



Smith + Andersen

1100 – 100 Sheppard Ave. East, Toronto ON, M2N 6N5

416 487 8151 f 416 487 9104 smithandandersen.com



ELECTRICAL SPECIFICATION

PROJECT NAME:

NORTH BIRCH CREDIT UNION
9 MADISON AVENUE, TORONTO, ON.

OUR PROJECT NUMBER:

17488.003

DATE:

2026-01-21

ISSUED FOR:

PERMIT/TENDER

26 00 00.00 Index

SECTION	NAME	Page #
26 00 00.00	Index	1
26 01 00.00	Operating and Maintenance Instructions	2
26 05 01.00	General Instructions for Electrical Sections	5
26 05 03.00	As-Built Drawings	32
26 05 04.00	Submittals/Shop Drawings	34
26 05 05.00	Mounting Heights	36
26 05 14.00	Power Cable and Overhead Conductors	38
26 05 21.00	Wires and Cables Under 2000 V	44
26 05 29.00	Hangers and Supports	51
26 05 31.00	Splitters, Junction, Pull Boxes and Cabinets	53
26 05 32.00	Outlet Boxes, Conduit Boxes and Fittings	55
26 05 34.00	Conduits, Conduit Fasteners and Fittings	58
26 05 53.00	Identification	62
26 05 83.00	Sleeves	66
26 08 00.00	Commissioning	68
26 09 24.00	Lighting Control Equipment – Addressable Low Voltage	72
26 09 24.01	Lighting Control Equipment – DALI Low Voltage	85
26 24 17.00	Panelboards – Breaker Type	100
26 24 18.00	Panelboards – Switch and Fuse Type	103
26 27 19.00	Multi-Outlet Assemblies	106
26 27 26.00	Wiring Devices	109
26 28 21.00	Moulded Case and Insulated Case Circuit Breakers	113
26 28 23.00	Disconnect Switches – Fused and Non-Fused	118
26 51 13.00	Lighting Equipment	120
26 52 01.01	Emergency Lighting - Inverter	128
26 52 01.02	Single Phase Inverters for Emergency Lighting	140
28 05 00.00	Raceways for Security System	143
28 31 02.00	Multiplex Fire Alarm System	144

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 – AS-BUILT DRAWINGS.
- 1.1.3. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.4. Section 26 08 00.00 – COMMISSIONING.
- 1.1.5. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.

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 Performance of the Work. 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 USB stick or sent via electronic transfer. As-Built Drawings to be included on the USB stick or sent via electronic transfer.
- 3.1.2. The contractor to identify the cost of AS-BUILT 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 – AS-BUILT 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 "NORTH BIRCH CREDIT UNION."
- 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 of the Work.
- 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.
 - .5 Cyber Security Report Letter and backup schedule as required by Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 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. DEFINITIONS

- 1.4.1. Where used on the Drawings or in the Specifications, the following words are given the meanings below.
- .1 Provide: means supply, install, connect, and test.
 - .2 Demolish: detach existing items and legally dispose of them off site.
 - .3 Remove and Reinstall: Detach existing items, prepare them for reuse, and reinstall them where indicated.
 - .4 Existing to Remain: existing items that are not removed and that are not otherwise indicated as being removed, removed and salvaged (turned over to Owner), or removed and reinstalled.
 - .5 Remove and Salvage: detach existing items and turn over to Owner.

1.5. SCOPE

- 1.5.1. Provide all labour, materials, equipment and services to complete the work of the electrical division as further specified and as shown on the drawings.
- 1.5.2. 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.

- 1.5.3. 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 120 V/208 V or 600 V electrical panel serving the equipment in that area at no additional cost to the Owner.
- 1.6. REGULATIONS
- 1.6.1. 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.
- 1.6.2. These specifications are supplementary to the requirements above.
- 1.6.3. Comply with all guidelines and standards issued by the authorities having jurisdiction.
- 1.6.4. Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the contractor shall notify the Engineer's Representative.
- 1.7. PERMITS, FEES, AND REVIEWS
- 1.7.1. 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.
- 1.7.2. If required by code, plans and specifications have been previously submitted to the Authority Having Jurisdiction.
- 1.7.3. Furnish certificates of Acceptance from the Authority Having Jurisdiction and include them in the Operation and Maintenance manual.
- 1.8. VOLTAGE RATINGS
- 1.8.1. Operating voltages are as specified in CAN3-C235 (latest edition).
- 1.8.2. Motors, electric heating, control and distribution devices and equipment are to operate satisfactorily at 60 Hz within operating limits established by the above standard.
- 1.9. COORDINATION WITH MECHANICAL DIVISIONS.
- 1.9.1. 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.
 - .1 Where harmonic filter is complete with a capacitor switching system, route a harmonic filter output conductor through the current transformer window within the harmonic filter. Coordinate with Mechanical Contractor and follow harmonic filter manufacturer's written instructions.
 - .5 Disconnect switches for all mechanical equipment.
 - .6 All power wiring (120 V & above) to all mechanical equipment.
 - .7 Electrical ramp heating cables and controls.
 - .8 All motorized damper power connections (120 V & above).

- .9 Fire alarm devices.
- .10 Wiring to electric space heaters.
- 1.9.2. 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 120 V control devices.
 - .6 All 120 V and low voltage control wiring and conduits.
- 1.9.3. 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/wiring, breakers, fuses, starters and equipment to supply power to the revised piece of equipment.
- 1.9.4. Should the Mechanical Contractor provide alternates to any mechanical equipment selection by deviating from the make and model identified on the Mechanical Schedules and Drawings, the Mechanical Contractor will incur all extra costs to revise the electrical provisions including but not limited to feeders/wiring, breakers, fuses, starters and equipment to supply power to the alternate piece of equipment.
- 1.9.5. Where power for any flush valves, hands-free faucets, or other powered plumbing fixtures are shown on the Drawings, provide either a hard wired direct connection or a duplex receptacle, as required for the valve/faucet/fixture in question, based on coordination with the Mechanical Contractor.
- 1.9.6. Where large smoke dampers or large combination smoke and fire dampers, with multiple actuators per damper, are supplied by the Mechanical Contractor, extend the power connections and fire alarm monitoring and control connections shown on the Drawings to each and every actuator.
- 1.10. PLYWOOD BACKBOARDS, EQUIPMENT MOUNTING, & HOUSEKEEPING PADS
- 1.10.1. 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.
- 1.10.2. Surface mounted electrical equipment boxes are to be installed on galvanized strut channel stand-offs. Electrical equipment boxes shall include, but not be limited to electrical panels, low voltage lighting control, fire alarm, security, communication, electrical sub-metering, etc. Panels are to be grouped on common base wherever practical.
- 1.10.3. Provide steel re-enforced concrete housekeeping pads under all floor mounted electrical equipment.
- 1.10.4. Additionally, provide steel re-enforced concrete housekeeping pads where shown on the Drawings.
- 1.10.5. Provide all housekeeping pads with a minimum height of 100 mm above finished floor and do not extend beyond 50 mm beyond the electrical equipment unless shown otherwise on the Drawings. Ensure concrete pads fully cured for 28 days before installing equipment.

1.11. FINISHES

- 1.11.1. 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.
- 1.11.2. Clean and touch up all surfaces of equipment scratched or marred during shipment or installation. Match the original paint.
- 1.11.3. Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

1.12. SAFETY

- 1.12.1. Protect exposed live equipment during construction for personnel safety.
- 1.12.2. Shield and mark all live parts "LIVE 120 VOLTS", or with appropriate voltage in English.
- 1.12.3. 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.

1.13. FIRE STOPS

- 1.13.1. Provide fire stops in accordance with front end, and Division 1 documents and as described herein. Contractor to coordinate fire stops with General Contractor.
- 1.13.2. 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.
- 1.13.3. Service penetration assemblies: certified by ULC in accordance with CAN/ULC-S115 (latest edition) and listed in ULC Guide No. 40 U19.
- 1.13.4. 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.
- 1.13.5. 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.
- 1.13.6. 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.
- 1.13.7. Fire stops and smoke seal all electrical penetrations through rated assemblies as per ULC Standards.
- 1.13.8. Where sound and vibration control is required, use an elastomeric seal; do not use a cementitious or rigid seal at such locations.
- 1.13.9. Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- 1.13.10. Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.

- 1.13.11. 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.
- 1.13.12. Sealants for vertical joints: non-sagging.
- 1.13.13. Colour: if range available to Engineer's Representative's choice of standard colours, generally to match background colour where visible in finished spaces.
- 1.13.14. 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.
- 1.13.15. Where-holes are core drilled in existing structures, sleeves shall be provided as specified complete with fire stopping as noted above.
- 1.13.16. 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.
- 1.13.17. 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.
- 1.14. ACOUSTIC TREATMENT
 - 1.14.1. 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.
 - 1.14.2. 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.
 - 1.14.3. 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.
- 1.15. HOISTING
 - 1.15.1. 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.
 - 1.15.2. Electrical Contractor to include for the qualified millwrights to move and place all equipment over 1000 lbs. Contractor to provide proof of millwright certification.

1.16. CLEANING AND WASTE REMOVAL

- 1.16.1. Clean all electrical equipment that has been exposed to construction dust and dirt.
- 1.16.2. 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.
- 1.16.3. Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.

1.17. SPRINKLERS

- 1.17.1. 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.

1.18. TEMPORARY LIGHT AND POWER

- 1.18.1. 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.
- 1.18.2. All temporary light to be LED. Provide adequate lighting to meet all health and safety standards.

1.19. EXAMINATION AND PROTECTION OF SITE

- 1.19.1. 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.
- 1.19.2. 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.
- 1.19.3. 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 2 m 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.
- 1.19.4. 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.

1.20. DRAWINGS AND INSTALLATION

- 1.20.1. 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.
- 1.20.2. 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.
- 1.20.3. 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.

- 1.20.4. The actual location of switches, outlets and luminaires, etc. shall be reviewed by the Engineer's Representative before installation.
- 1.20.5. 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.
- 1.20.6. 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.
- 1.20.7. Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades.
- 1.20.8. Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
- 1.20.9. Where equipment is shown to be 'roughed-in only' obtain accurate information from the Engineer's Representative before proceeding with the work.
- 1.20.10. Contractor is to review Architect's specifications, drawings and details to confirm locations of devices and equipment.
- 1.20.11. This Contractor is responsible to mark-out his work, fully coordinated 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.
- 1.20.12. 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.
- 1.21. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS
 - 1.21.1. 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.
 - 1.21.2. 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 – AS-BUILT DRAWINGS.
 - 1.21.3. 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.
 - 1.21.4. 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.
- 1.22. SUPPLEMENTARY BID FORM AND SUBMISSIONS OF BID
 - 1.22.1. Submit with tender, if included in the documents, a complete Electrical Supplementary Bid Form. Tenders not completed in full may, at the discretion of the Owner be rejected.

- 1.22.2. Several alternative, separate and itemized prices may have been requested. These shall be completed on the Electrical Supplementary Bid Form. Refer to the specific sections of the specifications and to the drawings for details.
- 1.23. APPROVED MANUFACTURERS
- 1.23.1. Where only one name appears in the specification, the bid shall include for the specified equipment.
- 1.23.2. 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.
- 1.23.3. The Contractor is to list substitute equipment as a price deduction to the Bid Price on the Electrical Supplementary Bid Form. Space has been provided to show manufacturers not specifically mentioned. Acceptance of substitute equipment shall be at the discretion of the Owner and/or Engineer's Representative. Any substitutes not listed on the Electrical Supplementary 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 Electrical Supplementary Bid Form.
 - .4 The Owner reserves the right to accept or reject any substitution without question.
 - .5 The "Base and Alternate Equipment" is for North American manufactured products. Where a listed manufacturer can offer either North American or non-North American source for the equipment, the country of origin shall be shown under "Substitute Equipment" and the cost savings shown under "Deduct from Tender Price".
- 1.24. PRODUCTS AND MATERIALS
- 1.24.1. Make and quality of materials used in the construction of this project shall be subject to the approval of the Engineer's Representative.
- 1.24.2. 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.
- 1.24.3. Factory assemble control panels and component assemblies.
- 1.24.4. 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.
- 1.24.5. 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.
- 1.24.6. Within 30 days of the award of contract, the Contractor is to submit a complete list of the manufacturers for all equipment being supplied on the project.
- 1.24.7. 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.
- 1.25. CO-OPERATION WITH CONSULTANTS
- 1.25.1. 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.
- 1.25.2. 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.
- 1.25.3. For electrical systems occupancy, provide a PDF copy of the following documents to the Engineer's office for review:
- .1 Electrical inspection authority inspection certificate/report with no deficiencies.
 - .2 Fire alarm verification report with no deficiencies.
 - .1 Ensure that the verification report meets the requirements for verification reports indicated in the Fire Alarm specification section, including the inclusion of audible sound pressure levels and testing with doors closed. Additionally, ensure that the sound pressure levels in the report comply with the minimums, maximums, and minimum levels above ambient stated in Part 3 of the applicable Building Code. Ensure that the report addresses maglocks and music system mute signal, where applicable to the project.
 - .3 Maglock test and verification report with no deficiencies.
 - .4 CAN/ULC-S561 "Standard for Installation and Services for Fire Signal Receiving Centres and Systems" certificate.
 - .5 CAN/ULC-S1001 "Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems" reports for electrical systems with no deficiencies.

- .1 Ensure that the report addresses all systems indicated in the "Life Safety Integration Testing" clause within this specification section.
 - .6 Letter confirming that all emergency lighting and exit signs are installed and illuminated and stating that emergency lighting and exit signs are installed in conformance with the Contract Documents.
 - .7 Letter confirming that all unit equipment for emergency lighting (batteries, heads, exit signs) are installed and powered and have been tested to demonstrate that they last for the run time indicated in the Specifications or on the Drawings. State the applicable run time in the letter. Additionally, ensure that letter states that emergency lighting and exit signs are installed in conformance with the Contract Documents.
 - .8 Letter with written confirmation that all new, relocated, or reinstalled ceiling luminaires are supported from the building structure, independent from the suspended ceiling, in accordance with the requirements of the Lighting Equipment specification section.
 - .9 Emergency generator testing and commissioning reports with no deficiencies.
 - .10 Emergency generator TSSA inspection report with no deficiencies.
 - .11 Fire pump testing and commissioning reports with no deficiencies.
 - .12 Emergency power (inverter) testing report with no deficiencies.
 - .13 Letter confirming that all openings in walls and floors for electrical services have been fire stopped.
 - .14 Cyber Security Report Letter and backup schedule as required by Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - .15 Lighting control commissioning documentation.
 - .16 Letter confirming that all breaker trip unit/protective relays settings have been set in accordance with the power system study.
 - .17 Additional items as indicated by the Engineer's Representative.
 - .18 Additional items as indicated on the Occupancy of Unfinished Buildings Checklist issued by Engineer's Representative.
- 1.26. CO-OPERATION WITH OTHER DIVISIONS
- 1.26.1. Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.
 - 1.26.2. Electrical conduits shall not touch or be supported on pipe or duct walls.
 - 1.26.3. 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.
 - 1.26.4. 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.
 - 1.26.5. 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.

1.27. TEMPORARY USE OF EQUIPMENT

- 1.27.1. Where the electrical systems are operated during construction, the Electrical Contractor shall maintain the system and equipment in proper operating condition.
- 1.27.2. 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.
- 1.27.3. 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.

1.28. TESTING

1.28.1. 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 Startup Service 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 system's 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 Services Division Startup Service (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.

1.28.2. 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 by 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.

1.28.3. Factory Witness Testing

- .1 For all factory witness testing, the manufacturer is to act as the test leader and is responsible for all required organization, coordination, performance of testing and documentation of test results. The manufacturer is to ensure the tests being performed are in alignment with the requirements of the Specification in advance of the testing and provide hard copies of the latest Shop Drawings and test scripts for each attendee of the witness test. Any deviations to the tests being requested in the Specifications and Drawings must be communicated to the Electrical Contractor and Engineer's Representative in advance and must be accompanied with a rationale and/or an alternate test method that demonstrates that the intent of the specified test would be met.
- .2 Each factory witness test is to include at a minimum:
 - .1 Introductions.
 - .2 A walkthrough of the latest Shop Drawing and review of latest Shop Drawing commentary with discussion on any remaining open items.
 - .3 A walkthrough of the test script.
 - .4 A walkthrough of the Design Specifications and Drawings noting/reiterating any required deviations from the design documents in terms of testing requirements.
 - .5 Performance of tests
 - .6 At the conclusion of all factory witness tests, the manufacturer is to produce signed factory test results recording all noted results and documenting any remaining deficiencies. Report to include record of the testing instruments used along with calibration dates (where required) and serial numbers.
- .3 Factory witness testing shall be attended by the persons as listed below, attendance at the witness testing is at the discretion of each representative and is to be confirmed by all parties prior to witness testing.
 - .1 One (1) Electrical Contractor Representative
 - .2 One (1) Engineer Representative
 - .3 One (1) Commissioning Agent Representative
 - .4 One (1) Technical Services Division Startup Service Representative
- .4 Manufacturers to include for the complete cost of the attendees listed above to attend the factory witness testing for the equipment. Cost to include but not limited to all travel, food and lodging costs. Manufacturer to note, attendees may be coming from different locations within Canada.
- .5 Manufacturer to provide factory witness test scripts to the Contractor as a formal Shop Drawing in advance of the factory witness test for review by the Contractor, Engineer and Commissioning Agent through the formal Shop Drawing review process. Factory witness test shall not be scheduled without a reviewed test script.
- .6 Manufacturer to notify the attendees minimum two (2) weeks prior to the date the tests are to be performed. Where travel out of province is required, provide minimum four (4) weeks notice.
- .7 Manufacturer to perform their own internal quality assurance and control check prior to any factory witness test such that the manufacturer is prepared to perform the complete demonstration of the equipment.
- .8 Any deficiencies noted in the factory testing is to be corrected prior to shipment of the electrical equipment.

1.28.4. 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.
- 1.28.5. 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.
- 1.28.6. 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.
- 1.29. WARRANTY
 - 1.29.1. Except where longer warranty periods are required by other specification sections, provide a one (1) year warranty for the Work, starting at Substantial Performance of the Work.
 - 1.29.2. Coordinate the extension of manufacturer warranties to comply with the clause above, based on the duration of construction.
- 1.30. TRAINING
 - 1.30.1. The Manufacturer is to include for qualified technician(s) with project specific knowledge to perform in depth training for facility management team members.
 - 1.30.2. Training may include up to ten (10) attendees and may be video recorded by others.
 - 1.30.3. 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.
 - 1.30.4. 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.
- 1.31. LIFE SAFETY INTEGRATION TESTING
 - 1.31.1. Provide testing of the integration of all life safety and fire protection systems.

- 1.31.2. The Integrated Testing Coordinator (ITC) will complete an Integration Testing Plan (ITP). Carry out the testing as described by the ITC in the ITP, and in accordance with CAN/ULC-S1001 as it relates to any electrical systems.
- 1.31.3. The ITC and development of the ITP are not the responsibility of this Contractor.
- 1.31.4. The testing of the integrated systems shall include, but not be limited to the following systems and all associated components:
 - .1 Fire Alarm System
 - .2 Fire Signal Receiving Centre
 - .3 Mass Notification
 - .4 Elevators
 - .5 Emergency Generators and/or Inverters
 - .6 Audio/Visual Systems
 - .7 Lighting Control Systems
 - .8 Notification Systems (Public Address)
 - .9 Sprinkler Systems
 - .10 Standpipe Systems
 - .11 Fire Pumps
 - .12 Water Supplies
 - .13 Water Supply Control Valves
 - .14 Heat Tracing for Life Safety Systems
 - .15 Fixed Fire Suppression Systems
 - .16 Cooking Equipment Fire Suppression Systems
 - .17 Automatic Door Operators for Stair Relief
 - .18 Hold-Open Devices
 - .19 Electromagnetic Locks
 - .20 Smoke Control Systems and Associated Dampers
 - .21 Venting to Aid Firefighting
 - .22 Smoke Alarms
 - .23 Hazardous Protection Monitoring
 - .24 Gas / CO Detection Systems
 - .25 Prevention of Smoke Recirculation (AHUs)
- 1.31.5. Coordinate with all other trades to carry out the appropriate testing.
- 1.31.6. Be responsible for carrying out and coordinating the testing work associated with the ITP. All work shall be coordinated with the ITC and shall include but not be limited to:
 - .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
 - .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
 - .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems."

- .4 Provide fire alarm verification report along with all other documentation requested by the ITC as it relates to the electrical systems in conformance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems."

1.32. STATEMENT OF PRICES

- 1.32.1. 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.
- 1.32.2. 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.
- 1.32.3. Contractor to list and track all fixed per unit cost luminaires as part of Light Fixtures - Materials on the progress draw.
- 1.32.4. Contractor to list and track each of the approved changes on separate lines on the progress draw.
- 1.32.5. Provide progress draw where the amount claimed is for the value, proportionate to the amount of the Contract, of Work performed and Products delivered to the Place of the Work as of the last day of the payment period. Do not include items on the progress draw which don't meet these conditions.
- 1.32.6. 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.

