unit equipment.
- 3.1.4. Contractor is to include the supply and installation of one additional head or an additional 5% of the total number of heads shown on the drawings, whichever is greater in the bid price. The installation is to include all wiring and conduit required to install the heads. If the heads are not installed during construction then the spare heads are to be turned over to the Owner at the end of the project.
- 3.2. TESTING AND COMMISSIONING
- 3.2.1. Contractor shall commission and test the entire system and adjust as necessary.
- 3.2.2. Trip breaker(s) feeding battery unit(s) to simulate power failure to building. Test the operation of each unit to document the duration of runtime. Testing shall be performed during non-daylight hours.

- 3.2.3. Inform Engineer's Representative 10 days in advance prior to testing being performed in order for Engineer's Representative to make arrangements to witness testing of emergency lighting system.
- 3.2.4. Provide Engineer's Representative with signed test report by Contractor that each unit successfully operated for the required duration of time.
- 3.2.5. Re-test voltage of battery units 24 hours after initial testing to verify rated nominal voltage of unit. If battery unit has not recharged properly, replace unit and re-test as stated above at no additional cost to Owner.

END OF SECTION

26 60 30.00 Roof and Gutter De-Icing Systems

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCE

1.2.1. UL Standard 508A, latest edition.

1.2.2. CSA Standard C22.2 NO. 14 – Industrial Control Equipment, latest edition.

1.3. SCOPE

1.3.1. Furnish and install a CSA Certified Roof and Gutter De-icing System complete with heating cable, termination components, junction boxes, contactors, hanger, tee and splice kits and sensor/controls for snow melting.

1.4. SEQUENCE OF OPERATION

1.4.1. The Roof and Gutter De-icing System shall be automatically controlled through a contactor to turn on as detected by a roof/gutter mounted moisture sensor. The sensor shall monitor both moisture and temperature such that the heating cables will only turn on if the ambient air temperature is below an adjustable trigger temperature (34°F to 44°F).

1.4.2. The Roof and Gutter De-icing System shall have a Manual/Off/Automatic control switch to allow manual control of the heating circuit. Manual control would be used whenever it is desired to turn on the heating system when it is not snowing.

1.4.3. Automatic and manual operation of the Roof and Gutter De-icing System shall be over-ridden by an Ambient Sensing Thermostat, detecting outside temperature, such that the heating circuit cannot turn on if the ambient temperature is above 44°F. The purpose of this ambient temperature shutdown is to minimize electricity costs by ensuring that the heating system does not remain energized if inadvertently left in "Manual" mode during warmer temperatures.

1.5. SHOP DRAWINGS AND PRODUCT DATA

1.5.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.6. WARRANTY

1.6.1. The heating cables for the Roof and Gutter De-icing system shall come with a 10 year warranty against any defects or failures and 1 year for the controllers.

2. Products

2.1. HEATING CABLE AND ACCESSORIES

2.1.1. Heating cable shall be a self-regulating heating cable suitable for roof and gutter de-icing applications.

- 2.1.2. The heating cable shall consist of a continuous core of conductive polymer that is radiation cross-linked, extruded between two tin or nickel-plated copper bus wires that varies its power output in response to temperature changes.
- 2.1.3. The heating cable shall have a modified polyolefin inner jacket and a tinned-copper braid to provide a ground path and enhance the cables ruggedness.
- 2.1.4. The heating cable shall have a fluoropolymer (XT) outer jacket for enhanced mechanical and chemical protection.
- 2.1.5. The heating cable shall have an inherently UV-resistant outer jacket (fluoropolymer).
- 2.1.6. The heating cable shall operate on line voltages of 120 or 208 volts (refer to drawings for exact voltage) without the use of transformers.
- 2.1.7. The heating cable power output shall be a maximum 12 W/ft at 32°F in ice or snow.
- 2.1.8. The heating cable shall be part of a UL Listed, CSA Certified and FM Approved system.
- 2.1.9. Manufacturer shall provide power connection, splice/tee and end seal kits compatible with selected heating cable.
- 2.1.10. The heating cable shall come complete with power connection and end-seal termination accessories as supplied by the heating cable manufacturer.
- 2.1.11. Connection kits shall be rated CSA Type 4X to prevent water ingress and corrosion. All components shall be UV stabilized.
- 2.1.12. Connection kits shall be UL Listed and CSA Certified.
- 2.1.13. Each circuit shall be protected by a 30-35 mA ground fault protection device.
- 2.2. CONTROL AND DISPLAY PANEL
 - 2.2.1. Furnish and install a complete pre-wired control and display panel ("Panel") to remotely monitor and control the Roof and Gutter De-icing System.
 - 2.2.2. The Panel shall display when the heating system is in either Manual/Off/Automatic mode.
 - 2.2.3. The Panel shall fit within a standard single gang or multi gang electrical box and be compatible with a standard Decora type cover plate. Otherwise the Panel shall come from the factory in a pre-fabricated stainless steel enclosure.
- 2.3. CONTROLLER AND SENSORS
 - 2.3.1. The controller shall have automatic activation based on precipitation and temperature readings from the sensor.
 - 2.3.2. Controller shall be designed for operation on 120 or 208 volts, single phase.
 - 2.3.3. The sensor shall be capable of being located up to 150 m (500 ft.) from the Panel.
 - 2.3.4. The controller shall have a replaceable remote sensor.
 - 2.3.5. The controller shall have a CSA Type 3R enclosure rating and shall be cUL and UL listed for its intended application.
 - 2.3.6. The sensor shall respond to air temperature changes. The thermostat shall be used to control a contactor coil. The weatherproof enclosure shall be a polyurethane-coated cast aluminum housing with stainless steel hardware.
 - 2.3.7. The thermostat trigger temperature set point shall be adjustable between 34°F to 44°F.
 - 2.3.8. The controller shall initiate heating cable operation when precipitation is present at temperatures below that specified by the adjustable trigger temperature set point.

2.4. MANUFACTURERS

2.4.1. Acceptable Roof and Gutter De-icing System manufacturer shall be :

- .1 Pentair – Raychem IceStop
- .2 Britech – Roof and Gutter De-icing

3. Execution

3.1. INSTALLATION

- 3.1.1. The heating cable shall be installed according to electrical code, manufacturer's recommendations, the instructions supplied with the heating cable and components, and the instructions in the manufacturer's Installation and Operation Manual.
- 3.1.2. Cable sheaths shall not touch or cross one another nor shall cables cross expansion joints. Concrete crack control joints must be crossed in accordance with manufacturer's recommendations.
- 3.1.3. Heating cables shall be laid out at the manufacturer's specified spacing.
- 3.1.4. The heating cable shall be installed only on roof and gutters designed for its intended application.
- 3.1.5. The sensor(s) shall be installed within the roof/gutter and orientated as per the manufacturer's installation recommendation and manual.
- 3.1.6. All junction boxes, if required, shall be located in accessible areas. Coordinate exact locations with the Architect/Consultant prior to installation. Covers shall be kept on boxes at all times when not working therein.
- 3.1.7. All terminations shall be protected from the weather and from physical damage. All conduits should enter at or near the bottom of the box. The gland assembly shall be bonded to the system ground.
- 3.1.8. Heating cable repairs and splices shall be made using a splice kit provided by the manufacturer and specifically approved for the purpose. They shall pass the Megger test after installation.
- 3.1.9. Any field alterations or deviations shall proceed only after authorization has been issued by the engineer. All changes shall be accurately recorded by the contractor and shall be turned over to the engineer upon completion of that phase of work.
- 3.1.10. A representative from the Roof and Gutter De-icing System manufacturer is to meet with the electrical and general contractors prior to installation, to advise on the recommended installation procedure, and to visit the site again to inspect the layout and installation of the heating cable. The representative shall visit at the completion of the installation to commission the system to ensure proper installation and operation.