1.33. METRIC CONVERSIONS

1.33.1. 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.

1.34. INTERRUPTION OF SERVICES

- 1.34.1. 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.
- 1.34.2. 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.
- 1.34.3. All such overtime work shall be carried out without additional cost to the Owners.
- 1.34.4. 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.
- 1.34.5. 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.
- 1.34.6. 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.
- 1.34.7. The Contractor is responsible for any damages caused to existing systems when making connections.
- 1.34.8. 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.

1.35. PRE-PURCHASED EQUIPMENT

- 1.35.1. The Electrical Trade shall assume complete responsibility for the Owner's pre-purchased equipment and its associated equipment as if it had been purchased by the Contractor, with the single exception of payment.
- 1.35.2. The Electrical Trade shall provide a warranty for all pre-purchased equipment during the warranty period and shall include for all labour, material and shipping charges not covered in the manufacturer's warranty to completely repair or replace any defective pre-purchased equipment at no cost to the Owner during the warranty period.
- 1.35.3. The Electrical Trade shall take complete responsibility for the co-ordination of delivery of the separate items of equipment and their proper placement as required by jobsite conditions.
- 1.35.4. The Electrical Trade shall provide all materials and labour required to incorporate pre-purchased equipment into a working system whether or not shown on the Drawings or specified herein.
- 1.35.5. The following list of equipment is pre-purchased:
.1

1.36. PRE-TENDERED EQUIPMENT

- 1.36.1. The Electrical Trade shall assume complete responsibility for the Owner's pre-tendered equipment and its associated equipment as if it had been purchased by the Contractor, including payment.
- 1.36.2. The Electrical Trade shall provide a warranty for all pre-tendered equipment during the warranty period and shall include for all labour, material and shipping charges not covered in the manufacturer's warranty to completely repair or replace any defective pre-tendered equipment at no cost to the Owner during the warranty period.
- 1.36.3. The Electrical Trade shall take complete responsibility for the co-ordination of delivery of the separate items of equipment and their proper placement as required by jobsite conditions.
- 1.36.4. The Electrical Trade shall provide all materials and labour required to incorporate pre-tendered equipment into a working system whether or not shown on the Drawings or specified herein.

1.37. VALUATION OF CHANGES

- 1.37.1. 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.
- 1.37.2. 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.

- 1.37.3. 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.
- 1.37.4. 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 As-Built, layout and working drawings and shop drawings. This includes any and all AutoCAD/BIM costs related to interference drawings or other associated drawings that may be required as part of the changes.
 - .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-productive time.
 - .11 Rentals, additional bonding, project financing.
- 1.37.5. 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 CCDC 2-2020 GC 6.2.
- 1.37.6. 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.
- 1.37.7. 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.
- 1.37.8. The maximum percentage fee for mark-ups shall be as stated in the Division 0/1 specifications or the Contract Supplementary Conditions.
- 1.37.9. All changes, change notices, revisions to contract, Supplemental 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.
- 1.37.10. 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.

1.37.11. 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 Provide detailed labour cost breakdown for both foreman and journeyman, including the categories shown below, with each category expanded to show the individual line items within the category:
 - .1 Category: Wages
 - .1 Base rate
 - .2 Vacation / Statutory Holiday pay
 - .3 xxx
 - .2 Category: Union / Association Funds
 - .1 xxx
 - .3 Category: Payroll Burdens
 - .1 EI
 - .2 CPP
 - .3 xxx
 - .4 Category: Labour Burdens
 - .1 xxx

- 1.37.12. 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.
- 1.37.13. Where a Proposed Change includes both credits and extras, overhead and permitted mark-ups apply to the net extra or credits, if any, of the entire change.
- 1.37.14. When pricing Proposed Changes containing both additions and credits, and where no work and/or materials have been installed on site, the Electrical Contractor shall only price the net new materials and net new labour that are required for the Proposed Change. Per unit labour and material costs shall be equal for credits and additions.

PROPOSED CHANGE ORDER

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

Description	Qty	Net Price U	Total Mat(\$)	Labor U	Total Hours
3/4" EMT		xxx.xx C		5.00 C	
3/4" EMT STL SS CONN		xx.xx C		10.00C	
3/4" EMT STL SS CPLG		xx.xx C		5.00 C	
3/4" EMT STRAP 1-H		xx.xx C		4.00 C	
#10 x 1" SELF TAPPING SCREW		x.xx C		5.50 C	

TOTALS

Description

Material

General Materials

Permitted Mark-up (@ xx.xx %)

Material Total

Labour

Journeyman (xx Hrs. @ \$xx.00)

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

Labour Total

Material and Labour Total

Final Amount

1.38. DEMOLITION

- 1.38.1. The demolition drawings show the general scope of the demolition and not exact details or total extent. For exact details and total extent each service must be carefully checked on site. Before removing services follow the service through to ensure other areas of the building are not affected.
- 1.38.2. Whenever existing services or equipment are to be removed, all electrical connections for such services shall be removed and securely terminated in an approved manner. If necessary to facilitate installation of new work, any existing services and equipment shall be removed and then replaced by this division.
- 1.38.3. Whenever it becomes necessary to relocate any electrical services equipment to make possible installation of the work under this contract, such relocation shall be done by this division without additional cost to the Owner.
- 1.38.4. Make safe and disconnect all power and systems, as and when, and to the extent required to facilitate the demolition.
- 1.38.5. If applicable, review the mechanical, architectural, and other related discipline drawings, and include for removing and making safe all power connections to demolished equipment and devices, back to the source panel, except where indicated otherwise on the drawings.
- 1.38.6. Ensure that all electrical, life safety services, and services for existing equipment, in areas outside the areas of this work, that are required to remain in service, shall do so.
- 1.38.7. Relocate any electrical feeders or equipment that are required to remain in service, that are secured to existing walls, floors or ceilings to be demolished or that are buried and required to be excavated for new work.
- 1.38.8. Remove and replace any electrical equipment on walls or ceilings that will be demolished and rebuilt.
- 1.38.9. Disconnect and remove existing light fixtures, devices, outlets, CCTV, security devices, etc. which are not to be reused. Such items shall be packaged and turned over to the Owner at a place designated by the Owner. Cut back and cap unused raceway and outlets and remove unused wiring back to panelboard in an approved manner.
- 1.38.10. Ensure that all existing equipment which is to be reused and/or relocated is thoroughly reviewed and refurbished to ensure correct operation when put back into service and to meet the requirements of the local authorities having jurisdiction. All existing electrical equipment which is no longer required shall be removed and disposed of off-site.
- 1.38.11. Carry out the work with a minimum of noise, dust and disturbance.
- 1.38.12. Provide tools and clean up equipment. Obtain the Owner's permission for the use of electrical, plumbing or drainage outlets.
- 1.38.13. Where a device is shown to be relocated on the drawings, contractor to remove and re-install device and back box and re-feed the device with new conduit and wire from the nearest existing accessible junction box.
- 1.38.14. Electrical Contractor is responsible for the patching and re-painting the entire wall where a device and/or box has been added, removed or relocated.

1.39. CYBER SECURITY

- 1.39.1. Coordinate with Owner's Information Technology representatives, obtain a copy of Owner's cyber security policy and provide all applicable cyber security configurations.
- 1.39.2. Definitions
 - .1 Cyber Assets: Systems (including hardware, software, and data) and communication networks (including hardware, software, and data).

- .2 Critical Cyber Assets: Cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.
 - .3 Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.
 - .4 Cybercrime: Any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.
 - .5 Cyber Hygiene: Practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.
 - .6 Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.
 - .7 Cyber Security: Technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
 - .8 Cyber Threat or Cyber Security Threat: Malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS / DoS) attacks and other attack vectors.
 - .9 Cyber Threat Actors: Broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.
 - .10 IP Multicast: Technique for one-to-many and many-to-many real-time communication over an IP Infrastructure network.
 - .11 Endpoint: Remote computing device that communicates back and forth with a network to which it is connected. Such as a server, desktop, or laptop.
 - .12 Network Certificates: Also known as a Digital Certificates, which are an electronic "password" that allows a person or organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:
 - .1 Secure Socket Layer Certificate (SSL) Digi-SSL
 - .2 Software Signing (Code Signing Certificate) Digi-Code
 - .3 Client Certificate (Digital ID) Digi-ID
 - .13 Social Engineering: Exploitation methods that target human vulnerabilities, such as carelessness and trust.
 - .14 Technical Vulnerabilities: Weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.
- 1.39.3. Cyber Security Measures
- .1 Implement at minimum the following multi-layered Cyber Security measures to limit and / or reduce the Owner's potential risk from a cyber threat event; such as a Cyber Security data breach or Cyber Security attack.
 - .2 Password Management
 - .1 Employ password management best practices such as:
 - .1 Do not use default passwords.

- .2 Use strong and unique passwords for all applications. Use a minimum of 8 characters where there is no password policy inherent in the software; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ?]).
- .3 Reset passwords at regular intervals.
- .4 Configure two-factor authentication for all accounts where possible in the system software.
- .5 Do not use System Admin logins for simple tasks; create separate User accounts with rights levels appropriate for the job function. Create and define user accounts as appropriate such as Role based, Individual logins or assigned roles.
- .6 Use different passwords for every account.
- .7 Enforce secure password policies within the business environment.
- .8 Have interface lock after a predefined # of failed login attempts for a pre determined time interval.
- .3 Port and Interface Management
 - .1 Employ Port Management techniques such as:
 - .1 Restrict access on network switch ports to assigned devices addresses.
 - .2 Lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
 - .3 Shut off all unused communication services and hardware interfaces.
 - .4 Advise Owner on use of 3rd party port security monitoring.
- .4 Physical and Virtual Networks
 - .1 Provide a dedicated VLAN for network connected systems where a dedicated LAN has not been provided.
- .5 Encryption
 - .1 Use minimum TLS 1.2 for all network attached equipment and use TLS 1.3 where available.
- .6 Network Certificates
 - .1 Ensure Network Certificates are up to date and not expired for all equipment and systems.
- .7 Firmware & Software Update Management
 - .1 Use the latest stable Firmware / Software version on all devices / equipment as well as implement a Firmware / Software Update management process and procedure.
- .8 Manufacturer's System Hardening Guides
 - .1 Provide the Manufacturer's System hardening guides for the equipment being installed and implement as many recommendations / features as possible.
- .9 External Memory
 - .1 Restrict the use of external memory. Restrict or eliminate the use of devices such as external USB Thumb drives unless expressly allowed by the Owner's Information Technology representatives.
- .10 Log Off
 - .1 Enable auto-log off timer for all software, websites and logins. Set auto-log off timer on local Workstation(s) being used to access the equipment with a

reasonable timer in the case that an employee leaves the workstation unattended.

.11 Anti-Virus Software

- .1 Enable and configure anti-virus software on PC endpoints in accordance with the Owner's Information Technology requirements, unless it is to be installed and configured by the Owner.

.12 Filtering Techniques

- .1 Apply filtering techniques including the types listed below where possible:
 - .1 Web Filtering: A Web filter adds another layer to anti-phishing defences by blocking the web based component of phishing and malware attacks.
 - .2 Multicast Message Filtering: Filters the packets sent to multicast groups users are not subscribed to.
 - .3 Content Filtering: Is the use of a program to screen and / or exclude access to web pages or email deemed objectionable. A content filter will then block access to this content.

.13 Back up Regularly

1. Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible.
2. Identify files that require manual backup and the backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.

1.39.4. IT Devices and Systems

- .1 Apply the Cyber security measures listed in the clauses above in part or in full, as possible, to a wide range of Information Technology (IT) Devices including:
 - .1 Firewalls
 - .2 Routers
 - .3 Network switches (Core and Edge Devices)
 - .4 Servers and databases
 - .5 Workstation computers
 - .6 Network connected system devices and controllers
 - .7 Wireless Access Points and wireless controllers
 - .8 Mobile phones and tablets
 - .9 Any IT System or endpoint connected to the network

1.39.5. Operational Technology (OT) Devices and Systems

- .1 Apply the Cyber security measures listed in the clauses above, in part or in full, as possible, to a wide range of OT Network devices including:
 - .1 Industrial Control Systems such as:
 - .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
 - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.

- .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.
 - .4 (CNC) Computer numerical Control is the automated control of machining tools (Drills, boring tools, lathes) and 3D printers by means of a computer.
 - .2 Building Management Systems (BMS) and Building Automation Systems (BAS)
 - .3 HVAC equipment
 - .4 Lighting controls for both internal and external applications
 - .5 Energy monitoring and metering equipment
 - .6 Transportation and parking systems
 - .7 Scientific equipment
 - .8 Any other OT System or endpoint that can be connected to the network
- 1.39.6. Report Cybercrime
- .1 Advise the Owner and / or their representatives of any indication of a Cyber Incident of a criminal nature when performing any work on a network connected system.
- 1.39.7. Cyber Security Report Letter
- .1 Provide a Cyber Security Report Letter in the closeout documents to the client stating which Cyber Security measures have been implemented, when implementing any and / or all of the Cyber Security Measures mentioned in this Specification.
2. Products
- 2.1. NOT USED
3. Execution
- 3.1. NOT USED
- END OF SECTION

26 05 03.00 As-Built 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 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. AS-BUILT DRAWINGS

2.1.1. Request in writing from the Engineer's Representative all electrical **Choose an item.** drawings. Complete release form provided by Engineer's Representative and pay the Engineer's Representative directly the costs identified in this section below prior to receiving the drawings. After the final as-built drawings have been reviewed, send the Engineer's Representative a copy via electronic transfer for their records and send a minimum of one copy on USB key with each set of maintenance manuals. Provide additional copies if required under the General Conditions. **Choose an item.** 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 As-Built 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 Autodesk standard. Custom fonts, shape files, etc., are not to be used.
- .3 Final as-built drawings shall be returned on USB stick.
- .4 Each USB stick shall include a file containing Engineer's Representative and Owner, Contract number, file names and Drawing number. Provide a "readme.txt" file in ASCII format. A printed copy of the readme file shall accompany each USB stick.
- .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. Maintain records on site, as the job progresses, and record all changes and deviations from that shown on Contract Drawings. After review and approval of service lines in trenches, take "as-built" measurements, including all depths, prior to commencement of backfilling operations. Show the location of buried electrical ducts and conductors on the drawings and dimensioned from fixed points. Keep drawings up-to-date during construction and in addition to field measurements include Change Orders, Supplemental Instructions and all other changes.

2.1.8. On completion of the building, forward to the Engineer's Representative the digital drawings indicating all such changes and deviations for review by the Engineer's Representative.

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 **Choose an item**. 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 electronic documentation (Electrical Drawings) in **Choose an item**. sent via electronic transfer. The Engineer's Representative will provide the Drawings one time at no charge. Where the Drawings are requested more than one time throughout the course of the project, a nominal charge of **Choose an item**. will apply to the second and subsequent requests.

2.1.11. The **Choose an item**. 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. Ensure shop drawing package for a given Specification Section is complete, including all equipment, products, materials, and systems to be used as part of that Specification Section, and submit as a single shop drawing package. Do not submit numerous separate shop drawings for the same 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 10 MB
 - .3 Provide FTP hyperlink for all attachments in excess of 10 MB 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.

2.2. ENVIRONMENTAL PRODUCT DECLARATIONS (EPD)

- 2.2.1. Where EPDs are available for Products, submit them for review.
- 2.2.2. Follow Product Category Rules (PCRs) for Life Cycle Assessment (LCA) presented on EPDs.
- 2.2.3. Where multiple EPDs are available for the same Product, the order of preference is as follows:
 - .1 Product Specific, Facility Specific EPD: a Product and manufacturer specific EPD, where the environmental impacts are unique to the specific manufacturing facility.
 - .2 Product Specific EPD: a Product and manufacturer specific EPD where the environmental impacts are considered across multiple manufacturing facilities (i.e. an average of the different facilities in which the Product is manufactured).
 - .3 Industry Average EPD: an EPD for a type of Product, representing the typical environmental impacts averaged across a number of different manufacturers.

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 they have checked the drawing for conformance with all requirements of the Drawings and Specifications, that they have co-ordinated this equipment with other equipment to which it is attached and/or connected and that they have 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. Should equipment or materials that arrive on site differ from those shown on the Shop Drawings, bear all costs for:
 - .1 Revising the equipment and materials.
 - .2 Revising the Work of other contractors impacted.
- 3.1.5. 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.

.1 Where these receptacles are located adjacent to and in close proximity to local switches, mount receptacles at the same elevation as the local switches to provide a neat, aligned, installation.

.4 In mechanical rooms: 1200 mm.

.5 In equipment storage rooms: 900 mm.

.3 Receptacles for maintenance of equipment located on rooftops:

.1 Not less than 750 mm above the finished roof, per Electrical Code.

.4 Panelboards: 2000 mm to top of panel.

.5 Telephone and interphone outlets: 450 mm.

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

.7 Fire alarm stations: 1200 mm, measured to the top of the manual pull station.

.8 Wall Mounted Fire alarm audible devices: 2300 mm and not less than 150 mm from the ceiling, measured to the top of the device.

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

.10 Wall mounted speakers: 2100 mm.

.11 Clocks: 2100 mm.

- .12 Power Door Operator push buttons: 1050 mm.
- .13 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.
- .14 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.
- .15 Wall mounted occupancy sensors: 1050 mm.
- .16 Wall mounted visible signal devices: 2100 mm to centre of lens; or as allowed by CAN/ULC-S524 "Standard for Installation of Fire Alarm Systems" except where facility accessibility standards require otherwise.
- .17 Top of remote annunciator and passive graphic panels shall be no more than 1800 mm above finished floor.
- .18 Wall mounted emergency telephone (Fireman's Handset): 1350 to 1500 mm.

END OF SECTION

26 05 14.00 Power Cable and Overhead Conductors

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 44.00 – INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS.
- 1.1.4. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.

1.2. REFERENCES

1.2.1. Canadian Standards Association (CSA)

- .1 CAN/CSA-C22.2 No.131, Type TECK 90 Cable, latest edition.
- .2 CSA C68.5, Primary Shielded and concentric neutral cable for distribution utilities 15-46kV, latest edition.
- .3 CSA C68.10 Shielded Power cable for commercial and industrial applications, 5-46kV, latest edition.
- .4 CAN/CSA C49.1, Round Wire, Concentric Lay, Overhead Electrical Conductors, latest edition.

1.2.2. National Electrical Manufacturers Association (NEMA)/Insulated Cable Engineers Association (ICEA)

- .1 NEMA WC74-2006/ICEA S-93-639 - Shielded Power Cables 5,000 - 46,000V, latest edition.
- .2 ANSI/ICEA - S-94-649 - Concentric Neutral Cables Rated 5 through 46 kV, latest edition.
- .3 ICEA - S-70-547 - Weather Resistant Polyethylene Covered Conductors, 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.

1.4. WARRANTY

- 1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. GENERAL

- 2.1.1. High voltage (5-46 kV) cables shall be constructed and tested to applicable standards for the system voltage specified.
- 2.1.2. Design shielded cables to safely withstand a ground fault current without damage for 8 cycles with an available shield fault of 3000 amps.
- 2.1.3. Coverings and outer jackets shall be rated for -40 deg. C.

- 2.1.4. Unless specified otherwise below or on the drawings, power cable to be provided with concentric neutral.
- 2.2. POWER CABLE
 - 2.2.1. Cable: to NEMA WC7 1992/ICEA-S-66-524/ CSA C68.10 Shielded Power commercial and industrial applications, 5-46 kV.
 - 2.2.2. Conductor: copper, size and number as indicated.
 - 2.2.3. Conductor shield: Extruded semi conducting layer over conductor.
 - 2.2.4. Insulation: TR XLPE rated 90 deg. C. and a 133 % insulation level.
 - 2.2.5. Insulation shielding: Extruded semi-conductor layer over insulation.
 - 2.2.6. Metallic Shield: Copper tape applied helically over semi-conductor layer.
 - 2.2.7. Overall PVC jacket rated -40 deg. C. rated at a minimum of FT-1 and "Sun Res".
- 2.3. CONCENTRIC NEUTRAL POWER CABLES
 - 2.3.1. Concentric neutral power cable: to CSA C68.5-(latest edition) Primary Shielded and concentric neutral cable for distribution utilities 15-46 kV.
 - 2.3.2. Conductor: copper, size and number as indicated.
 - 2.3.3. Conductor shield: Extruded semi conducting layer over conductor.
 - 2.3.4. Insulation: TR XLPE rated 90 deg. C. and 133 % Insulation Level.
 - 2.3.5. Insulation shield: Semi conducting insulation shielding layer.
 - 2.3.6. Metallic Shield: Copper neutral wires applied helically over insulation shield with a minimum of one third full capacity.
 - 2.3.7. Overall PVC jacket rated -40 deg. C. rated at a minimum of FT-1 and "Sun Res".
- 2.4. TECK POWER CABLE
 - 2.4.1. Cable: to CAN/CSA C22.2 No. 131 and C68.10 Shielded Power commercial and industrial applications, 5-46 kV.
 - 2.4.2. Conductor: Copper, size and number as indicated.
 - 2.4.3. Conductor shield: Extruded semi conducting layer over conductor.
 - 2.4.4. Insulation: TR XLPE 90 deg. C. and a 133 % insulation level.
 - 2.4.5. Insulation shielding: Extruded semi-conductor layer over insulation.
 - 2.4.6. Metallic Shield: Copper Wires or Tape shielding: All single conductor TECK cables to have helically wound concentric ground wire over extruded semi-conductor layer and all three conductor TECK cables to have copper tape, helically applied over semi-conductor layer.
 - 2.4.7. Ground Conductors: For single conductor cable, same copper wires applied helically over insulation shields can be used as grounding conductor. For three conductor cables, an un-insulated stranded copper conductor serve as bonding conductor.
 - 2.4.8. Inner jacket; flame retardant PVC inner jacket.
 - 2.4.9. Armor: Interlocked aluminium armour.
 - 2.4.10. Overall PVC jacket rated -40 deg. C. rated at a minimum of FT-4 and "Sun Res".

2.5. VERTICAL RISER TECK POWER CABLE

- 2.5.1. Cable: to CAN/CSA C22.2 No. 131 and CSA C68.10 Shielded Power commercial and industrial applications, 5-46 kV.
- 2.5.2. Conductor: copper, size and number as indicated.
- 2.5.3. Conductor shield: Extruded semi conducting layer over conductor.
- 2.5.4. Insulation: TR XLPE 90 deg. C. and a 133 % insulation level.
- 2.5.5. Insulation shielding: Extruded semi-conductor layer over insulation.
- 2.5.6. Metallic Shield: Copper Tape shielding: cables to have copper tape, helically applied over semi-conductor layer.
- 2.5.7. Ground Conductors: An un-insulated stranded copper conductor serve as bonding conductor.
- 2.5.8. Inner jacket; flame retardant PVC inner jacket.
- 2.5.9. Armor: Interlocked steel armour.
- 2.5.10. Overall PVC jacket rated -40 deg. C. rated at a minimum of FT-4.

2.6. FIRE/ARC PROOFING

- .1 Fire proofing tape to be Scotch® Fire-Retardant Electric Arc Proofing Tape 77.

2.7. TESTING

- 2.7.1. Cable shall be tested at the manufacturer's plant prior to shipping. Tests shall include:
 - .1 Standard quality control testing to verify cable construction parameters.
 - .2 Insulation resistance.
 - .3 Compliance with CSA.

2.8. DELIVERY

- 2.8.1. Cable shall be delivered on reels in a manner to suit the installation requirements of the Electrical Contractor.

2.9. APPROVED CABLE MANUFACTURERS

- 2.9.1. High voltage cables shall be from the following manufacturers:
 - .1 General Cable / Prysmian.
 - .2 Nexans.
 - .3 Okonite.
 - .4 Southwire.
 - .5 Texcan.
 - .6 Approved equal.

2.10. APPROVED HIGH VOLTAGE CONTRACTORS

- 2.10.1. All high voltage cable work, including splicing and terminations, shall be performed by qualified and experienced personnel.
- 2.10.2. The following contractors are approved to supply, install and terminate the high voltage cables:
 - .1 K-Line Construction.

- .2 Power Cable Installations.
- .3 Independent High Voltage.
- .4 Power Services Canada Inc. (SWO)
- .5 Jesstec Industries Inc.
- .6 Ascent Group Inc.

3. Execution

3.1. GENERAL

- 3.1.1. Install primary cables in ducts and manholes in accordance with Section 26 05 44.00 – INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS.
- 3.1.2. Install primary cables in trenches in accordance with Section 26 05 44.00 – INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS.
- 3.1.3. Where High voltage cables are shown on cable tray, maintain a separation of 100 % of the diameter of the largest cable between adjacent cables.
- 3.1.4. Where cables are run in a vertical riser in a building, Contractor to provide and install vertical-riser TECK cables. Provide strain relief support as detailed in Section 12 of the Electrical Code.
- 3.1.5. Splices and terminations to be made by personnel skilled in this type of work. Submit evidence of this experience and obtain approval prior to commencing this work.
- 3.1.6. Installation of cable, splices and terminations to be performed by firms specializing in this type of work.

3.2. INSTALLATION OF CABLES

- 3.2.1. Determine cable lengths with care, using field measurements, so that number of splices is minimized.
- 3.2.2. Perform Pulling calculations prior to cable installation / cable pulling in duct or on tray. Submit calculations as a shop drawings for review and records.
- 3.2.3. Protect cable from damage when handling cable on reel and when installing cable in duct or tray.
- 3.2.4. Clean and test ducts, before installing cable, by pulling steel wire brush through ducts followed by steel bound mandrel made up of four discs having an over length of not less than 300 mm. Diameter of discs to be 6 mm less than nominal inside diameter of duct.
- 3.2.5. Pull cables in accordance with best standard practice, and as recommended by cable manufacturer. Do not exceed pulling tensions on cables. If recommended pulling tensions are exceeded, cable is to be removed and replaced. When pulling in very-low temperatures, check the with cable supplier.
- 3.2.6. Do not pull cable splices inside ducts.
- 3.2.7. While cable is being pulled, inspect sheath for any visible cracks or other damage. If damage is evident, pulling to be stopped immediately, and cable to be replaced or repaired. Pulling, except for short runs, to be done through use of pulling eye attached directly to conductors that make up cable. Use CSA approved cable lubricants, suitable for ambient temperatures.
- 3.2.8. Seal cable ends to prevent entrance of moisture.
- 3.2.9. Fireproof cables in manholes, vaults and splices in manholes, vaults and cable tray using two helically wound layers of fireproofing tape.

3.3. SPLICES AND TERMINATIONS

- 3.3.1. All splicing and terminations to be performed by qualified and experienced personnel.
- 3.3.2. All cables to be terminated with two-hole long barrel compression type lugs complete with lug inspection / viewing windows that allow installer to see how far the conductor has been inserted into the lug. Lugs to be dual rated for Copper/Aluminum (Cu/Al). Cables to be crimped to the manufacturer's recommendations.
- 3.3.3. Make splices using packaged kits, assembled in accordance with cable type, voltage rating and cable manufacturer's recommendations. Kits and tape products to be equal to 3M products.
- 3.3.4. Terminations are to be packaged kits, installed as per the manufacturer's recommendations. Terminations to be 3M or equal.
- 3.3.5. Terminations or splices are not to be made if cable internals will be exposed to inclement weather. In an emergency, splices or terminations may be made in tent or other protective enclosure with prior approval from Engineer.
- 3.3.6. Shielding grounding is to be reviewed with engineer prior to installation. Shielding to be grounded a source end. If step voltage greater than 50 V is developed based on the length of cable, then the cable shall be grounded at both ends.

3.4. TESTING

- 3.4.1. Arrange and pay for high voltage cables to be tested by the Technical Services Division Startup Service Contractor before being placed in service.
- 3.4.2. Conduct these tests, at time suitable to Engineer, with Engineer present as witness.
- 3.4.3. Perform tests using qualified personnel. Provide necessary instruments and equipment.
- 3.4.4. Use updated and latest "Field test" procedure and criteria from Cable manufacturer.
- 3.4.5. Check phase rotation and identify each phase conductor of each feeder.
- 3.4.6. Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 mega-ohms.
- 3.4.7. Pre-acceptance tests:
 - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 5000 V megger on each phase conductor.
 - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
 - .3 Verify phasing of cabling.
- 3.4.8. Acceptance Tests:
 - .1 Ensure that terminations and accessory equipment are disconnected.
 - .2 Ground shields, ground wires, metallic armour and conductors not under test.
 - .3 High Potential (Hipot) Testing:
 - .1 Conduct hipot testing at 80 % of original factory test voltage in accordance with ICEA recommendations.
 - .4 Leakage Current Testing:
 - .1 Raise voltage in steps from zero to maximum values as specified by ICEA for type of cable being tested.
 - .2 Hold maximum voltage for time period specified by ICEA.
 - .3 Record leakage current at each step.

3.4.9. Provide Engineer's Representative with list of test results showing location at which each test was made, circuit tested and result of each test.

.1 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

26 05 21.00 Wires and Cables Under 2000 V

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 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.

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.

1.4. WARRANTY

- 1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

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 1000 V for 600 V systems that are ungrounded or have a neutral grounding resistor to limit ground fault current.
 - .2 Insulation rated at 600 V for the other 600 V and 347/600 V distribution systems not covered under item #1 above.
 - .3 Insulation rated at 600 V for all systems rated at 480 V 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.
- 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 or No. 131, and to CSA C22.2 No. 174.
- 2.3.3. Conductors:
- .1 Three (3) bare copper bonding conductor sized to Table 16 of the electrical code.
 - .2 Circuit conductors: copper, size as indicated on Drawings.
 - .3 Profile of VFD Cable cross section shall be entirely symmetrical.
- 2.3.4. Shield: Flat copper tape shield, or continuously corrugated and welded aluminum sheath, depending on cable construction.
- 2.3.5. Insulation:
- .1 Chemically cross-linked thermosetting polyethylene (XLPE) with high dielectric strength to withstand repetitive high voltage spikes of 3.1 times the nominal system voltage rating due to VFD IGBT output.
 - .2 Type RW90 or RWU90 CSA rated for 1000 V, and suitable for voltage spikes mentioned in .1 above.
- 2.3.6. Where compliant with CSA C22.2 No. 123, Armour: continuously corrugated and welded aluminum.
- 2.3.7. Where compliant with CSA C22.2 No. 131, Inner jacket: polyvinyl chloride material.
- 2.3.8. Where complaint with CSA C22.2 No. 131, Armour: interlocking aluminum.
- 2.3.9. Overall covering: thermoplastic polyvinyl chloride (PVC) material rated at a minimum of FT-4.

- 2.3.10. Cable to be complete with manufacturer's cable termination kits including terminating connectors for proper termination of shield to ground. Termination kits to ensure common mode stray currents are drawn away from the motor to extend motor life-span. Termination kits to include self-terminating connectors that provide 360 degree contact to the shield / sheath.
- 2.4. MINERAL-INSULATED CABLES
- 2.4.1. Conductors: solid bare soft-annealed copper, size as indicated.
- 2.4.2. Insulation: compressed powdered magnesium oxide to form compact homogeneous mass throughout entire length of cable.
- 2.4.3. Overall covering: annealed seamless copper sheath, Type M1 rated 600 V, 250 C.
- 2.4.4. Outer jacket: PVC applied over sheath, where installed in damp and wet locations.
- 2.4.5. Two (2) hour fire rating.
- 2.4.6. Conform to requirements of CSA C22.2 No. 124; and CAN/ULC S139.
- 2.4.7. All mineral-insulated cable larger than #6 AWG shall be single conductor. For conductors #6 AWG and smaller, multi-conductor mineral-insulated cable is acceptable.
- 2.4.8. Manufacturer / Product: nVent Pyrotenax System 1850.
- 2.5. FIRE RATED TYPE RC CABLE
- 2.5.1. Conductors: stranded annealed copper, size as indicated.
- 2.5.2. Insulation: low smoke silicon rubber.
- 2.5.3. Armour: continuously welded and corrugated copper sheath.
- 2.5.4. Outer Jacket: Provide black low smoke, zero halogen polyolefin, FT4 rated where installed in damp and wet locations.
- 2.5.5. Two (2) hour fire rating.
- 2.5.6. Conform to requirements of CSA C22.2 No. 123; and CAN/ULC S139 with hose stream.
- 2.5.7. Manufacturer / Product:
- .1 Prysmian Draka Lifeline Type RC90.
 - .2 Berkshire Hathaway Marmon RSCC VITALink Type RC90.
- 2.6. ARMOURED CABLES
- 2.6.1. Cables to: CSA C22.2 No. 51.
- 2.6.2. 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.
- 2.6.3. Type: AC90 (BX).
- 2.6.4. Armour: interlocking type fabricated from aluminium strip.
- 2.6.5. 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.
- 2.7. ALUMINUM SHEATHED CABLE
- 2.7.1. 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.
- 2.7.2. Insulation: type RA90 rated 1000 V.

- 2.7.3. Sheath: aluminium applied to form continuous corrugated seamless sheath.
- 2.7.4. Outer jacket of PVC applied over sheath for direct burial or wet locations.
- 2.8. DIESEL LOCOMOTIVE CABLES (DLO)
 - 2.8.1. Cable: to CSA C22.2 No. 96 Portable Power Cables, rated to 2000 V.
 - 2.8.2. Conductor: stranded tinned annealed copper, size and number as indicated
 - 2.8.3. Separator: paper or polyester tape separates the conductor from the rubber insulation to aid in stripping.
 - 2.8.4. Insulation: premium grade Ethylene Propylene Rubber (EPR), rated 90 deg. C.
 - 2.8.5. Jacket: black, heavy duty chlorinated polyethylene (CPE), sunlight resistant, rated at a minimum of FT-4.
- 2.9. WIRING TERMINATION
 - 2.9.1. Lugs, terminals, screws used for termination of wiring to be to be dual rated for Copper/Aluminum (Cu/Al).
 - 2.9.2. Lugs, terminals, and screws used for termination of multiple wires must be rated for their intended use.
 - 2.9.3. For lugs used in connecting power utility company equipment or services, provide lugs that have CSA Die Index stamped on lug to facilitate proper crimping.
- 3. Execution
 - 3.1. GENERAL
 - 3.1.1. Provide a minimum of one bonding conductor for each three ungrounded conductors on all cable runs that do not include conduit. Provide a minimum of one bonding conductor within each power conduit.
 - 3.1.2. For all bonding conductors, provide copper conductors insulated with a green coloured insulation.
 - 3.1.3. Provide a separate dedicated insulated bonding conductor for isolated ground receptacles. See detail on Drawings for more information.
 - 3.1.4. Provide a dedicated neutral for GFCI and AFCI breaker circuits. Install in accordance with breaker manufacturer's written instructions.
 - 3.1.5. Size bonding conductor to applicable tables of the:
 - .1 Ontario Electrical Safety Code.
 - 3.1.6. All equipment, junction boxes, pull boxes, liquid tight flex, etc. to be bonded to ground through bonding conductors.
 - 3.1.7. Provide separate neutral conductor for each 120 volt circuit for all circuits feeding receptacles and power outlets.
 - 3.1.8. Do not install cables or devices on the surface of, or within 100 mm of the underside of roof decks.
 - 3.1.9. Ensure slack is provided in wiring connections to equipment which contains moving parts.
 - 3.1.10. 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.

- 3.1.11. Utilize compression type fittings for the following terminations: incoming conductors into main lug only panelboards rated over 600 A; and terminations onto bus work in switchboards, switchgear, transformers, transfer switches, generators, UPSs, and other electrical equipment.
- .1 For all compression type fittings, provide two-hole long barrel type lugs complete with lug inspection / viewing windows that allow installer to see how far the conductor has been inserted into the lug. Where mechanical screw type lugs are allowed, ensure that they are suitable for the quantity of parallel runs of wire that are to be terminated under. Provide lugs that are dual rated for copper (Cu) and aluminum (Al).
- 3.1.12. 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.
- 3.1.13. 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.
- 3.1.14. 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.
- 3.1.15. Where one (1) hour or two (2) hour conductor fire rating is indicated on the Drawings, provide fire rated Mineral-Insulated cables or fire rated MC cables. Fire rated Mineral-Insulated and MC cables shall be installed in accordance with the manufacturer's installation instructions and the fire rated cable product listing in order to maintain their fire rating. Special attention shall be paid to cable supporting method and fire rating of the structure from which the cables are supported.
- 3.1.16. Where conductors supply power to emergency lighting and the emergency lights are located on a different floor level than the power source (i.e. panel), then the conductors shall be fire rated for at minimum one (1) hour using fire rated Mineral-Insulated cables. Conductors with two (2) hour fire rating shall be used where indicated on Drawings. Provide fire rated Mineral-Insulated cables or fire rated MC cables where conductors require fire ratings.
- 3.1.17. Where alternatives to fire rated cables are indicated on the Drawings, such as running conduits within concrete cast in place slabs, under concrete slabs on grade, or within fire rated shaft/riser, care must be taken to ensure that the required fire rating is maintained. Where drawings call for conduits to be run within concrete cast in place slabs, the slabs must be of sufficient thickness to achieve the required fire rating and be no less than 51 mm (2 in.) of concrete cover both above and below conduits where one (1) hour fire rating is required and 102 mm (4 in.) concrete cover both above and below conduits where two (2) hour fire rating is required. The contractor shall submit a letter confirming the concrete coverage or construction of fire rated assembly provides the sufficient fire rating of the enclosed conduits.
- 3.1.18. 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 installation instructions.
- 3.3.3. Fastenings:
 - .1 One-hole steel straps to secure surface cables 53 mm and smaller. Two-hole steel straps for cables larger than 53 mm.
 - .2 Channel type supports for two or more cables.
 - .3 Galvanized threaded rods: 6 mm diameter minimum to support suspended channels.
 - .4 Pre-engineered support systems complying with CSA C22.2 No. 18.4 "Hardware for the support of conduit, tubing, and cable (Bi-national standard with UL 2239)."
- 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.
- 3.3.6. Where TECK 90 cable is run through or passes through a plenum space, install TECK 90 cable in conduit and comply with electrical code conduit fill percentage rules.

3.4. INSTALLATION OF MINERAL-INSULATED CABLE SYSTEM AND FIRE RATED TYPE RC CABLE SYSTEM

- 3.4.1. General:
 - .1 Comply with: the requirements of the manufacturer's UL listing for the fire rated cable system and the manufacturer's written installation instructions.
 - .2 Provide all Products required by the manufacturer's UL listing to provide a fully certified system.
- 3.4.2. Handling:
 - .1 Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or centre.
- 3.4.3. Splicing:
 - .1 Make all fire rated splices in the factory. In the event that a field splice is necessary, have the manufacturer's field technician make it in the field.
- 3.4.4. Terminations:

- .1 Make field made terminations using the cable manufacturer's termination kits. Use stripping tools, crimping tools and compression tools, available from the manufacturer for proper cable termination.
- .2 Connections to ferrous cabinets for single conductor cables shall incorporate brass plates. Install per manufacturer's drawing.
- .3 At cable terminations, use thermoplastic sleeving over bare conductors.
- 3.4.5. Sheath induction reduction:
 - .1 When multi-phase circuits have paralleled single conductors, run cables in groups having one of each phase in each group.
 - .2 Separate each set of paralleled conductors by at least two single cable diameters.
- 3.4.6. Exposed or Surface Installations:
 - .1 Secure cable(s) to the fire rated building structure using:
 - .1 Supporting methods outlined in the manufacturer's UL listing for the fire rated system utilized.
 - .2 Support fire rated cables at the intervals required by the manufacturer's UL listing.
- 3.4.7. Wall or floor penetrations:
 - .1 Provide approved fire stopping of all penetrations.
 - .2 Neatly train and lace cable inside boxes, equipment, and panelboards.
 - .3 Where cables are buried in cast concrete or masonry, sleeve for entry of cables.
 - .4 When penetrating a fire rated wall or fire rated floor, the cable must extend a minimum of 305 mm beyond the fire rated wall or fire rated floor. The 305 mm dimension can be in any direction as 305 mm of cable length is required to allow for proper heat dissipation such that cable terminations do not overheat.
- 3.5. FIELD QUALITY CONTROL
 - 3.5.1. 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.
 - 3.5.2. All Wires and Cables to be tested on site as defined in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE and herein. Contractor to oversee all testing and correct any deficiencies noted.
- 3.6. INSTALLATION OF CONTROL CABLES
 - 3.6.1. Install control cables in conduit.
 - 3.6.2. Ground control cable shield.

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.
 - 1.3. WARRANTY
 - 1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Provide “U” type support Strut as manufactured by Unistrut or Hilti.
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 103 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.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

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.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

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. 347 V 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 16 mm and 21 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 vertical 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:
- .1 160 cm² (0.016 m²) each in area, AND

- .2 an aggregate area of 650 cm² (0.065 m²) 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.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

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 on centre.

2.2.4. Hot dipped galvanized threaded rods, 6 mm dia. minimum, to support suspended channels.

- 2.2.5. For non-fire rated applications, pre-engineered support systems complying with CSA C22.2 No. 18.4 "Hardware for the support of conduit, tubing, and cable (Bi-national standard with UL 2239)."
- 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 35 mm 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. Do not embed conduits in horizontal concrete floor/ceiling slabs and instead install conduits below the ceiling slab in the ceiling space, unless written consent for embedded conduits is received from the Engineer's Representative. Assume installation of conduits in the ceiling space as a basis of bid. The clauses in this and other spec sections related to conduits embedded in concrete slabs only apply if written consent has been granted by the Engineer's Representative.
- 3.1.2. Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- 3.1.3. Do not install conduits, associated raceway system, or devices on the surface of, or within 100 mm of the underside of roof decks.
- 3.1.4. 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.
- 3.1.5. Where vertically run conduit passes through a slab, Contractor to provide a 100 mm high concrete pad with the pad extending 100 mm on all sides of the conduit.
- 3.1.6. Use electrical metallic tubing (EMT) conduit except where specified otherwise.
- 3.1.7. Use epoxy coated conduit in corrosive areas.
- 3.1.8. Use rigid galvanized steel threaded conduit where conduit is subject to mechanical damage.
- 3.1.9. Use rigid PVC conduit underground or in corrosive areas and where indicated.