3.2. TESTING

- 3.2.1. The heating cable shall be tested for continuity with a multi-meter (or ohmmeter), and for insulation resistance with a 2500 Vdc Megger, when received on the job site, after installation, during and after the concrete pour, and annually thereafter according to the manufacturer's recommendations.
- 3.2.2. Insulation resistance shall be consistently not less than 20 mega-ohms.
- 3.2.3. A complete system test of controls shall be conducted to verify cable operation.

- 3.2.4. Copies of all such testing shall be delivered to the Engineer and included in the Operation and Maintenance (O&M) manuals.

END OF SECTION

33 05 23.00 Excavation and Backfill for Electrical Work

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 31 00 00.00 – EXCAVATION/EARTHWORKS.

1.2. SCOPE

- 1.2.1. This Section governs requirements for all excavating and backfilling Work required for the installation of buried power and communication services and backfill.
- 1.2.2. Assume that material to be excavated is earth. When rock is encountered during construction, payment will be made on unit price basis to the extent of net difference in cost between dry earth excavation and solid rock excavation, all as indicated in Contract Documents.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.3.2. Provide Shop Drawings indicating proposed method of bedding and backfilling.

2. Products

2.1. SOILS

- 2.1.1. To the requirements for Granular “A”, “B” (Type 1), “M” and “Select Subgrade Material”.
- 2.1.2. Requirements for Pea Gravel: Granular, well-graded clean rounded pea gravel or stone with not more the 2% material that will pass 75 um (No. 200) sieve, maximum 6 mm (1/4 in.), containing no other deleterious material, and subject to testing that specified density can be achieved without compaction.
- 2.1.3. Requirements for Sand Fill: Uniform quality and unwashed river sand or any clean sand containing less than 5% organic materials, clay or silt (passing 125 um sieve) is acceptable. It can contain a limited amount of small stones or rocks as it comes from the pit. Sharp, clean, coarse sand, water washed, free from clay, salts and organic matter, and in accordance with CSA A179 – Mortar and Grout for Unit Masonry, for masonry sand is also acceptable.

3. Execution

3.1. INSTALLATION

- 3.1.1. All excavation and backfilling for all services shall be in accordance with Site Work Division.
- 3.1.2. Protection:
 - .1 Provide protection to existing structures and services. Be responsible for rectifying any damage to existing structures and services resulting from this operation.
- 3.1.3. Excavation in Soil:

- .1 Excavation carried below the correct inverts shall be backfilled with 2000 psi (13.5 mPa) concrete to the underside of the pipe lines, unless otherwise directed in writing.

3.1.4. Excavation in rock:

- .1 All excavation in rock is included under separate Section, (the Site Work Division Section 31 00 00.00 – EXCAVATION/EARTHWORKS) and is taken to a minimum of 150 mm below the correct pipe invert. This Division shall use a bedding material to the correct trench invert.

3.1.5. Backfilling

- .1 Backfill with sand from the bottom of the trench or excavation up to a point 300 mm above the top of service line or appurtenance.
- .2 Backfill duct trenches with sand to a depth 300 mm above the ducts. The sand shall be thoroughly tamped around and over the pipes in 150 mm layers.
- .3 Backfill the remainder of trench or excavation up to top of subgrade or bottom of floor slabs on-grade.

END OF SECTION

33 71 19.00 Concrete Encased Duct Banks and Maintenance Chambers

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. Canadian Standards Association (CSA)

- .1 CAN/CSA-A5, Portland Cement, latest edition.
- .2 CSA-A23.1, Concrete Materials and Methods of Concrete Construction, latest edition.
- .3 CSA G30.3, Cold-Drawn Steel Wire for Concrete Reinforcement, latest edition.
- .4 CSA G30.5, Welded Steel Wire Fabric for Concrete Reinforcement, latest edition.
- .5 CSA G30.18, Billet-Steel Bars for Concrete Reinforcement, latest edition.