- 3.1.10. Use flexible metal conduit for connection to motors or vibrating equipment in dry areas, connection to recessed luminaires without a prewired outlet box, connection to surface or recessed luminaires and work in movable metal partitions. Ensure slack is provided in wiring connections to equipment which contains moving parts.
- 3.1.11. 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. Ensure slack is provided in wiring connections to equipment which contains moving parts.
- 3.1.12. Use explosion proof flexible connection for connection to explosion proof motors.
- 3.1.13. Install conduit sealing fittings in hazardous areas. Fill with compound.
- 3.1.14. Minimum conduit size for lighting and power circuits: NPS 21 mm, unless otherwise noted on the Drawings.
- 3.1.15. Minimum conduit size for data / voice cabling: as indicated on drawings, otherwise 27 mm.
- 3.1.16. Install EMT conduit from a raised floor branch circuit panel to outlet boxes located in sub floor.
- 3.1.17. 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.
- 3.1.18. Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- 3.1.19. Mechanically bend steel conduit over 21 mm diameter.
- 3.1.20. Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- 3.1.21. Install fish cord in empty conduits.
- 3.1.22. Run two 27 mm spare conduits up to ceiling space and two 27 mm 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.
- 3.1.23. Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- 3.1.24. Dry conduits out before installing wire.
- 3.1.25. 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.
- 3.1.26. Provide sleeves for all new conduit passing through floor and roof slabs, beams, concrete walls and slab to slab partitions, etc.
- 3.1.27. 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.
- 3.1.28. 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.

- 3.1.29. Prior to installation of any wire or cable in direct buried conduits or the conduits in an underground duct bank, pull through each conduit a flexible mandrel not less than 300 mm long and size for the internal diameter of conduit, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging conduits where concrete has not set completely. Provide photo and video evidence of compliance with this clause and send to Engineer's Representative for review within 24 hours of Work occurring.

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 CONCRETE

- 3.4.1. Locate to suit reinforcing steel. Install in centre one third of slab.
- 3.4.2. Protect conduits from damage where they stub out of concrete.
- 3.4.3. Install sleeves where conduits pass through slab or wall.
- 3.4.4. Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.
- 3.4.5. Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- 3.4.6. Encase conduits completely in concrete with minimum 25 mm concrete cover.
- 3.4.7. Organize conduits in slab to minimize cross-overs.

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

- 3.5.1. Run conduits 27 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.

3.6. CONDUITS UNDERGROUND

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

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.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

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 Red nameplates for emergency power.
- .8 Blue nameplates for UPS Power.
- .9 Sample:

SWITCHBOARD AA 3000A, 600/347V, 3 PH, 4W, 50kA FED FROM SWITCHBOARD AAA
--

MANUFACTURED IN MM/YYYY; SERIAL NUMBER ##-####

- .10 Wording on nameplates to be approved by Engineer's Representative prior to manufacture.
- .11 Nameplates for splitters, terminal cabinets, grid boxes, pull boxes, and junction boxes are to indicate the system and/or voltage characteristics.
- .12 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .13 Transformers: indicate capacity, primary and secondary voltages, and upstream source where Transformer is fed from.
- .14 Mechanical equipment: indicate equipment name and full circuit number including panel board identification.
- .15 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.
- .16 Automatic Transfer Switches (ATS): Name designation, rated ampacity, voltage, transfer switch arrangement (e.g. 3 pole with no neutral, 3 pole with solid neutral, 3 pole with overlapping neutral, 4 pole), withstand rating in units of kA, upstream normal power source from which ATS is fed, upstream emergency power source from which ATS is fed, month and year manufactured, and serial number.
- .17 Generators:
 - .1 Indicate kW rating, kVA rating, voltage, number of phases, number of wires, generator neutral grounding arrangement, year and month manufactured, and engine and alternator serial number.
 - .2 Indicate Maximum Site Design Load (as defined in CSA C282) in units of kW; engineering firm responsible for Maximum Site Design Load calculation; drawing number, issuance title (e.g. Issued for Construction, Electrical Contactor As-Built, Issued for CCN-E01, etc.), and issuance date which Maximum Site Design Load is based on. It is very important for future renovations and load additions that it is clear when the Maximum Site Design Load is from and what drawing it is based on.
 - .3 Sample nameplate:

Generator G1
600 kW / 750 kVA
600/347V, 3 PH, 4W, Wye solidly grounded
Connected to ATS-PHXA
MANUFACTURED IN MM/YYYY; SERIAL NUMBER ##-####
Maximum Site Design Load 420 kW

- .18 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, paint, or coiled conduit markers 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 12 mm 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 83.00 Sleeves

1. General

1.1. WORK INCLUDED

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

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of 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 150 mm above finished floor to accommodate a 100 mm concrete pad. Contractor to pour the concrete pad with the pad extending 100 mm on all sides of the sleeve.

END OF SECTION

26 08 00.00 Commissioning

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 – AS-BUILT DRAWINGS.

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

1.1.4. Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.

1.2. SCOPE

1.2.1. The commissioning 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 Provision of building operator training.
- .4 Provision of As-Built documentation, operating and maintenance manuals, and systems operating manuals.

1.2.2. The Contractor, Engineer's Representative and Commissioning Agent shall provide the services to complete the process. The execution portion of this Section defines the areas of responsibility.

1.2.3. Provide labour, equipment and material to conduct the Contractor commissioning process as outlined in this Section.

1.2.4. The Owner will hire a Commissioning Agent who will provide services identified in the article within this section.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests as specified in the Electrical Sections. The Contractor shall advise the Engineer's Representative or Commissioning Agent of instrumentation to be used and the dates the instruments were calibrated.

3. Execution

3.1. INSTALLATION

3.1.1. This Section describes the commissioning process to be performed by the Contractor. The process shall provide a high level of quality control during the construction.

3.1.2. The commissioning process shall consist of:

- .1 Shop Drawings/As-Built Drawings.
- .2 Installation inspection and equipment verification.
- .3 Power distribution system commissioning.
- .4 Emergency Power system commissioning.
- .5 Fire alarm system verification and commissioning.
- .6 Commissioning Agent performance testing.
- .7 Commissioning meetings.
- .8 Operating and maintenance manuals.
- .9 Training.
- .10 Systems acceptance.

3.2. INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION

- 3.2.1. The Contractor shall complete the equipment verification forms for each piece of equipment. The completed forms shall be forwarded to the Engineer's Representative for review and be included in the operating and maintenance manual.

3.3. TEST FORMS AND VERIFICATION FORMS

- 3.3.1. The Commissioning Agent will prepare a test form manual, which will contain a form for every test identified in the Specification. A copy of this manual will be given to the Contractor, the General Contractor and the Engineer's Representative.
- 3.3.2. The Contractor shall prepare test forms for every test identified in this Specification. The Contractor shall complete each form as tests are completed and forward a copy to the Engineer's Representative for review on a monthly basis.
- 3.3.3. The forms shall be signed by either the authorities, the Engineer's Representative or the Commissioning Agent.

3.4. TESTING OF EQUIPMENT AND SYSTEMS

- 3.4.1. Conform to Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- 3.4.2. The Contractor shall hire the services of the manufacturer's technicians to test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The tests shall be witnessed by the Engineer's Representative or the Commissioning Agent. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms.
- 3.4.3. When equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Engineer's Representative or the Commissioning Agent.
- 3.4.4. Tests which have not been witnessed shall not be accepted and shall be repeated.

3.5. COMMISSIONING MEETINGS AND SCHEDULING

- 3.5.1. The Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
- 3.5.2. The commissioning meetings shall occur during the regular construction meetings. The testing schedules and results of all tests shall be reviewed.

3.6. OPERATING AND MAINTENANCE MANUALS

3.6.1. Conform to Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.

3.6.2. Submit Operating and Maintenance Manuals to Commissioning Agent for review.

3.7. OPERATOR TRAINING

3.7.1. Conform to Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.

3.7.2. Submit Operating and Maintenance manuals to Commissioning Agent for review.

3.7.3. The training shall be conducted in a classroom and at the equipment or system.

3.7.4. Training will begin when the operating and maintenance manuals have been delivered to the Owner and reviewed by the Engineer's Representative.

3.7.5. Submit a course outline to the Engineer's Representative before training commences. Provide course documentation for up to eight people.

3.7.6. Each training session will be structured to cover:

- .1 The operating and maintenance manual.
- .2 Operating procedures.
- .3 Maintenance procedures.
- .4 Trouble-shooting procedures.
- .5 Spare parts required.

3.7.7. The training sessions will be scheduled and co-ordinated by the Commissioning Agent. The Commissioning Agent will video record the session.

3.7.8. Training shall be provided for the following systems:

System	Minimum Training Times
Diesel Generator	4 hours
Automatic Transfer switches	4 hours
Fire alarm	4 hours
The electrical system	8 hours
UPS systems	4 hours
LV lighting control system	4 hours

3.8. COMMISSIONING AGENT

3.8.1. A Commissioning Agent will be hired by the Owner.

3.8.2. The commissioning agent responsibilities shall include:

- .1 Preparing the commissioning plan.
- .2 Co-ordinating with the contractor to schedule tests.
- .3 Preparing a test form manual.
- .4 Witnessing selected tests.
- .5 Receiving all test forms.
- .6 Conducting performance test.
- .7 Co-ordinating the contractor's training.
- .8 Attend commissioning meetings.
- .9 Preparing the systems operating manuals.

3.8.3. The Contractor shall co-ordinate and co-operate with the Commissioning Agent.

3.9. PERFORMANCE TESTING

3.9.1. The Commissioning Agent will conduct performance tests on each electrical system to verify that the design intent performance has been met. The performance tests will cover all seasonal modes.

3.9.2. The Contractor shall conduct performance tests on all electrical systems and document the results on the performance forms provided by the Commissioning Agent in accordance with this Specification.

3.9.3. The Contractor shall provide assistance to the Commissioning Agent and have personnel available during the performance testing procedures during construction and the warranty period.

3.9.4. Performance testing will begin when all electrical systems have been completed, tested by the Contractor reviewed by the Engineer's Representative and Substantial Performance of the Work has been achieved.

3.10. COMMISSIONING PROCESS ALLOCATION

3.10.1. The commissioning process shall be allocated a value as follows:

\$7,500	For electrical contract value less than \$250,000
3 % of electrical contract value	For electrical contract value from \$250,000 to \$10,000,000
\$500,000	For electrical contract value more than \$10,000,000

3.10.2. This value shall be itemized in the Statement of Prices which forms the basis for progress payment for the various portions of work. The Contractors may draw from this allocation as the commissioning process is completed.

- .1 The Contractors shall submit all test and verification forms. The Engineer's Representative will use these forms to calculate a percentage complete.
- .2 The Contractor may claim up to 50 % of the value indicated above, as per Schedule of Breakdown, on a monthly basis, from this allocation leading up to performance testing. The remaining amount shall not be paid out until the performance testing, O&M manuals and training have been completed satisfactorily.

END OF SECTION

26 09 24.00 Lighting Control Equipment – Addressable 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.
- 1.1.3. Section 26 51 13.00 – LIGHTING EQUIPMENT.
- 1.1.4. Lighting Control Sequence of Operations as attached to Specifications or as shown on drawings.

1.2. REFERENCES

- 1.2.1. CAN/CSA-C22.2 No. 141, Emergency Lighting Equipment, latest edition.
- 1.2.2. CAN/CSA-C22.2 No. 205, Signal Equipment, latest edition.
- 1.2.3. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
- 1.2.4. International Electrotechnical Commission (IEC)
- 1.2.5. National Electrical Manufacturers Association (NEMA)
- 1.2.6. Underwriters Laboratories, Inc. (UL)
- 1.2.7. UL 508 – Standard for Industrial Control Equipment
- 1.2.8. UL 916 – Standard for Energy Management Equipment
- 1.2.9. UL 924 – Standard for Emergency Lighting and Power Equipment

1.3. SUMMARY

- 1.3.1. This specification is intended to fully describe all of the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.
- 1.3.2. Lighting Control System includes computer-based software that provides control, configuration, monitoring and reports. System includes the following components:
 - .1 Energy Control Unit
 - .2 System Server
 - .3 0-10 V Dimming, Fixed Output Ballasts or 0-10 V LED Drivers
 - .4 System Field Devices (Input and Output Modules)
 - .5 Occupancy Sensors – Low Voltage
 - .6 Photo Sensors – Low Voltage
 - .7 Wall stations – Low Voltage
 - .8 Lighting Control System Software - Graphical User Interface based
 - .9 Communication Wire
 - .10 Area Lighting Controllers and/or Room Controllers (to dim/switch a group of luminaires)
 - .11 Interface to Audio Visual equipment (for integration with 3rd party LCD Touch Screen Panel)

- .12 Interface to BACnet
- .13 Interface to customizable Energy dashboard

1.4. DESCRIPTION OF SYSTEM

- 1.4.1. The work covered in this section is subject to the requirements in the General Conditions of the Specifications. Contractor shall coordinate the work in this section with the trades covered in other sections of the specification to provide a complete and operable system.
 - 1.4.2. Extent of the lighting control system work is indicated by drawings and by the requirements of this section. It is the intent of this section to provide an integrated, energy saving lighting control system as described herein from a single supplier. Contractor is responsible for confirming that all components and accessories of the lighting control system interoperate as a single system.
 - 1.4.3. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the System Provider, as required to ensure proper system operation and maintainability.
 - 1.4.4. The lighting control system shall include a fully distributed WAN/LAN network of global controller/routers, individually addressable System Field Devices that are not integral to luminaires, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system WAN/LAN start-up shall be by the control system Manufacturer or Contractors certified by the Manufacturer.
 - 1.4.5. The lighting control system shall utilize non-proprietary industry standard 0-10 V dimming or fixed output ballasts and/or 0-10 V LED drivers, occupancy sensors, daylight sensors, etc.
 - 1.4.6. UL 924 listed devices shall have the ability to control 120 V / 277 V load.
 - 1.4.7. System software interface shall have the ability to notify communication failures to system users via system & email messages. Email messages shall be available in html and text formats.
 - 1.4.8. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
 - 1.4.9. The electrical drawings may show a lighting control system designed with a specific manufacturer as a Basis of Design. There are pre-approved alternate manufacturers listed herein, which are acceptable lighting control systems to be used; however, by using pre-approved alternate manufacturers, the Contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring, etc. as required to suit the alternate pre-approved manufacturer's lighting control system. The Contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design highlighted for review and approval prior to rough-in. Where additional components or devices are required to meet the same design intent as indicated in the drawings and specifications, the Contractor shall include for all costs.
- #### 1.5. LIGHTING CONTROL APPLICATIONS
- 1.5.1. Provide a minimum application of lighting controls as follows:
 - .1 Space Control Requirements – Provide occupancy/vacancy sensors as shown and noted on the electrical drawings. Occupancy/vacancy sensors to provide Manual- or

- Partial-ON functionality or Automatic-ON as described in the drawings and specifications.
- .2 Bi-Level Lighting – Provide multi-level controls in all spaces as indicated in the electrical drawings and specifications.
 - .3 Task Lighting / Plug Loads – Where indicated on the drawings, provide automatic shut off of plug loads and task lighting. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
 - .4 Daylit Areas – Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) and as indicated in the drawings, where daylight contribution is available. Daylighting control shall operate as follows:
 - .1 All luminaires within defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
 - .2 Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes and/or as indicated in the drawings and specifications.
 - .3 Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
 - .4 Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
- 1.5.2. All enclosed rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.
- 1.6. SHOP DRAWINGS AND PRODUCT DATA
- 1.6.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.6.2. Submit manufacturer's data on lighting control system and components and the product data specified below at the same time as a package. Shop drawing submission shall include but not limited to the following:
- .1 Complete list of all parts needed to fully install selected system components.
 - .2 Composite wiring and/or schematic diagram of each control circuit as proposed to be installed. Submitted shop drawings shall detail control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.
 - .3 Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - .1 Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - .2 For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
 - .3 Show exact location of all digital devices, including at minimum sensors, load controllers, and switches for each area on reflected ceiling plans. Contractor

must provide AutoCAD and PDF format reflected ceiling plans. For sensors, prove sensor is suitable for the proposed application.

- 1.6.3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
- 1.6.4. Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades as required.
- 1.6.5. Software Operational Documentation:
 - .1 Software operating and upgrade manuals
 - .2 Program Software Backup: On portable memory storage device, USB stick, complete with data files.
 - .3 Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.
- 1.6.6. Catalog sheets, specifications and installation instructions.
- 1.6.7. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
- 1.6.8. Copy of applicable warranty.
- 1.6.9. Additional information as required on a project specific basis.
- 1.7. PROJECT CONDITIONS
- 1.7.1. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - .1 Ambient temperature: 0° to 40° C (32° to 104° F).
 - .2 Relative humidity: Maximum 90 percent, non-condensing.
- 1.8. WARRANTY
- 1.8.1. Provide a five year limited manufacturer's warranty on all equipment to be free of defects in materials and workmanship.
- 1.8.2. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
- 2. Products
- 2.1. MATERIALS
- 2.1.1. Control system: by one manufacturer and assembled from compatible components.
- 2.2. CENTRAL LIGHTING CONTROL SOFTWARE
- 2.2.1. The system shall offer central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.

- 2.2.2. Native central control software shall be utilized for energy reporting status and complete programming without the need for any third party hardware or software. Systems that require any third party linked software or graphics is not acceptable.
- 2.2.3. Software shall provide information on general system settings via mouse click on a floor plan. Left clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.
- 2.2.4. The system shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user's computer or the lighting control system's main computer. Shall include the navigational features listed below to allow for user's orientation within the controlled space, geographic heading and/or landmarks:
 - .1 Interactive;
 - .2 Vector based;
 - .3 Zoom;
 - .4 Rotate;
 - .5 Pan;
 - .6 Tilt.
- 2.2.5. The system shall allow the building operator to navigate through an entire facility both in two-dimensional and three-dimensional multi-floor view, allowing for fast and easy navigation.
- 2.2.6. Three-dimensional view shall exclude walls and other structural features to avoid shadowing and cluttering of the plan view.
- 2.2.7. Shall display multiple floors in single view resulting in easier system performance visualization for the entire site as well as individual zones or spaces.
- 2.2.8. The system shall allow system performance visualization across a portfolio of buildings via a single interface.
- 2.2.9. All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don't offer real time feedback are not acceptable.
- 2.2.10. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.
- 2.2.11. Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual luminaire availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.
- 2.2.12. The system shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels, Load shedding status, or Lighting energy consumption, Occupancy status in a colorized gradient ("weather" map) type of graphical representation.
- 2.2.13. Energy Analysis data shall be exportable in CSV or image file formats.
- 2.2.14. The system shall allow import of native AutoCAD files.

- 2.2.15. Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:
- .1 Energy consumption broken down by energy management strategy.
 - .2 Energy demand broken down by energy management strategy.
 - .3 Occupancy data by zone.
 - .4 Building wide occupancy status
 - .5 Time Schedule configuration status
 - .6 Lighting energy consumption in a color gradient ("weather map" type) view
 - .7 Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.
- 2.2.16. The software shall offer user configurable fade times (up to 86400 seconds) for individual or group of luminaire during transition between scenes.
- 2.2.17. The system shall be programmable for Time Clock Scheduling of lights on or off via the Lighting Control Software interface.
- 2.2.18. There shall be an "Emergency Mode", when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building emergency monitoring system at a convenient point and not require multiple connections.
- 2.2.19. All ballasts and/or drivers shall be centrally addressable, on a per luminaire or multiple luminaire/zone basis, through the Central Control Software. The basis of design shall utilize 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers connected to an Output Module. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of start-up or reconfiguration.
- 2.2.20. System shall be capable of operating independent of building's existing network infrastructure if desired and shall not rely on Tenant supplied PCs for operation.
- 2.2.21. Firewall Technologies & VLAN Configuration methods shall be utilized to separate tenants from the lighting control network and ensure the integrity of lighting control network.
- 2.2.22. The assignment of individual or group of system components to zones shall be performed via the Central Control Software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.
- 2.2.23. Occupancy sensor time delays shall be configurable through software. Light level sensor parameters shall be configurable through software.
- 2.2.24. System shall auto-configure lighting controls for spaces that have been combined or divided temporarily by moving wall or similar systems.
- 2.2.25. System shall automatically lock wall stations and/or disable sensors based on one of the following system inputs: contact closure, a time schedule or the status of a monitored space.
- 2.2.26. The light management system shall be capable of interfacing digitally with a building automation system via BACnet/IP. The lighting control system shall be capable of communicating the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) to the BAS. Building Automation System shall utilize data from lighting control system input devices such as occupancy sensors to determine the status (occupied/unoccupied) of the mechanical control zones and perform climate adjustments accordingly.

2.3. DIGITAL WALLSTATIONS

- 2.3.1. The system shall connect with the wall stations via field bus that carry low voltage control signals.
- 2.3.2. Software configurable wall stations shall provide on/off switching and dimming control for up to six lighting zones/ five lighting scenes per wall station or more with allowable multi-gang configurations.
- 2.3.3. Shall allow manual dimming of light levels and override of the time schedule.
- 2.3.4. Scenes/zones in the system control software shall be synchronized with the buttons on the wall station.
- 2.3.5. All wall stations shall be individually addressable & reconfigurable via System Control Software.
- 2.3.6. All wall stations shall feature status LED's
- 2.3.7. All wall stations shall be Class 2 Low Voltage devices.
- 2.3.8. All wall stations power source will be from the communication bus.
- 2.3.9. Communication shall be via NEC/CEC Class 2 communication wire.
- 2.3.10. Wall station configuration shall be via GUI in a drag and drop format.
- 2.3.11. Custom button cap configuration shall allow combination of scene & zone in one wall station.
- 2.3.12. Custom commands shall be applied to individual wall station buttons.
- 2.3.13. Wall station shall display its current status (zone/scene under system control or OFF) when motion is detected in the close proximity of the wall station
- 2.3.14. The following User Interface and custom labelling options shall be available:
 - .1 Up to five (5) scene switching & dimming
 - .2 Up to six (6) zone switching
 - .3 One (1) zone switching
- 2.3.15. Shall allow vacancy sensor configuration.
- 2.3.16. Dimensions shall meet NEMA WD-6 spec.
- 2.3.17. The following mounting options shall be supported:
 - .1 Mount in standard size wall box
 - .2 On mounting brackets for low voltage devices
- 2.3.18. Shall be used with "Decorator" style wall plate.

2.4. SYSTEM FIELD DEVICES

- 2.4.1. Shall provide a common interface to low voltage occupancy sensors and photo sensors via Input Modules. These modules shall automatically detect the type of devices they are connected to (i.e., photo sensor, occupancy sensor). Addresses to the field devices shall be assigned during system start-up. Upon establishing two way communication with the Energy Control Unit (ECU), these individually addressable modules shall enable each lighting component to be independently controlled and configured to best meet the needs of the facility. These modules shall connect directly to the NEC/CEC Class 2 communication bus.
- 2.4.2. System Field Devices shall be individually addressable via System Control Software.
- 2.4.3. System shall automatically address individual nodes during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
- 2.4.4. Electrically rated for up to 24 VDC.

- 2.4.5. Shall connect to NEC/CEC Class 2 communication wire.
- 2.4.6. Shall retain all system settings in non-volatile memory.
- 2.4.7. Suitable for fixture or junction box mounting in standard 1/2" knockout (7/8" dia.)
- 2.5. AREA LIGHTING CONTROLLER/ROOM CONTROLLER
 - 2.5.1. Shall provide a common interface (DIM/SWITCH) to a group of 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers via field bus that carry low voltage control signals.
 - 2.5.2. Area Lighting Controllers shall be addressable via Control Software.
 - 2.5.3. System shall automatically address individual area lighting controllers during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
 - 2.5.4. Electrical Maximum Load Ratings:
 - .1 20A 120-347 Vac Ballast
 - .2 20A 120-347 Vac Resistive
 - .3 20A 120-347 Vac Tungsten
 - .4 20A 120-347 Vac General Purpose
 - .5 1.5 HP 120-277 Vac Motor
 - 2.5.5. Communication shall be via NEC/CEC Class 2 communication wire.
 - 2.5.6. Control Options for:
 - .1 ON/OFF Switching
 - .2 Continuous 0-10V dimming
 - .3 Shall be able to communicate with 0-10V ballasts/drivers
 - 2.5.7. Shall be used for general purpose plug load control.
 - 2.5.8. Shall control up to 30 ballast/LED Drivers.
 - 2.5.9. Shall retain all system settings in non-volatile memory.
 - 2.5.10. Mechanically has mounting for standard 1/2" electrical box knockout.
 - 2.5.11. Colour to be selected by Architect/Engineer's Representative.
 - 2.5.12. UL916, UL924 & UL2043 listed.
- 2.6. DIGITAL DAYLIGHTING SENSORS
 - 2.6.1. Digital daylighting sensors shall work to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type.
 - 2.6.2. Daylighting sensors shall be interchangeable without the need for rewiring.
 - 2.6.3. The indoor sensor range shall be between 0 and 750 FC.
 - 2.6.4. The outdoor sensor range shall be between 0 and 750 FC.
 - 2.6.5. Atrium sensor range shall be from 2 to 2,500 FC.
 - 2.6.6. Skylight sensor range shall be between 10 and 7,500 FC.
 - 2.6.7. The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
 - 2.6.8. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.

- 2.6.9. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
- 2.6.10. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
- 2.6.11. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
- 2.7. DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR
 - 2.7.1. Wall or ceiling mounted (refer to drawings) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
 - 2.7.2. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 - .1 Digital calibration and pushbutton configuration for the following variables:
 - .1 Sensitivity – 0-100% in 10% increments
 - .2 Time delay – 1-30 minutes in 1 minute increments
 - .3 Test mode – Five second time delay
 - .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - .5 Walk-through mode
 - .2 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 - .3 Programmable control functionality including:
 - .1 Each sensor may be programmed to control specific loads within a local network.
 - .2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - .3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - .4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - .5 Ultrasonic and Passive Infrared
 - .6 Ultrasonic or Passive Infrared
 - .7 Ultrasonic only
 - .8 Passive Infrared only
 - .9 Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 - .4 Communication shall be via Class 2 communication bus.
 - .5 Manual override of controlled loads.
 - .6 All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
 - .7 Units shall not have any dip switches or potentiometers for field settings.

- 2.7.3. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.
- 2.8. COMMUNICATION WIRE
- 2.8.1. The system shall have the capability to use both NEC/CEC Class 1 and Class 2 wiring to integrate peripheral devices such as ballasts/LED drivers, occupancy sensors, photo sensors, relay-based controls, area lighting controllers, and wall stations into a complete, networked programmable lighting control system.
- 2.8.2. Electrically uses NEC/CEC Class 2 Communication bus.
- 2.8.3. Multi-conductor cable with stranded-copper conductors.
- 2.8.4. Shall power photo sensors, PIR and dual-technology occupancy sensors.
- 2.8.5. Shall allow random devices connection without the need for special network channel termination.
- 2.8.6. Flame rated jacket for plenum use NFPA 262 (UL: FT6, CSA: CMP).
- 2.9. ENERGY CONTROL UNIT (ECU)
- 2.9.1. The Energy Control Unit (ECU) shall collect, process and distribute lighting control information to the system field devices and wall stations over NEC/CEC Class 2 communication bus. Each CU shall feature multiple NEC/CEC Class 2 communication channels that can control a large quantity of nodes (sensors, wall stations, 0-10V Dimming, Fixed Output Ballasts, 0-10V LED Drivers, etc.) per channel, per the manufacturers recommended maximum.
- 2.9.2. The ECU shall be the central intelligence point for the area it controls collecting signal information from sensors, wall stations and personal control software and determining appropriate brightness levels or on/off status for each luminaire or zone. The CU shall connect with a facility's or tenant's Local Area Network (LAN) via Ethernet to enable desktop personal control.
- 2.9.3. Ethernet communication ports that employ TCP/IP protocol shall be provided to simultaneously enable the following connections:
- .1 Lighting Control Network
 - .2 Tenant LAN Access Point
- 2.9.4. Shall have 8 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting NEC/CEC Class 2 communication bus.
- 2.9.5. Each CU channel shall support up to 100 nodes or 800 nodes in total.
- 2.9.6. Shall have status LEDs for the following:
- .1 Network activity on CU's Ethernet port/s
 - .2 CU channel status
 - .3 CU status
- 2.9.7. Shall enable the following functionalities:
- .1 Backup to and Restore from USB flash drives
 - .2 Cycle lights through 100%, 25% & 0% steps
 - .3 Disable/enable all controller functionalities
 - .4 IP Address Reset
 - .5 Electronically deactivate individual channels
- 2.9.8. Shall have configuration stored in non-volatile flash memory.

- 2.9.9. Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
- 2.9.10. UL916 and UL924 listed.
- 2.10. SYSTEM SERVER (SSU)
 - 2.10.1. The System Server shall host the lighting control system database for all the lighting control devices. In addition, it shall provide remote accessing capability to change system settings and/or parameters.
 - 2.10.2. Server shall have the ability to:
 - .1 Analyze system performance or energy data or generate system report;
 - .2 Record energy consumption with average sampling every 5 minutes for unlimited duration;
 - .3 Host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
 - .4 Reside on a client server (virtual server);
 - .5 Interconnect with Control Units over standard Ethernet connection that employs TCP/IP protocol;
 - 2.10.3. Each System Server shall have two Ethernet 10/100Base - Tx Cat 5 RJ45 ports that employ TCP/IP protocol.
 - 2.10.4. Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
- 2.11. EMERGENCY LIGHTING CONTROL DEVICES
 - 2.11.1. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - .1 120/277 volts, 50/60 Hz, 20 amp ballast rating
 - .2 Push to test button
 - .3 Auxiliary contact for remote test or fire alarm system interface
- 2.12. MANUFACTURERS
 - 2.12.1. The following are acceptable manufacturers:
 - .1 Legrand– Encelium
 - .2 Cooper Lighting Solutions
 - .3 Lutron – Athena
 - .4 Acuity – nLight
 - .5 Crestron – Commercial Lighting Controls

3. Execution

3.1. PRE-INSTALLATION MEETING

3.1.1. A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:

- .1 Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
- .2 Review the specifications for low voltage control wiring and termination.
- .3 Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
- .4 Discuss requirements for integration with other trades.

3.2. INSTALLATION AND SERVICES

3.2.1. Locate and install equipment in accordance with manufacturer's recommendations and as indicated.

3.2.2. Install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.

3.2.3. Install all room/area devices using manufacturer's factory-tested cable with pre-terminated connectors. If pre-terminated cable is not used for room/area wiring, test each field-terminated cable following installation and supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-supplied network wire. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.

3.2.4. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.

3.2.5. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.

- .1 Adjust time delay so that controlled area remains lighted while occupied.

3.2.6. Provide written or computer-generated documentation on the configuration of the system including room by room description including:

- .1 Sensor parameters, time delays, sensitivities, and daylighting setpoints.
- .2 Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
- .3 Load Parameters (e.g. blink warning, etc.)

3.2.7. Post start-up tuning – After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report to the Consultant/Owner of post start-up activity.

3.3. FACTORY SERVICES

3.3.1. Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.

3.3.2. The Electrical Contractor shall provide both the manufacturer and the Consultant with three weeks written notice of the system start up and adjustment date.

- 3.3.3. Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.
- 3.4. SYSTEM START UP AND COMMISSIONING
- 3.4.1. If applicable, a commissioning agent will verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician's time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available. Manufacturer is NOT responsible for helping the commissioning agent inspect the individual devices. It will be the commissioning agent's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the agent with this task.
- 3.4.2. The commissioning agent shall work with the electrical contractor during installation of the lighting control hardware to become familiar with the specific products. The agent may also accompany the manufacturer's technicians during their start-up work to better understand the process of testing, calibration and configuration of the products. However, the contractor and manufacturer shall ensure that interfacing with the agent does not prevent them from completing the requirements outlined in the contract documents.
- 3.5. TESTING
- 3.5.1. Upon completion of all line, load and interconnection wiring, and after all luminaire are installed and lamped, a qualified factory representative shall completely configure and test the system.
- 3.5.2. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.
- 3.6. TRAINING
- 3.6.1. Provide four half days of training for the Owner and the Owner's maintenance staff on the operation and maintenance of the system.
- 3.6.2. Training to be recorded for use by Owner in the future.

END OF SECTION

26 09 24.01 Lighting Control Equipment – DALI Low Voltage

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Section 25 10 10.00 – BUILDING SYSTEMS INTEGRATION.
 - 1.1.2. Section 25 10 25.00 – SEQUENCE OF OPERATIONS FOR BUILDING SYSTEMS INTEGRATION.
 - 1.1.3. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - 1.1.4. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
 - 1.1.5. Section 26 51 13.00 – LIGHTING EQUIPMENT.
 - 1.1.6. Lighting Control Sequence of Operations as attached to Specifications or as shown on drawings.
 - 1.2. REFERENCES
 - 1.2.1. CAN/CSA-C22.2 No. 141, Emergency Lighting Equipment, latest edition.
 - 1.2.2. CAN/CSA-C22.2 No. 205, Signal Equipment, latest edition.
 - 1.2.3. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
 - 1.2.4. International Electrotechnical Commission (IEC)
 - 1.2.5. National Electrical Manufacturers Association (NEMA)
 - 1.2.6. Underwriters Laboratories, Inc. (UL)
 - 1.2.7. UL 508 – Standard for Industrial Control Equipment
 - 1.2.8. UL 916 – Standard for Energy Management Equipment
 - 1.2.9. UL 924 – Standard for Emergency Lighting and Power Equipment
 - 1.3. SUMMARY
 - 1.3.1. This specification is intended to fully describe all of the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide Digital Addressable Lighting Interface (DALI) networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.
 - 1.3.2. Lighting Control System includes computer-based software that provides control, configuration, monitoring and reports. System includes the following components:
 - .1 Energy Control Unit
 - .2 System Server
 - .3 DALI Interface
 - .4 DALI LED Drivers
 - .5 0-10 V LED Drivers
 - .6 System Field Devices (Input and Output Modules)
 - .7 Occupancy Sensors – Low Voltage
 - .8 Photo Sensors – Low Voltage

- .9 Wallstations – Low Voltage
- .10 Lighting Control System Software - Graphical User Interface based
- .11 Communication Wire
- .12 Area Lighting Controllers and/or Room Controllers (to dim/switch a group of luminaires)
- .13 Interface to Audio Visual equipment (for integration with 3rd party LCD Touch Screen Panel)
- .14 Interface to BACnet IP and the common Base Building Network
- .15 Interface to customizable Energy dashboard

1.4. DESCRIPTION OF SYSTEM

- 1.4.1. The work covered in this section is subject to the requirements in the General Conditions of the Specifications. Contractor shall coordinate the work in this section with the trades covered in other sections of the specification to provide a complete and operable system.
- 1.4.2. Extent of the lighting control system work is indicated by drawings and by the requirements of this section. It is the intent of this section to provide an integrated, energy saving lighting control system as described herein from a single supplier. Contractor is responsible for confirming that all components and accessories of the lighting control system interoperate as a single system.
- 1.4.3. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the System Provider, as required to ensure proper system operation and maintainability.
- 1.4.4. The lighting control system shall include a fully distributed network of global controller/routers, individually addressable System Field Devices that are not integral to luminaires, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system start-up shall be by the control system Manufacturer or Contractors certified by the Manufacturer.
- 1.4.5. The lighting control system shall use the common Base Building Network for all Ethernet Level communications. Connectivity to the Base Building Integration Platform for consolidated visualization, monitoring and control system for common lighting control functions and intersystem integrations will be enabled through the Base Building Network using BACnet IP protocol. All data within the lighting control system shall be made available on the Base Building Network for access by other systems.
- 1.4.6. The basis of system design shall utilize non-proprietary industry standard DALI LED drivers, occupancy sensors, daylight sensors, etc.
- 1.4.7. The lighting control system shall also utilize non-proprietary industry standard 0-10V LED drivers, occupancy sensors, daylight sensors, etc. for areas where lights are identified to be grouped controlled in lighting zones and not individually addressable fixtures (i.e. parking areas, service rooms, etc.).
- 1.4.8. UL 924 listed devices shall have the ability to control 120 V / 277 V load.
- 1.4.9. System software interface shall have the ability to notify communication failures to system users via system & email messages. Email messages shall be available in html and text formats.

- 1.4.10. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
- 1.4.11. The electrical drawings may show a lighting control system designed with a specific manufacturer as a Basis of Design. There are pre-approved alternate manufacturers listed herein, which are acceptable lighting control systems to be used; however, by using pre-approved alternate manufacturers, the Contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring, etc. as required to suit the alternate pre-approved manufacturer's lighting control system. The Contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design highlighted for review and approval prior to rough-in. Where additional components or devices are required to meet the same design intent as indicated in the drawings and specifications, the Contractor shall include for all costs.
- 1.5. LIGHTING CONTROL APPLICATIONS
- 1.5.1. Provide a minimum application of lighting controls as follows:
- .1 Space Control Requirements – Provide occupancy/vacancy sensors as shown and noted on the electrical drawings. Occupancy/vacancy sensors to provide Manual- or Partial-ON functionality or Automatic-ON as described in the drawings and specifications.
 - .2 Bi-Level Lighting – Provide multi-level controls in all spaces as indicated in the electrical drawings and specifications.
 - .3 Task Lighting / Plug Loads – Where indicated on the drawings, provide automatic shut off of plug loads and task lighting. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
 - .4 Daylit Areas – Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) and as indicated in the drawings, where daylight contribution is available. Daylighting control shall operate as follows:
 - .1 All luminaires within defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
 - .2 Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes and/or as indicated in the drawings and specifications.
 - .3 Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
 - .4 Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
- 1.5.2. All enclosed rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.

1.6. SHOP DRAWINGS AND PRODUCT DATA

- 1.6.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.6.2. Submit manufacturer's data on lighting control system and components and the product data specified below at the same time as a package. Shop drawing submission shall include but not limited to the following:
- .1 Complete list of all parts needed to fully install selected system components.
 - .2 Composite wiring and/or schematic diagram of each control circuit as proposed to be installed. Submitted shop drawings shall detail control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.
 - .3 Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - .1 Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - .2 For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
 - .3 Show exact location of all digital devices, including at minimum sensors, load controllers, and switches for each area on reflected ceiling plans. Contractor must provide AutoCAD and PDF format reflected ceiling plans. For sensors, prove sensor is suitable for the proposed application.
 - .4 Provide identification of each available point in an index or registry for use by the Base Building Integration Platform programmer to identify the display, command and control parameters.
- 1.6.3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
- 1.6.4. Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades as required.
- 1.6.5. Software Operational Documentation:
- .1 Software operating and upgrade manuals
 - .2 Program Software Backup: On portable memory storage device, USB stick, complete with data files.
 - .3 Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.
- 1.6.6. Catalog sheets, specifications and installation instructions.
- 1.6.7. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
- 1.6.8. Copy of applicable warranty.
- 1.6.9. Additional information as required on a project specific basis.
- 1.7. PROJECT CONDITIONS
- 1.7.1. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

- .1 Ambient temperature: 0° to 40° C (32° to 104° F).
- .2 Relative humidity: Maximum 90 percent, non-condensing.

1.8. WARRANTY

- 1.8.1. Provide a five year limited manufacturer's warranty on all equipment to be free of defects in materials and workmanship.
- 1.8.2. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.

2. Products

2.1. MATERIALS

- 2.1.1. Control system: by one manufacturer and assembled from compatible components.

2.2. CENTRAL LIGHTING CONTROL SOFTWARE

- 2.2.1. The system shall offer two separate levels of lighting control:
 - .1 Personal lighting control for the average building occupant to control and adjust basic lighting functions in their workspace, and
 - .2 Central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.
- 2.2.2. Native central control software shall be utilized for energy reporting status and complete programming without the need for any third party hardware or software.
- 2.2.3. Software shall provide information on general system settings via mouse click on a floor plan. Left clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.
- 2.2.4. The system shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user's computer or the lighting control system's main computer. Shall include the navigational features listed below to allow for user's orientation within the controlled space, geographic heading and/or landmarks:
 - .1 Interactive;
 - .2 Vector based;
 - .3 Zoom;
 - .4 Rotate;
 - .5 Pan;
 - .6 Tilt.
- 2.2.5. The system shall allow the building operator to navigate through an entire facility both in two-dimensional and three-dimensional multi-floor view, allowing for fast and easy navigation.
- 2.2.6. Three-dimensional view shall exclude walls and other structural features to avoid shadowing and cluttering of the plan view.

- 2.2.7. Shall display multiple floors in single view resulting in easier system performance visualization for the entire site as well as individual zones or spaces.
- 2.2.8. The system shall allow system performance visualization across a portfolio of buildings via a single interface.
- 2.2.9. All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don't offer real time feedback are not acceptable.
- 2.2.10. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.
- 2.2.11. Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual luminaire availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.
- 2.2.12. The system shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels, Load shedding status, or Lighting energy consumption, Occupancy status in a colorized gradient ("weather" map) type of graphical representation.
- 2.2.13. Energy Analysis data shall be exportable in CSV or image file formats.
- 2.2.14. The system shall allow import of native AutoCAD or REVIT files.
- 2.2.15. Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:
 - .1 Energy consumption broken down by energy management strategy.
 - .2 Energy demand broken down by energy management strategy.
 - .3 Occupancy data by zone.
 - .4 Building wide occupancy status
 - .5 Time Schedule configuration status
 - .6 Lighting energy consumption in a color gradient ("weather map" type) view
 - .7 Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.
- 2.2.16. Personal Lighting Control: the Personal Control Software interface shall provide current status and enable each user with the ability to dim and brighten lights, and turn them on and off by individual luminaire or zone. The Software shall offer user configurable light scenes, which may be programmed and then selected via the Software. Personal lighting control shall be available in open/private office environments. This software shall have the capability of acting as a "virtual occupancy sensor" for the system by detecting keyboard or mouse activity on each PC for incremental occupancy status data.
- 2.2.17. The software shall offer user configurable fade times (up to 86400 seconds) for individual or group of luminaire during transition between scenes.
- 2.2.18. The system shall be programmable for Time Clock Scheduling of lights on or off via the Lighting Control Software interface.