1.2.2. American Society for Testing and Materials (ASTM)

- .1 ASTM D 1056, Specification for Flexible Cellular Materials - Sponge or Expanded Rubber, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.3.2. Submit Shop Drawings for precast maintenance chambers.

1.3.3. Submit Shop Drawings for ground rod details for cable rack grounding.

2. Products

2.1. PVC DUCTS

2.1.1. PVC ducts, type DB1, encased in reinforced concrete.

2.2. PVC DUCT FITTINGS

2.2.1. Rigid PVC opaque solvent welded type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.

2.2.2. Expansion joints.

2.2.3. Rigid PVC 5 degree angle couplings.

2.3. CABLE PULLING EQUIPMENT

2.3.1. Pulling iron: galvanized steel rods, size and shape as indicated.

2.3.2. Pull rope: 6 mm stranded polypropylene, tensile strength 5 kN, continuous throughout each duct run with 3 m spare rope at each end.

2.4. MARKER TAPE

- 2.4.1. Use of red plastic marker tape with black letters "DANGER – HIGH VOLTAGE" identifying the underground electrical installation.

3. Execution

3.1. INSTALLATION GENERAL

- 3.1.1. Install underground duct banks and maintenance chambers including formwork.
- 3.1.2. Build duct bank and maintenance chambers on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95% of maximum proctor dry density.
- 3.1.3. Open trench completely between connected maintenance chambers before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.
- 3.1.4. Prior to laying ducts, construct "mud slab" not less than 75 mm thick.
- 3.1.5. Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400.
- 3.1.6. Install base spacers at maximum intervals of 1.5 m leveled to grades indicated for bottom layer of ducts.
- 3.1.7. Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 mm horizontally and vertically. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with 75 mm thick concrete cover. Use galvanized steel conduit for sections extending above finished grade level.
- 3.1.8. Make transpositions, offsets and changes in direction using angle sections.
- 3.1.9. Use bell ends at duct terminations in maintenance chambers or buildings.
- 3.1.10. Use conduit to duct adapters when connecting to conduits.
- 3.1.11. Terminate duct runs with duct coupling set flush with end of concrete envelope when dead ending duct bank for future extension.
- 3.1.12. Cut, ream and taper end of ducts in field in accordance with manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.
- 3.1.13. Allow concrete to attain 50% of its specified strength before backfilling.
- 3.1.14. Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete. Tie ducts to spacers with twine or other non-metallic material. Remove weights or wood braces before concrete has set and fill voids.
- 3.1.15. Clean ducts before laying. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.
- 3.1.16. Install a minimum of four 3 m lengths of 15 mm reinforcing rods, one in each corner of duct bank when connecting duct to maintenance chambers or buildings. Wire rods to 15 mm dowels at maintenance chamber or building and support from duct spacers. Protect existing cables and equipment when breaking into existing maintenance chambers. Place concrete down sides of duct bank filling space under and around ducts. Rod concrete with flat bar between vertical rows filling voids.
- 3.1.17. Prior to installation of any wire or cable in the ducts, pull through each duct a flexible mandrel not less than 300 mm long and size for the internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Notify the engineer's representative no less than 48 hours prior to the event, so that the engineer's representative may witness.

- 3.1.18. Install a polypropylene pull string in each duct. Secure the pull string at each end of the duct.
- 3.1.19. Install red "DANGER – HIGH VOLTAGE" warning tape across the entire width of the ductbank in the soil half way between the duct bank and grade.
- 3.1.20. Mark location of duct runs under hard surfaced areas not terminating in maintenance chamber with railway spike driven flush in edge of pavement, directly over run.
- 3.1.21. Where markers are removed to permit installation of additional duct, reinstall existing markers.
- 3.1.22. Provide As-Built Drawings showing locations of markers.

3.2. REVIEWS

- 3.2.1. Review of duct and duct clean out will be witnessed by the Engineer's Representative prior to placement of concrete.

END OF SECTION

Attachment A – Luminaire Schedule

Attachment B – Lighting Sequence of Operation

Attachment C – Battery Unit Schedule

Attachment D – Panel Schedules