- 2.2.19. The system shall be capable of daylight harvesting (Light Regulation Averaging. In a photo sensor-equipped system, the Central Controller Unit shall rationalize changes to light levels when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions where dimming drivers exist. The System shall operate with multiple users in harmony and not react adversely to manual override inputs.
- 2.2.20. There shall be an "Emergency Mode", when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building emergency monitoring system at a convenient point and not require multiple connections.
- 2.2.21. All drivers shall be centrally addressable for all of the Office floor areas, on a per luminaire or multiple luminaire/zone basis, through the Central Control Software. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of start-up or reconfiguration.
- 2.2.22. System shall be capable of operating independent of building's Base Building network infrastructure if desired on a zone basis and shall not rely on Tenant supplied PCs for operation.
- 2.2.23. Firewall Technologies & VLAN Configuration methods shall be utilized to separate tenants from the lighting control network and ensure the integrity of lighting control network.
- 2.2.24. Do not use default IP addresses for configuration, all systems shall be configured based on the Base Building Network assigned IP address scheme.
- 2.2.25. The assignment of individual or group of system components to zones shall be performed via the Central Control Software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.
- 2.2.26. Occupancy sensor time delays shall be configurable through software. Light level sensor parameters shall be configurable through software.
- 2.2.27. System shall auto-configure lighting controls for spaces that have been combined or divided temporarily by moving wall or similar systems.
- 2.2.28. System shall automatically lock wall stations and/or disable sensors based on one of the following system inputs: contact closure, a time schedule or the status of a monitored space.
- 2.2.29. The light management system shall be capable of interfacing digitally with the Base Building Integration Platform and building automation system via BACnet/IP. The lighting control system shall be capable of communicating the status of output devices (lighting loads, status and dimming percentage) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) on the Base Building Network. Building Automation System shall utilize data from lighting control system input devices such as occupancy sensors to determine the status (occupied/unoccupied) of the mechanical control zones and perform climate adjustments accordingly. Connectivity to the Base Building Integration Platform for consolidated visualization, monitoring and control system for common lighting control functions and intersystem integrations will be enabled through the Base Building Network using BACnet IP protocol. All data within the BAS system shall be made available at the Base Building Network level for access by other systems.
- 2.2.30. All data collected by the system at any level is the property of the building Owner. The vendor shall provide access to all data in an output format collected when requested if it is embedded within the system.

2.3. DIGITAL WALLSTATIONS

- 2.3.1. The system shall connect with the wall stations via field bus that carry low voltage control signals.
- 2.3.2. Software configurable wall stations shall provide on/off switching and dimming control for up to six lighting zones/ five lighting scenes per wall station or more with allowable multi-gang configurations.
- 2.3.3. Shall allow manual dimming of light levels and override of the time schedule.
- 2.3.4. Scenes/zones in the system control software shall be synchronized with the buttons on the wall station.
- 2.3.5. All wall stations shall be individually addressable & reconfigurable via System Control Software.
- 2.3.6. All wall stations shall feature status LED's
- 2.3.7. All wall stations shall be Class 2 Low Voltage devices.
- 2.3.8. All wall stations power source will be from the communication bus.
- 2.3.9. Communication shall be via NEC/CEC Class 2 communication wire.
- 2.3.10. Wall station configuration shall be via GUI in a drag and drop format.
- 2.3.11. Custom button cap configuration shall allow combination of scene & zone in one wall station.
- 2.3.12. Custom commands shall be applied to individual wall station buttons.
- 2.3.13. Wall station shall display its current status (zone/scene under system control or OFF) when motion is detected in the close proximity of the wall station.
- 2.3.14. The following User Interface and custom labelling options shall be available:
 - .1 Up to five (5) scene switching & dimming
 - .2 Up to six (6) zone switching
 - .3 One (1) zone switching
- 2.3.15. Shall allow vacancy sensor configuration.
- 2.3.16. Dimensions shall meet NEMA WD-6 spec.
- 2.3.17. The following mounting options shall be supported:
 - .1 Mount in standard size wall box
 - .2 On mounting brackets for low voltage devices
- 2.3.18. Shall be used with "Decorator" style wall plate.

2.4. SYSTEM FIELD DEVICES

- 2.4.1. Shall provide a common interface to low voltage occupancy sensors and photo sensors via Input Modules. These modules shall automatically detect the type of devices they are connected to (i.e., photo sensor, occupancy sensor). Addresses to the field devices shall be assigned during system start-up. Upon establishing two way communication with the Energy Control Unit (ECU), these individually addressable modules shall enable each lighting component to be independently controlled and configured to best meet the needs of the facility. These modules shall connect directly to the NEC/CEC Class 2 communication bus.
- 2.4.2. System Field Devices shall be individually addressable via System Control Software.
- 2.4.3. System shall automatically address individual nodes during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
- 2.4.4. Electrically rated for up to 24 VDC.

- 2.4.5. Shall connect to NEC/CEC Class 2 communication wire.
- 2.4.6. Shall retain all system settings in non-volatile memory.
- 2.4.7. Suitable for fixture or junction box mounting in standard 1/2" knockout (7/8" dia.)
- 2.5. AREA LIGHTING CONTROLLER/ROOM CONTROLLER
 - 2.5.1. Shall provide a common interface (DIM/SWITCH) to a group of 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers via field bus that carry low voltage control signals.
 - 2.5.2. Area Lighting Controllers shall be addressable via Control Software.
 - 2.5.3. System shall automatically address individual area lighting controllers during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
 - 2.5.4. Electrical Maximum Load Ratings:
 - .1 20A 120-347 Vac Ballast
 - .2 20A 120-347 Vac Resistive
 - .3 20A 120-347 Vac Tungsten
 - .4 20A 120-347 Vac General Purpose
 - .5 1.5 HP 120-277 Vac Motor
 - 2.5.5. Communication shall be via NEC/CEC Class 2 communication wire.
 - 2.5.6. Control Options for:
 - .1 ON/OFF Switching
 - .2 Continuous 0-10V dimming
 - .3 Shall be able to communicate with 0-10V ballasts/drivers
 - 2.5.7. Shall be used for general purpose plug load control.
 - 2.5.8. Shall control up to 30 ballast/LED Drivers.
 - 2.5.9. Shall retain all system settings in non-volatile memory.
 - 2.5.10. Mechanically has mounting for standard 1/2" electrical box knockout.
 - 2.5.11. Colour to be selected by Architect/Engineer's Representative.
 - 2.5.12. UL916, UL924 & UL2043 listed.
- 2.6. DIGITAL DAYLIGHTING SENSORS
 - 2.6.1. Digital daylighting sensors shall work to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type.
 - 2.6.2. Daylighting sensors shall be interchangeable without the need for rewiring.
 - 2.6.3. The indoor sensor range shall be between 0 and 750 FC.
 - 2.6.4. The outdoor sensor range shall be between 0 and 750 FC.
 - 2.6.5. Atrium sensor range shall be from 2 to 2,500 FC.
 - 2.6.6. Skylight sensor range shall be between 10 and 7,500 FC.
 - 2.6.7. The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
 - 2.6.8. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.

- 2.6.9. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
- 2.6.10. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
- 2.6.11. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
- 2.7. DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR
 - 2.7.1. Wall or ceiling mounted (refer to drawings) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
 - 2.7.2. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 - .1 Digital calibration and pushbutton configuration for the following variables:
 - .1 Sensitivity – 0-100% in 10% increments
 - .2 Time delay – 1-30 minutes in 1 minute increments
 - .3 Test mode – Five second time delay
 - .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - .5 Walk-through mode
 - .2 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 - .3 Programmable control functionality including:
 - .1 Each sensor may be programmed to control specific loads within a local network.
 - .2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - .3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - .4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - .5 Ultrasonic and Passive Infrared
 - .6 Ultrasonic or Passive Infrared
 - .7 Ultrasonic only
 - .8 Passive Infrared only
 - .9 Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 - .4 Communication shall be via Class 2 communication bus.
 - .5 Manual override of controlled loads.
 - .6 All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
 - .7 Units shall not have any dip switches or potentiometers for field settings.

- 2.7.3. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.
- 2.8. COMMUNICATION WIRE
- 2.8.1. The system shall have the capability to use both NEC/CEC Class 1 and Class 2 wiring to integrate peripheral devices such as ballasts/LED drivers, occupancy sensors, photo sensors, relay-based controls, area lighting controllers, and wall stations into a complete, networked programmable lighting control system.
- 2.8.2. Electrically uses NEC/CEC Class 2 Communication bus.
- 2.8.3. Multi-conductor cable with stranded-copper conductors.
- 2.8.4. Shall power photo sensors, PIR and dual-technology occupancy sensors.
- 2.8.5. Shall allow random devices connection without the need for special network channel termination.
- 2.8.6. Flame rated jacket for plenum use NFPA 262 (UL: FT6, CSA: CMP).
- 2.8.7. Communications cabling for connection to the Base Building network shall confirm to Division 27 requirements.
- 2.9. ENERGY CONTROL UNIT (ECU)
- 2.9.1. The Energy Control Unit (ECU) shall collect, process and distribute lighting control information to the system field devices and wall stations over NEC/CEC Class 2 communication bus. Each CU shall feature multiple NEC/CEC Class 2 communication channels that can control a large quantity of nodes (sensors, wall stations, 0-10V Dimming, Fixed Output Ballasts, 0-10V LED Drivers, etc.) per channel, per the manufacturers recommended maximum.
- 2.9.2. The ECU shall be the central intelligence point for the area it controls collecting signal information from sensors, wall stations and personal control software and determining appropriate brightness levels or on/off status for each luminaire or zone. The CU shall connect with a facility's or tenant's Local Area Network (LAN) via Ethernet to enable desktop personal control.
- 2.9.3. Ethernet communication ports that employ TCP/IP protocol shall be provided to simultaneously enable the following connections:
- .1 Lighting Control Network
 - .2 Tenant LAN Access Point
- 2.9.4. Shall have 8 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting NEC/CEC Class 2 communication bus.
- 2.9.5. Each CU channel shall support up to 100 nodes or 800 nodes in total.
- 2.9.6. Shall have status LEDs for the following:
- .1 Network activity on CU's Ethernet port/s
 - .2 CU channel status
 - .3 CU status
- 2.9.7. Shall enable the following functionalities:
- .1 Backup to and Restore from USB flash drives
 - .2 Cycle lights through 100%, 25% & 0% steps
 - .3 Disable/enable all controller functionalities
 - .4 IP Address Reset

- .5 Electronically deactivate individual channels
- 2.9.8. Shall have configuration stored in non-volatile flash memory.
- 2.9.9. Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
- 2.9.10. UL916 and UL924 listed.
- 2.10. DALI INTERFACE (DALI BRIDGE)
 - 2.10.1. The system shall provide an interface between the ECU and DALI Control Gear (DALI LED Drivers). The ECU, through the DALI Interface, automatically detects and addresses the DALI LED Drivers it is connected to and establishes two-way communication. The DALI Interface shall connect directly to the Class 2 communication wire.
 - 2.10.2. The system shall automatically address DALI Control Gear during system commissioning thus eliminating the need to pre-address the devices or record serial numbers during installation.
 - 2.10.3. The system shall retain all system settings in non-volatile memory.
- 2.11. SYSTEM SERVER (SSU)
 - 2.11.1. The System Server shall host the lighting control system database for all the lighting control devices. In addition, it shall provide remote accessing capability to change system settings and/or parameters.
 - 2.11.2. Server shall have the ability to:
 - .1 Analyze system performance or energy data or generate system report;
 - .2 Record energy consumption with average sampling every 5 minutes for unlimited duration;
 - .3 Host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
 - .4 Reside on a client server (virtual server);
 - .5 Interconnect with Control Units over standard Ethernet connection that employs TCP/IP protocol;
 - 2.11.3. Each System Server shall have two Ethernet 10/100BaseT Cat 6 RJ45 ports that employ TCP/IP protocol and provide lighting control system data on BACnet IP to the Base Building Network for use by other systems.
 - 2.11.4. Shall mount in a standard 19" rack (1U width), in the Base Building Network Main Equipment Room.
- 2.12. EMERGENCY LIGHTING CONTROL DEVICES
 - 2.12.1. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - .1 120/277 volts, 50/60 Hz, 20 amp ballast rating
 - .2 Push to test button
 - .3 Auxiliary contact for remote test or fire alarm system interface

2.13. BUILDING INTEGRATION INTERFACE

- 2.13.1. The lighting control system, shall communicate on the Base Building Network via BACnet IP to share the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) to the building automation system and the Base Building Integration Platform.
- 2.13.2. The Building Automation System, utilize data from lighting control system to switch/dim lighting, perform load shedding of lighting load, to turn lights on in response to emergency signal through fire alarm and perform HVAC adjustments.
- 2.13.3. The Base Building Integration Platform will use this data exchange for consolidated visualization, monitoring and control of common lighting control functions and intersystem integrations.
- 2.13.4. All data within the lighting control system and the functions listed in 2.11.2 shall be made available on the Base Building Network for access by other systems.
- 2.13.5. All data collected by the system at any level is the property of the building Owner. The vendor shall provide access to all data in an output format collected when requested if it is embedded within the system.

2.14. MANUFACTURERS

- 2.14.1. The following are acceptable manufacturers:
 - .1 Legrand – Encelium
 - .2 Cooper Lighting Solutions
 - .3 Crestron – Commercial Lighting Solutions
 - .4 Lutron – Athena

3. Execution

3.1. PRE-INSTALLATION MEETING

- 3.1.1. A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
 - .1 Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
 - .2 Review the specifications for low voltage control wiring and termination.
 - .3 Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 - .4 Discuss requirements for integration with other trades.
 - .5 Coordinate the required number of IP addresses, required number and location of Ethernet ports and subnets; identification of Internet socket port number requirements for external communication through the building firewall.
 - .6 Do not use default IP addresses for configuration, all systems shall be configured based on the Base Building Network provider's assigned IP address scheme.

3.2. INSTALLATION AND SERVICES

- 3.2.1. Locate and install equipment in accordance with manufacturer's recommendations and as indicated.
- 3.2.2. Install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.
- 3.2.3. Install all room/area devices using manufacturer's factory-tested cable with pre-terminated connectors. If pre-terminated cable is not used for room/area wiring, test each field-terminated cable following installation and supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-supplied network wire. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.
- 3.2.4. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.
- 3.2.5. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
 - .1 Adjust time delay so that controlled area remains lighted while occupied.
- 3.2.6. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - .1 Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - .2 Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - .3 Load Parameters (e.g. blink warning, etc.)
 - .4 IP Addresses - Do not use default IP addresses for configuration, all systems shall be configured based on the Base Building Network provider's assigned IP address scheme.
 - .5 Provide identification of each available point in an index or registry for use by the Base Building Integration Platform programmer to identify the display, command and control parameters.
- 3.2.7. Technical Services Division Startup Service provider shall provide technical services for the lighting control system as follows:
 - .1 Verify proper communication over control wires.
 - .2 Map addresses of all 0-10 V, DALI gear and wireless devices.
 - .3 Verify communication to control units and system server.
 - .4 Software configuration of occupancy sensors, light level sensors, wall stations and other contacts to suit design specifications.
 - .5 Configure and program lighting control sequences as described on contract documents.
 - .6 Demonstrate to Owner and Engineer proper operation of all areas the system is installed.
- 3.2.8. Post start-up tuning – After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report to the Consultant/Owner of post start-up activity.

3.3. FACTORY SERVICES

- 3.3.1. Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.

- 3.3.2. The Electrical Contractor shall provide both the manufacturer and the Consultant with three weeks written notice of the system start up and adjustment date.
- 3.3.3. Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.
- 3.4. SYSTEM START UP AND COMMISSIONING
 - 3.4.1. If applicable, a commissioning agent will verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician's time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available. Manufacturer is NOT responsible for helping the commissioning agent inspect the individual devices. It will be the commissioning agent's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the agent with this task.
 - 3.4.2. The commissioning agent shall work with the electrical contractor during installation of the lighting control hardware to become familiar with the specific products. The agent may also accompany the manufacturer's technicians during their start-up work to better understand the process of testing, calibration and configuration of the products. However, the contractor and manufacturer shall ensure that interfacing with the agent does not prevent them from completing the requirements outlined in the contract documents.
 - 3.4.3. Each data point that requires input from/output to another system to accomplish the integrated systems operation outlined in 25 06 00.00 shall be demonstrated to respond to/send the information to demonstrate independent system operation.
- 3.5. TESTING
 - 3.5.1. Upon completion of all line, load and interconnection wiring, and after all luminaire are installed and lamped, a qualified factory representative shall completely configure and test the system.
 - 3.5.2. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.
- 3.6. TRAINING
 - 3.6.1. Provide four half days of training for the Owner and the Owner's maintenance staff on the operation and maintenance of the system.
 - 3.6.2. Training to be recorded for use by Owner in the future.

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.
- 1.1.5. Section 26 28 21.00 – MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS.

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.
- 1.3.3. 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, submit at a minimum a preliminary short circuit study for review.

1.4. WARRANTY

- 1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

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.
 - .1 120/208 V panelboards – 10 kA
 - .2 347/600 V panelboards – 22 kA

- 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 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, for all panelboards other than those used in residential suites.
- 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. Provide Surge Protection Device where shown on Drawings.
- 2.1.15. Series ratings aren't acceptable.
- 2.1.16. All lugs to be dual rated for Copper/Aluminum (Cu/Al).
- 2.1.17. Where panelboards shown on the Drawings are indicated as Power Panels (PPs) or Distribution Panels (DPs), provide panelboard models that by default accommodate a minimum of 3 feeder circuit breakers rated for a minimum of 200 A – 3P, in addition to those shown on the Drawings.
- 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).
 - 2.2.9. Comply with Section 26 28 21.00 - MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS.

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
 - .4 ABB

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 strut channel 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 24 18.00 Panelboards – Switch and Fuse 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. 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.

1.3.2. Drawings to include electrical detail and dimensions of panel, branch switch type, ampacity and quantity.

1.3.3. 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, submit at a minimum a preliminary short circuit study for review.

1.4. PLANT ASSEMBLY

1.4.1. Assemble panelboard interior before shipment. Ship fuses loose for on-site installation.

1.4.2. In addition to CSA requirements, manufacturer's nameplates must show fault current that panelboard has been built to withstand.

1.5. WARRANTY

1.5.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. CONSTRUCTION FEATURES

2.1.1. Panelboards: product of one manufacturer.

2.1.2. Sequence phase bussing with odd numbered sections on left and even on right, with each section identified by permanent number identification as to circuit number and phase.

- 2.1.3. Panelboards with mains, number of circuits, and number and size of branch sections 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.
- 2.1.4. Panelboards to have the following minimum ratings for interrupting capacity or as indicated on the drawings or panel schedules.
 - .1 120/208 V panelboards – 10 kA
 - .2 347/600 V panelboards – 22 kA
- 2.1.5. Two keys for each panelboard and key panelboards alike.
- 2.1.6. Copper bus with neutral sized to 200 % of the mains rating.
- 2.1.7. Suitable for bolt-on fusible sections.
- 2.1.8. Trim and door finish: baked grey enamel.
- 2.1.9. Enclosure to be CSA Type 1 with drip hood.
- 2.1.10. Fusible pull-outs or door-operated type switches not acceptable.
- 2.1.11. Fuse clips: suitable for High Rupturing Capacity (HRC) Class J fuses.
- 2.1.12. All lugs and switch terminals to be dual rated for Copper/Aluminum (Cu/Al).
- 2.2. CUSTOM BUILT PANELBOARD ASSEMBLIES
 - 2.2.1. Double stack panels as indicated.
 - 2.2.2. Contactors in mains as indicated.
 - 2.2.3. Feed through lugs as indicated.
- 2.3. EQUIPMENT IDENTIFICATION
 - 2.3.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
 - 2.3.2. Nameplate for each panel engraved in 8 mm high letters.
 - 2.3.3. Nameplate for each circuit in distribution panels engraved "name of load" as indicated in 5 mm high letters.
 - 2.3.4. Complete circuit directory with typewritten legend showing location and load of each circuit. Install circuit directory under plastic protective cover on front of panel.
 - 2.3.5. Provide a lamacoid for each fused circuit that indicates the replacement fuse size.
- 2.4. MANUFACTURERS
 - 2.4.1. The following are acceptable manufacturers:
 - .1 Schneider Electric
 - .2 Eaton Cutler-Hammer
 - .3 Siemens
 - .4 ABB

3. Execution

3.1. INSTALLATION

- 3.1.1. Locate panelboards as indicated and mount securely, plumb, and square, to adjoining surfaces.
- 3.1.2. Install surface-mounted panelboards on plywood backboards. Where practical group panelboards on common backboard. The plywood backboards are to be as per Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 3.1.3. Mount panels 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.

END OF SECTION

26 27 19.00 Multi-Outlet Assemblies

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 27 26.00 – WIRING DEVICES.

1.1.4. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.

1.2. REFERENCE

1.2.1. CSA C22.2 No. 62 – Surface Metal Raceways, latest edition.

1.2.2. ANSI/TIA 569-C – Commercial Building Standard for Telecommunications Pathways and Spaces, 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. If variations from the reviewed shop drawings occur during the installation of the system, final as built drawings shall be submitted for each floor that has been altered.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. SURFACE RACEWAY FOR WIRING DEVICES

2.1.1. The raceway and all system components must be CSA listed.

2.1.2. Raceway to be constructed of galvanized steel unless stainless steel is identified on the drawings. Raceway base shall have a minimum thickness of 1.3 mm (0.050 in.) and the cover shall have a minimum thickness of 1 mm (0.040 in.).

2.1.3. Raceways shall be painted with the colour to be determined by the architect at the time of shop drawing stage. Submit available colour selections with the shop drawing submittal.

2.1.4. The raceway shall have a minimum of two compartments unless additional compartments are identified on the drawings. Assembled base and cover shall be a 120 mm (4¾ in.) wide for two section raceway and additional 60 mm (2-3/8 in.) for every additional compartment with a minimum depth of 45 mm (1¾ in.) unless specified otherwise on the drawing.

- 2.1.5. The raceway shall be a modular design with separate covers for each compartment divided with fixed barriers. The compartment covers to be snap on design, which snap side by side on a common base. Raceway covers shall be enhanced tamper resistant form, where screws are only necessary on access plates and the covers of certain fittings, but not on standard cover lengths. A tool shall be provided to form the shape in the cover flange necessary to maintain enhanced tamper resistance when the cover is field cut. Another tool shall be provided for cutting covers to ensure square field cuts.
- 2.1.6. Provide all required fittings including, but not limited to flat, internal and external elbows, couplings for joining raceway sections, wire clips, blank end fittings, entrance fittings, and a full complement of device mounting brackets and plates. All fittings shall be an enhanced tamper resistant form and shall be divided with barriers and made to match the size of the accompanying raceway base.
- 2.1.7. Provide full capacity corner elbows and tee fittings to maintain a controlled 50 mm (2 in.) cable bend radius, which meets the specifications for Fiber Optic cabling and exceeds the TIA 569 requirements for communications pathways.
- 2.1.8. Device brackets shall be provided in sizes to match the width of the raceway and with mounting-holes appropriately located to ensure proper mounting of devices in all compartments.
- 2.1.9. Device plates shall be made in any length from 152.4 mm (6 in.) to 1.5 m (60 in.) with cut outs to accommodate various combinations of power and/or communication devices in all compartments. Device plates shall be 152.4 mm (6 in.) and 304.8 mm (12 in.) long with a flange to overlap the joint of the adjacent cover. Provide 5% additional device plates for future additions or modifications for all types of devices installed.
- 2.2. MANUFACTURERS
- 2.2.1. The following are approved manufacturers:
- .1 CER - Canadian Electric Raceways.
 - .2 Legrand – Wiremold.
 - .3 Hubbell.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Prior to and during installation, refer to system layout or approval drawings containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets, which accompany system components, as well as complete system instruction sheets, whichever is applicable.
- 3.1.2. All raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, also in accordance with manufacturer's installation sheets.
- 3.1.3. All metal raceway shall be electrically continuous and bonded in accordance with the respective electrical code for proper grounding.
- 3.1.4. Provide a separate insulated bonding conductor in the entire length of the raceway.
- 3.1.5. Raceway shall be securely supported at intervals not exceeding 1500 mm (5 ft.) or in accordance with manufacturer's installation sheets.

- 3.1.6. All raceway systems shall be installed complete, including insulating bushings and inserts where required by manufacturer's installation sheets. All unused raceway openings shall be closed.
- 3.1.7. Locate wireway and wiring devices as shown.
- 3.1.8. Install supports, elbows, tees, connectors and fittings. Keep the number of elbows, offsets and connections to a minimum.
- 3.1.9. Install wiring and wiring devices as indicated.
- 3.1.10. Install barriers to separate different wiring systems.

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. REFERENCES

1.2.1. CSA C22.2 No. 42, General use receptacles, attachment plugs, and similar wiring devices, 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.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

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 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. Duplex receptacles with USB charging outlets, 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 Six back wired entrances, four side wiring screws.
 - .4 Triple wipe contacts and riveted grounding contacts.
 - .5 One USB A charging outlet and one USB C charging outlet, 5 V DC, 6 A shared between the two ports.
- 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. All dwelling receptacles of CSA configuration 5-15R and 5-20R shall be tamper resistant receptacles and shall be so marked; receptacles dedicated for microwaves, refrigerators, freezers or those receptacles located in an attic or crawl space shall not be required to be tamper-resistant.
- 2.2.8. All dwelling receptacles rated 125 V, 20 A or less shall be provided with arc-fault protection, except for the following:
- .1 Bathroom and washroom basin receptacles.
 - .2 Kitchen counter receptacles
 - .3 Refrigerator receptacles
- 2.2.9. Arc-fault protection for dwelling unit receptacles shall be provided by:
- .1 A combination-type arc-fault circuit interrupter
 - .2 An outlet branch-circuit interrupter installed at the first outlet on the branch circuit, where the wiring method for the portion of branch circuit between the branch circuit overcurrent device and the first outlet consists of metal raceway, armoured cable, or non-metallic conduit or tubing.
- 2.2.10. 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 600 W, 1500 W, 2000 W.

- .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 600 W of Electronic Low Voltage load.
- .3 Reset-able overload protection when capacity is exceeded.

2.4.3. LED dimmers.

- .1 Slide to Off only. Must match driver and LED requirements.

2.4.4. 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.

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 21.00 Moulded Case and Insulated 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.

1.3.3. 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, submit at a minimum a preliminary short circuit study for review.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

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.

2.1.5. Where a circuit breaker shown on the Drawings is rated 1200 A or higher, provide the following:

.1 Energy reducing maintenance switching (ERMS) system that provides a means to reduce arcing fault clearing time, with the following features:

.1 Positive feedback status indication LED light to indicate the status of the system, built into the equipment housing the breaker.

- .2 A selector switch to turn the system on and off, built into the equipment housing the breaker.
- .3 A selector switch to be located remote from the equipment and a 24 V DC circuit, to turn the system on and off.
- .4 Ability for circuit breaker trip unit to have two trip curves – the first for normal operation and the second for when a qualified person is working within the arc flash boundary (maintenance mode).
- .5 Ability for second trip curve to be set so that the breaker operates faster and more sensitively.
- .6 Pickup settings as low as 2.5 times breaker rating plug.
- .7 Provide system with documentation and equipment lamacoids that explain how the system works.

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. Circuit breaker to operate by means of an adjustable solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition.
- 2.5.2. Electronic trip with true RMS sensing.
- 2.5.3. Use current transformers to ensure accurate measurement from low current up to high currents.
- 2.5.4. Electronic trip with thermal memory/imaging.
- 2.5.5. Adjustable solid state trip unit complete with:
 - .1 Adjustable long time pick-up
 - .2 Adjustable long time delay
 - .3 Adjustable short time pick-up (where S indicated on Drawings)
 - .4 Adjustable short time delay (where S indicated on Drawings)
 - .5 Adjustable instantaneous pick-up (where I indicated on Drawings)
 - .6 Adjustable ground fault pick-up (where G indicated on Drawings)
 - .7 Adjustable ground fault delay (where G indicated on Drawings)

- .8 Long time, short time, instantaneous tripping for phase and ground fault short circuit protection as noted above.
- 2.5.6. Trip unit consisting of adjustable protection settings set by rotating switch or digital keypad, and rating plug.
- 2.5.7. Provide features listed below:
 - .1 For breakers rated less than 1200 A:
 - .1 Comply with the requirements for breakers rated 1200 A and above in the "Breakers General" section above.
 - .2 Provide trip unit with local trip indication and ability to locally and remotely indicate reason for trip (e.g. overload, short circuit, or ground fault).
- 2.6. INSULATED CASE CIRCUIT BREAKERS GENERAL
- 2.6.1. Use insulated case circuit breakers where shown on the Drawings.
- 2.6.2. Provide draw out type electrically operated circuit breaker with remote open/close key switch.
- 2.6.3. Provide circuit breaker operating mechanisms that are two-step, fully-stored energy devices for quick-make, quick-break operation with a maximum of a five-cycle closing time. Open-close-open (O-C-O) cycle possible without recharging. Provide motor operator that automatically charges when circuit breaker is closed. Charge the closing springs (step one) upon actuation of the operating handle or an operation cycle of the circuit breaker motor and close the circuit breaker contact (step two) upon operation of a local "close" button. Automatically charge the opening springs when closing the circuit breaker contacts.
- 2.6.4. Provide breaker that is 100 % continuous current rated in its enclosure.
- 2.6.5. Provide kirk keys where indicated on the Drawings.
- 2.6.6. Completely isolate current-carrying components from the accessory mounting area and double insulate current-carrying components from the operator with accessory cover in place.
- 2.6.7. Provide padlocking provisions furnished to receive up to three padlocks when circuit breaker is in the open position, positively preventing unauthorized closing of the circuit breaker contacts.
- 2.6.8. Provide provisions for up to two key locks allowing locking in the disconnected position. Provide provisions for locking in the connected, test and disconnected positions by padlock or key lock.
- 2.6.9. Provide buttons, with lockable clear cover, located on the face of the circuit breaker, to open and close the circuit breaker and indicators to show the position of the circuit breaker contacts, status of the closing springs, and circuit breaker position in the cell. Provide an indicator that shows "charged-not OK to close" if closing springs are charged but circuit breaker is not ready to close. Provide circuit breaker racking system that has positive stops at the connected, test, disconnected and withdrawn positions.
- 2.6.10. Equip circuit breaker with an interlock to discharge the stored energy spring before the circuit breaker can be withdrawn from its cell. Provide circuit breaker that provides a positive ground contact check between the circuit breaker and cell when the accessory cover is removed while the circuit breaker is in the connected, test or disconnected positions.
- 2.6.11. Provide interlocks to prevent circuit breaker draw out when in closed position and to prevent closing unless fully engaged or in test position. Provide breaker that is trip free during racking operation.
- 2.6.12. Provide as an option, primary connectors that can be rotated to provide flexible vertical or horizontal connections. Ensure front connections are available as an option for shallow depth equipment designs.

- 2.6.13. Provide ready-to-close contact that indicates remotely that the circuit breaker is "ready to close." The circuit breaker is ready to close when it is open, spring mechanism is charged, a maintained closing order is not present, a maintained opening order is not present, and the circuit breaker is in an operational position.
- 2.6.14. Provide secondary control wiring that is front accessible and available in cage clamp or ring terminal connections. Provide secondary wiring that is inaccessible when switchboard door is closed.
- 2.6.15. Provide long service life circuit breaker. Provide circuit breakers certified to perform a minimum of 10,000 operations without maintenance where circuit breaker frames are 3000 A and below.
- 2.6.16. Equip circuit breaker with a visual contact wear indicator.
- 2.6.17. Provide circuit breaker arc chutes that don't contain asbestos.
- 2.6.18. Trip Unit
 - .1 Comply with the requirements noted above in the Solid State Trip Breakers section.
 - .2 Provide trip units that are removable to allow for field upgrades.
 - .3 Provide trip units that are capable of the following types of ground-fault protection: residual, zero sequence, source ground return, and modified differential. Ground-fault sensing systems may be changed in the field.
 - .4 Ensure neutral current transformers are available for four-wire systems.
 - .5 Provide trip units that have real time metering and metering functions that include current, voltage, power and frequency. Provide metering accuracy of 1.5 % current, 0.5 % voltage, and 2 % power. Accuracies listed are total system including CT and meter and are of reading, not full scale, in a range of 5 – 500 %.
 - .6 Provide trip unit with provisions for communications on a network.
- 2.7. ACCESSORIES
 - 2.7.1. 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.
- 2.8. MANUFACTURERS
 - 2.8.1. The following are acceptable manufacturers:
 - .1 Schneider Electric
 - .2 Eaton Cutler-Hammer
 - .3 Siemens
 - .4 ABB

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.

1.3.2. 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, submit at a minimum a preliminary short circuit study for review.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. DISCONNECT SWITCHES

2.1.1. Fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, size as indicated.

2.1.2. Non-fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, with minimum 10 kA Short Circuit Current Rating (SCCR), with manufacturer listed series rating with upstream breaker / fuse where available fault current exceeds 10 kA and with UL series rating label on disconnect switch, size as indicated.

2.1.3. Provision for padlocking in on-off switch position by three locks.

2.1.4. Mechanically interlocked door to prevent opening when handle in ON position.

2.1.5. Fuses: size as indicated, class J, current limiting, in accordance with Section 26 28 14.00 – FUSES LOW VOLTAGE.

2.1.6. Fuse-holders: suitable without adaptors, for type and size of fuse indicated.

2.1.7. Quick-make, quick-break action.

2.1.8. 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.
 - .4 ABB.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install disconnect switches complete with fuses if applicable.

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 UNDER 2000 V.
- 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.
- 1.2.7. CSA C22.2 No. 141 – Emergency Lighting Equipment, 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 in accordance with the requirements of the Luminaire Schedule. If alternates or substitutions are entertained, then it is the responsibility of the Contractor/Supplier to provide: a comparison table showing the specified and the proposed luminaire performance information, IES files for the proposed luminaires, the 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. An extra review fee, per luminaire submitted, will be charged to the Contractor (with no additional costs to the Project Owner). Reviewed alternates may be rejected, regardless of the payment fee received, when alternates do not meet the project requirements. Invoices must be paid prior to Consultant's review starting or changes in the design documents to incorporate the proposed alternates after their review. 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, and voltage.
- 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. FIXED PER UNIT COST LUMINAIRES
- 1.6.1. Listed in the luminaire schedule are a fixed per unit cost for certain luminaire types. Electrical Contractor is responsible for completing a take-off of the drawings to determine quantity of each luminaire type and use the listed fixed unit price to calculate the total cost per luminaire type. The total cost for all luminaires shall be carried in the bid for the electrical contract. Provide a breakdown of the total cost, per luminaire type, that is carried under the electrical contract. All luminaires are to be included in the electrical contract including all luminaires identified with fixed unit costs. The Electrical Contractor is to include fixed per unit cost luminaires in Light Fixtures – Materials in the standard progress draw breakdown defined in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.6.2. The fixed per unit cost excludes applicable taxes and includes lamps and distributor markups. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all fixed per unit cost luminaires. Show the applicable taxes as a separate line item.

1.7. CASH ALLOWANCE LUMINAIRES

- 1.7.1. Listed in the luminaire schedule are 'cash allowance' fixtures for certain luminaire types. A complete take-off of the drawings has been done to determine the quantity of each 'cash allowance' luminaire type and the total cost has been carried in the Div-0/1 cash allowance value. The total cost for all 'cash allowance' luminaires are NOT to be carried in the bid for the electrical contract.
- 1.7.2. After tender award to the successful Electrical Contractor, the Consultant shall provide the Electrical Contractor the exact manufacturer/model number(s) of all 'cash allowance' luminaires and the Electrical Contractor shall be responsible for purchasing the fixtures through the monies from the cash allowance.
- 1.7.3. Provide a breakdown of the total cost, per luminaire type, that is carried under the base electrical contract. All luminaires are to be included in the base electrical contract excluding all luminaires identified as 'cash allowance' luminaires. However the Electrical Contractor is to include 'cash allowance' luminaires in Light Fixtures – Materials in the standard progress draw breakdown defined in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS once the Consultant provides the Electrical Contractor with the exact manufacturer/model number(s).
- 1.7.4. The cash allowance value carried excludes applicable taxes and includes lamps and distributor markups. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all 'cash allowance' luminaires. Show the applicable taxes as a separate line item.

1.8. WARRANTY

- 1.8.1. The manufacturer shall provide a warranty against defects in material and workmanship, starting at Substantial Performance of the Work. Parts warranty shall be 5 years and labour warranty shall be 1 year.
- 1.8.2. LED's, Drivers, Lamps and ballasts showing signs of premature failure shall be replaced at no cost to the owner.
- 1.8.3. LED Drivers must have a 5 year warranty.

2. Product

2.1. GENERAL

- 2.1.1. Only utilize Products that are certified for use in Canada in accordance with the requirements of Section 2 of the Electrical Code and that have been tested by a Certification Body accredited by the Standards Council of Canada and acceptable to the Electrical Authority Having Jurisdiction for the approval of electrical equipment. Furthermore, ensure that Products utilized have been approved to a recognized Canadian Standard.

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. Lamps are to be in accordance with the lamp specifications detailed in the Luminaire Schedule and as noted below. Luminaire schedule shall take precedence where differences occur.

- 2.2.4. 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.
- 2.2.5. 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 Cree, Osram, Nichia, Toshiba, Lumileds, Bridgelux, or Samsung. 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 3 V through 55 V.

- .2 Adjustment of LED current from 200 mA to 1.05 A at the 100 percent control input point in increments of 1 mA.
- .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 120 V through 277 VAC at 60 Hz.
- 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 0.5 V and 0.65 V 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 10 V Analog Control Protocol, Class 2, capable of sinking 0.6 mA per driver at a low end of 0.3 V. Limit the number of drivers on each 0-10 V control output based on voltage drop and control capacity.
- 2.3.16. Must meet ESTA E1.3 for RGBW LED drivers
- 2.3.17. Provide drivers manufactured by Cree, Osram, Nichia, Toshiba, Lumileds, Bridgelux, Samsung, or Edoleds.

2.4. BALLASTS

- 2.4.1. All Ballasts shall comply with CSA C22.2 No. 74 and are to meet or exceed the standards of the Certified Ballast Manufacturers Association (CBM).
- 2.4.2. All ballasts shall be tested and comply with maximum in-rush current limits as stated in NEMA 410.
- 2.4.3. Not all ballasts could be used, refer to luminaire schedule for project specific details.
- 2.4.4. All ballasts shall be manufactured by Osram/Sylvania, Philips, Advance, GE, Lutron or Magnetek unless indicated otherwise. Ballasts shall operate at voltage and control lamps as noted in the Luminaire Schedule.
- 2.4.5. Ballasts shall contain no PCB's and audible rating will be class A or better.
- 2.4.6. Racks are to be provided for remote ballasts.
- 2.4.7. Ballasts with unacceptable noise levels are to be replaced at no cost to the owner.

2.5. LUMINAIRES

- 2.5.1. 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.
- 2.5.2. Luminaires shall be suitable for the environment where installed, include seals and gaskets, and corrosion resistant baked-on finish as required and as specified.
- 2.5.3. Louvers, lenses and diffusers must be of suitable thickness to prevent sagging.
- 2.5.4. Where drawings show luminaires mounted end-to-end, luminaires shall be suitable for continuous, seamless and tandem mounting.
- 2.5.5. All poles are to come complete with internal vibration dampeners to accommodate wind conditions to avoid damage due to wind-induced vibrations.
- 2.5.6. 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.
- 2.5.7. 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.
- 2.5.8. The supply and installation of fixed per unit cost and 'cash allowance' luminaires shall comply with all standards set forth in Electrical Specifications. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all fixed per unit cost and 'cash allowance' luminaires.
- 2.5.9. Provide exit signs that comply with building code requirements, including CSA C22.2 No. 141.
- 2.5.10. 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 900 mm above grade in parking lots and a minimum 150 mm 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 Performance of the Work unless permission is received from the owner, architect or Engineer's Representative.
- 3.1.21. Lamps are to be installed after luminaire is cleaned.
- 3.1.22. Clean all luminaires, inside and out at time of Substantial Performance of the Work. Replace all scratched or damaged luminaires, lenses, louvers and diffusers at no cost to the owner.
- 3.1.23. 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 01.01 Emergency Lighting - Inverter

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 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.

1.2. REFERENCES

- 1.2.1. CSA C22.2 No.141 – Emergency lighting equipment, latest edition.
- 1.2.2. CSA or cUL listed for Canadian application, UL and ETL listed to UL924 – AC inverter system for emergency power supply, latest edition.
- 1.2.3. CSA or cUL listed to CSA C22.2 No.107.1 – Power Conversion Equipment, latest edition; ANSI C62.41; ANSI C62.45 (Cat. A&B), latest edition.
- 1.2.4. FCC Rules and Regulations 47 Part 15, Subpart J, Class A - Certified Compliance, latest edition.
- 1.2.5. Systems comply with Electrical Code and Building Code, latest edition.
- 1.2.6. UL 1778 – Standard for Uninterruptable Power Supply Equipment, latest edition.
- 1.2.7. ANSI C62.41 – Recommended Practice on Surge Voltages in Low Voltage Power Circuits, latest edition.
- 1.2.8. NEMA PE1 – Uninterruptible power supply, latest edition.
- 1.2.9. NFPA 111 – National Fire Protection Agency, 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. QUALITY ASSURANCE

- 1.4.1. The Emergency Lighting Inverter (ELI) module shall be “burned-in” without failure for a minimum of 24 hours.
- 1.4.2. A final test procedure for the product shall include a check of performance specifications before and after the twenty-four hour “burn-in.”
- 1.4.3. An on-site test procedure shall include a check of controls, functions and indicators after installation of the equipment.

1.5. FIELD QUALITY CONTROL

- 1.5.1. Factory-trained field service personnel shall perform the following inspections and test procedures during the ELI start-up.
- 1.5.2. Visual inspection
- 1.5.3. Mechanical inspection
- 1.5.4. Electrical inspection
- 1.5.5. Functional inspection
- 1.5.6. After installation of equipment, a signed commissioning report describing on-site testing and functionality shall be sent to the factory to validate warranty.

1.6. WARRANTY

- 1.6.1. The warranty of the equipment shall be twelve (12) months from Substantial Performance of the Work.
- 1.6.2. For batteries, the warranty period shall be extended to 120 months from Substantial Performance of the Work., with a no-charge replacement during the first 5 years and a pro-rated charge on the second 5 years.

2. Products

2.1. SYSTEM DESCRIPTION

- 2.1.1. Provide a complete Emergency Lighting Inverter (ELI) as specified herein to provide continuous, regulated ac power to various emergency lighting fixtures under normal and abnormal conditions, as well as loss of the utility ac power. This system shall incorporate conditioning and power filters on both the input and output sides of the ELI.
- 2.1.2. ELI Module Components: The ELI module consists of the following major components:
 - .1 Input ac filter
 - .2 Output ac filter
 - .3 Full galvanic output isolation transformers
 - .4 Inverter
 - .5 Rectifier/Charger
 - .6 Power factor correction (PFC) circuit
 - .7 Dc to dc converter
 - .8 Emergency power off (EPO) interface
 - .9 Input, rectifier, and reserve circuit breakers
 - .10 Internal Maintenance bypass
 - .11 Static bypass switch
 - .12 Microprocessor controlled logic and control panel with alarm indicators and digital metering display
 - .13 Communications interface:
 - .1 RS-232
 - .2 RS-485
 - .3 Ethernet

- .4 8 port relay
- .14 Input power walk-in
- .15 Front cable entry
- .16 External battery connection
- .17 Battery Cabinet Component
 - .1 Sealed, maintenance free batteries
 - .2 Battery circuit breaker
- .18 Optional features:
 - .1 Remote terminal strip
- .19 All lugs and terminals to be dual rated for Copper/Aluminum (Cu/Al).

2.1.3. Definitions

- .1 ELI Module: The portion of the ELI system that contains the rectifier/charger, inverter, static bypass switch, manual bypass switch, controls, monitoring, isolation transformer and indicators.
- .2 Rectifier/Charger: The portion of the ELI module, which converts the normal source AC input power to DC power for the inverter input and for charging the battery.
- .3 Inverter: The portion of the ELI module that converts DC power from either the rectifier/charger or the battery, to regulated and filtered AC power, which is supplied to the critical load.
- .4 Static Bypass Switch: The portion of the ELI module which automatically transfers the critical loads, without interruption, from the inverter output to the bypass AC power source in the event of an overload or degradation of the inverter's performance.
- .5 Manual Bypass Switch: The portion of the ELI module, which is used to connect the utility AC power source to the critical loads while maintaining galvanic isolation.
- .6 Battery: The battery system that provides DC power to the inverter input when the normal AC input power to the ELI module fails or in the event that the rectifier/charger should fail.
- .7 Critical Loads: Those loads that require regulated continuous AC power and which are connected to the output of the ELI module.

2.2. SYSTEM OPERATION

- 2.2.1. Normal: the inverter shall supply ac power continuously to the critical loads. The inverter output shall be synchronized with the bypass ac power source provided that the bypass ac power source is within the specified frequency range. The PFC circuit shall convert the normal ac input power to dc power for the inverter in conjunction with the charger to maintain the battery charge.
- 2.2.2. Loss of normal ac input power: the battery shall supply dc power, via the dc to dc converter, to the inverter so that there is no interruption of ac power to the critical loads whenever the normal ac input power source of the ELI module deviates from the specified tolerances or fails completely. The battery shall continue to supply power to the inverter for the specified protection time.
- 2.2.3. Return of normal ac input power source: the PFC circuit shall perform a walk-in start and assume the dc load from the battery when the normal ac input power source returns. The charger shall then simultaneously supply the inverter with dc power and recharge the battery. This shall be an automatic function and shall cause no disturbance to the critical load.

- 2.2.4. Transfer to bypass ac power source: if the control circuitry senses an overload, an inverter shutdown signal, a dc bus fault or degradation of the inverter output, then it shall automatically transfer the critical loads from the inverter output to the bypass ac power source without an interruption of power. If the bypass ac power source is above or below normal voltage limits, then the transfer shall be inhibited.
- 2.2.5. Transfer back to inverter: the static bypass switch shall be capable of automatically transferring the load back to the inverter after the inverter has returned to normal conditions. Retransfer shall not occur if the two sources are not synchronized. The static bypass control circuit shall have the ability to lock the critical load to either the inverter output or the bypass source (selectable). This lockout condition shall be reset under manual command.
- 2.2.6. ELI without battery: if the battery is taken out of service for maintenance, it shall be disconnected from the rectifier/charger and inverter. The ELI shall continue to function and meet the performance criteria specified herein except for the battery reserve time and step load performance.

2.3. ELECTRICAL CHARACTERISTICS

2.3.1. ELI Module Input

- .1 Voltage and number of input wires: as shown on electrical single line diagram
- .2 Voltage range: -20 % to +15 % without discharging the battery
- .3 Input frequency: 45 to 65 Hz continuous
- .4 Reserve frequency: 60 Hz $\pm$ 7% continuous
- .5 Current walk-in: 20 seconds to full load rating
- .6 Maximum input current: 150 % of nominal full load current
- .7 Power factor: 0.60 lagging at nominal input voltage, 30 % THD at nominal conditions and at full ELI load.
- .8 Current harmonics: <9 % THD, with 12 pulse rectifier and input factor
- .9 Input transient protection: ANSI C62.41.

2.3.2. ELI Module Output

- .1 Voltage and number of output wires: as shown on electrical single line diagram
- .2 Frequency: 60 Hz
- .3 Power rating: as shown on electrical single line diagram
- .4 Battery back-up time: 90 minutes unless otherwise noted
- .5 Voltage regulation: $\pm$ 2 % of nominal for any of the combined effects
 - .1 No load to full load
 - .2 Minimum to maximum output power factor
 - .3 Minimum to maximum ac input voltage
 - .4 Minimum to maximum dc input voltage
 - .5 0 to 40 °C ambient temperature
- .6 Dynamic regulation:
 - .1 $\pm$ 3 % from nominal for 100 % step load
 - .2 $\pm$ 2 % from nominal for 50 % step load
 - .3 Recovering to within 1 % in less than one cycle
- .7 Voltage unbalance: $\pm$ 3 % of nominal for 100 % unbalanced loads
- .8 Phase separation:

- .1 $120^{\circ} \pm 1\%$ of nominal for 100 % balanced loads
- .2 $120^{\circ} \pm 2\%$ of nominal for 100 % unbalanced loads
- .9 Voltage distortion
 - .1 $< 2\%$ THD at 100 % loads (linear load)
 - .2 $< 3\%$ THD at 100 % load (non-linear load)
- .10 Frequency stability: 60 Hz $\pm 0.01\%$ free running
- .11 Phase-lock window: 60 Hz, $\pm 4\%$
- .12 Overload capability:
 - .1 Inverter:
 - .1 $< 110\%$ continuous
 - .2 125 % for 15 minutes
 - .3 150 % for 10 seconds
 - .2 Static bypass:
 - .1 200 % for 30 seconds
 - .2 400 % for 1 second
- .13 Fault clearing capability:
 - .1 Static bypass: 1000 % for $\frac{1}{2}$ cycle (non-repetitive)
- .14 Crest factor: 3:1 maximum

2.3.3. Battery

- .1 Type: Sealed lead-acid (maintenance-free AGM)
- .2 Number of Cells: 174 Cells
- .3 Voltage range: 295 – 410 VDC
- .4 Float voltage: 396 VDC
- .5 Min. discharge voltage: 295 VDC
- .6 20 year life type battery

2.3.4. Power Factor Correction Circuit

- .1 The PFC circuit shall consist of an input breaker, an input EMI/transient suppressor network, output filter power factor correction circuit and a solid-state rectifier with control circuitry to provide constant voltage/constant current regulation and a current walk-in on start-up. The PFC circuit shall be a full wave high frequency controlled type using SCRs in both the positive and negative legs.
- .2 Over-current/Transient protection: The input of the PFC circuit shall be protected from noise and transients by an input EMI/transient suppressor network. The PFC circuit shall be electronically regulated and current limited to protect the connections to the inverter input and to prevent damage to the charger.
- .3 Control circuitry: The PFC circuit shall be equipped with Digital Signal Processor (DSP) control circuitry to provide constant DC voltage regulation of $\pm 1\%$ for $+15\%$ to -20% ac input voltage change, for 45 to 65 Hz input frequency change, or for 0 % to 100 % load variations.
The control circuitry shall enable continuous PFC circuit operation from an engine generator with output frequency transients of up to 5 Hz.
- .4 Whenever ac power is applied to the PFC circuit, the current limiting control circuitry shall walk-in over a period of at least 20 seconds to allow gradual loading of the normal input ac power source.

- .5 The control circuitry shall automatically turn off the PFC circuit without opening circuit breakers if any of the following conditions occur:
 - .1 High dc voltage
 - .2 Ac over-voltage of 120 % of normal ac input
 - .3 Loss of normal ac input
 - .4 Loss of a phase on normal circuit
 - .5 The control circuitry shall be capable of additional PFC circuit features with future DSP control software releases.
- .6 Output filter: The PFC circuit shall be furnished with output filtering to limit output ripple voltage to 0.5 % for 0 to 100 % load.
- .7 Capacity: The PFC circuit shall have sufficient capacity to supply the inverter at 100 %, 0.8 PF load plus recharge the battery bank to 90 % of full capacity within 24 hours.

2.3.5. Inverter

- .1 The inverter shall utilize fast-switching IGBT transistors, pulse width modulation (PWM) and phase vector synchronization (PVS). It shall consist of a switching bridge, dc input, output filter and control circuitry to provide precise ac voltage regulation, harmonic cancellation//conditioning and superior transient response.
- .2 Control circuitry:
 - .1 The inverter shall be provided with a digital signal processor (DSP) control circuitry to provide constant ac voltage regulation and transient response as specified. The high-speed DSP controls shall sample the output continuously to provide precise voltage control.
 - .2 The high speed DSP control shall sample the inverter output and the ELI module output to determine the phase and amplitude of the output voltage. The results shall be used by the DSP to control the inverter output to ensure a clean output ac voltage sine wave when driving non-linear loads.
 - .3 The circuitry shall provide low voltage initial start-up of the inverter and ramp-up to full voltage.
 - .4 The control circuitry shall automatically synchronize and phase lock the inverter output to the bypass ac power source as long as the bypass source is within the synchronization range. If the bypass ac power source is not within these pre-set limits, then the control circuitry shall break synchronization and lock to an internal crystal oscillator.
 - .5 The control circuitry shall automatically send a signal to the static bypass switch to transfer to the bypass ac source and then turn off the inverter for any of the following conditions:
 - .1 Blown inverter fuse
 - .2 Over-temperature
 - .3 Overloads per specified limits
 - .4 High/low dc voltage
 - .5 Inverter over-voltage or under-voltage condition
 - .6 The control circuitry shall automatically turn off the inverter when the battery reaches the end of discharge. The ELI shall automatically restart and return to normal when input ac power returns.
 - .7 The control circuitry shall be capable of additional inverter features with future DSP control software releases.

2.3.6. Static Bypass Switch

- .1 The static bypass shall consist of two pairs of Silicon Controlled Rectifiers (SCR's) per phase with each pair connected in inverse parallel. The static bypass shall be connected between the bypass (input) AC power source and the output transformer. Static bypass and inverter shall be isolated from one another.
- .2 Inverter Failure: If the inverter is out of normal limits due to under voltage or over voltage, or is shut down for any reason, the static bypass switch shall turn on to provide power to the load from the bypass AC power source without interruption.
- .3 Retransfer to Inverter: The static bypass switch shall be capable of automatically retransferring the load back to the inverter after the inverter has returned to normal conditions and stabilized for a pre-set period of time.
- .4 Overload: If an inverter overload is detected, the static bypass switch shall operate as described in 2.5.1 and .2 above. A transfer shall not occur unless the inverter overload ratings and time duration described in paragraph 2.1.2.m) are exceeded.
- .5 Over-current Protection
 - .1 Input over current protection shall be provided internal to the ELI rated at no less than 125 % of ELI rating.
 - .2 The static bypass switch shall be rated to carry 200 % of the ELI's rated output current for thirty seconds and 1000 % of the ELI's rated output current for one half cycle.
- .6 Transfer Conditions
 - .1 The static bypass switch shall transfer the critical load from the output of the inverter to the bypass AC power source for the following conditions:
 - .1 Inverter voltage less than 95 % of nominal.
 - .2 Inverter voltage greater than 105 % of nominal.
 - .3 Inverter overload period expired.
 - .4 Inverter shutdown for any reason.
 - .2 The static bypass switch shall inhibit transfer to the bypass AC power source for the following conditions:
 - .1 Bypass AC power source voltage less than 80 % of nominal line to neutral.
 - .2 Bypass AC power source voltage greater than 120 % of nominal line to neutral.
 - .3 Inverter not phase-locked to the bypass AC source.
 - .4 Bypass AC power source frequency deviation greater than 7 % of nominal.
- .7 Automatic Retransfer Conditions: The system shall automatically retransfer the load to the inverter provided all of the following conditions are met:
 - .1 The inverter logic and the bypass AC power source are synchronized and in phase.
 - .2 Inverter conditions are normal.
 - .3 The ELI output is not overloaded.
- .8 Transfer Time: Maximum transfer time to switch from inverter to bypass AC power source shall be 100 microseconds.
- .9 Single Input Configuration: The rectifier and internal bypass systems (static bypass and manual bypass switch) shall be connected to the AC power source through a common set of terminals at the ELI input. This single input configuration shall enable the ELI

primary and bypass AC power sources to be provided from a single input feeder. This will simplify installation complexity and reduce installation costs.

2.3.7. Internal Manual Bypass Switch

- .1 The ELI shall incorporate an internal manual bypass switch. This switch shall provide provisions to allow the input ac power to bypass the electronics and supply the load without interruption of power to the loads. This switch shall not bypass the output isolation transformer or power filters to ensure minimal power problems on manual bypass mode.
- .2 The main CPU shall monitor the manual bypass breaker position. In the event of accidental operation of the breaker without the inverter being shutdown, the CPU will automatically shut down the inverter and trigger an alarm notification. As long as the manual bypass breaker remains in the "on" position inverter operation shall remain inhibited.

2.3.8. Front Panel and User Interface

- .1 The ELI front panel shall include the following LED's and an active mimic diagram of the ELI operation:
 - .1 Eight warning LED's
 - .1 Rect. AC Fail
 - .2 Res AC Fail
 - .3 Fuse/Temp
 - .4 Overload
 - .5 High DC
 - .6 Bat Low
 - .7 Bat Low Shutdown
 - .8 Fault
 - .2 Twenty-four operation LED's
 - .1 Inv On
 - .2 Inv Static Switch
 - .3 Short Circuit
 - .4 Fuse/Temp Shutdown
 - .5 Inv Fail Inverter Shutdown
 - .6 Bypass On Inverter Shutdown
 - .7 High DC Inverter Shutdown
 - .8 Overload Inverter Shutdown
 - .9 70 % Load
 - .10 110 % Load
 - .11 125 % Load
 - .12 150 % Load
 - .13 Res AC Fail
 - .14 Res AC Freq. Fail
 - .15 Bat Low
 - .16 Bat Low Shutdown
 - .17 Rect. AC Fail

- .18 Rotation Error
- .19 Rect. Shutdown
- .20 Rect. High DC
- .21 Boost Charge
- .22 Battery Test
- .23 Emergency Stop
- .24 Data Line
- .3 The front panel shall include the following buttons for system operation and control of the LCD display:
 - .1 System operation buttons:
 - .1 Inverter On
 - .2 Inverter Off
 - .3 Inverter Control
 - .2 LCD display control buttons:
 - .1 Up
 - .2 Down
 - .3 Enter
- .2 The ELI shall include an audible alarm-warning device. This alarm shall sound whenever any abnormal condition occurs. Any subsequent alarm shall cause reactivation of the status indicator and audible alarm.
- .3 The following parameters shall be measured and displayed by an alphanumeric LCD display on the Front Panel. Each display shall have the nomenclature of the parameter indicated with the associated value. AC voltage and current values shall be measured in true RMS units.
 - .1 Main Menu Display
 - .1 ELI identification
 - .2 Serial number
 - .3 Maximum output rating
 - .4 Input and output voltage configuration
 - .5 Current date and time
 - .2 Select Menu Display
 - .1 Access to further menus
 - .3 Status Warning Menu Display
 - .1 Current status of ELI operation
 - .2 Warning codes
 - .3 Fault codes
 - .4 Real Time Data Menu Display
 - .1 Allow access to further menu options
 - .5 Historical Event Menu Display
 - .1 Recorded events, warnings or faults
 - .6 Parameter Setting Menu Display
 - .1 Allows control of basic features

- .7 Rectifier Data Display:
 - .1 Input frequency.
 - .2 Rectifier AC voltage - phase to neutral.
- .8 Reserve Data Display
 - .1 Reserve frequency.
 - .2 Reserve AC voltage - phase to neutral.
- .9 Output Data Display
 - .1 Output frequency.
 - .2 Percent load per phase.
 - .3 Output voltage - phase to neutral.
- .10 Other Data Display
 - .1 Internal temperature.
 - .2 Battery voltage.
 - .3 Battery current with flow direction.
- .4 ELI event history shall be available through the alphanumeric display. The event history shall store a minimum of 77 previous status and alarm events with the date and time of each occurrence on an EEPROM. Allowances for a second EEPROM shall be made to allow for the stored recorded events to be increased to 154.

2.3.9. Communication Interface

- .1 The ELI shall be equipped with eight (8) Form A (Normally Open) relay alarm contacts for remote signalling:
 - .1 Common (programmable OR gate for any combination of contacts)
 - .2 Battery Low
 - .3 Back-up Mode
 - .4 Manual Bypass Mode
 - .5 Static Bypass Mode
 - .6 Fault Condition
 - .7 Overload Condition
 - .8 Inverter On
- .2 The ELI shall be equipped with one Form A (Normally Open) summary alarm contact for remote fire alarm panel connection.
- .3 An input opto-coupled contact shall be included for remote shutdown of the ELI.
- .4 Remote alarm panel interface. Summary includes:
 - .1 Safety shutdown
 - .2 Low battery
 - .3 Bypass activated
 - .4 Output voltage not present
 - .5 Inverter stop activation

2.3.10. Communication Ports

- .1 The ELI shall be equipped with:
 - .1 RS-232 port for SNMP (Ethernet Adapter)
 - .2 RS-485 port for computer communications

- .3 RS-485 port for remote display panel
- .2 SNMP (Simple Network Management Protocol) Ethernet Adapter shall be included as a standard feature. This adapter will allow for intranet and/or internet communication and monitoring of the ELI system. This adapter shall be password protected and accessible to authorized personnel only.
 - .1 The adapter shall allow the user to monitor the status of the ELI through a web page stored on the adapter from a remote station located on, or have access to the network the adapter is connected.
 - .2 The adapter shall be able to email, page or phone a user programmed number in the event of an emergency.
- 2.3.11. Construction
 - .1 Enclosure: The ELI electronics shall be housed in a CSA Type 1 with drip hood, sprinkler proof enclosure. The enclosure shall be primed and painted inside and outside with manufacturer's standard paint. The enclosure shall be a freestanding floor mount design. Enclosure shall incorporate integrated drip shield.
 - .2 Material and workmanship:
 - .1 Workmanship shall be first class in every respect.
 - .2 All material shall be new and of best industrial grade.
 - .3 Internal wiring conductors shall be combined into cables or bundles, and shall be tied securely together.
 - .4 All bundled wiring shall be identified by color codes or by wire numbers. Power cables shall be identified at each end.
- 2.3.12. Cooling
 - .1 The ELI shall be forced air-cooled. Ventilation shall be from the bottom to the top. The cooling shall be adequate for operation at altitudes up to 2,500 meters.
- 2.3.13. Audible Noise Reduction
 - .1 The ELI shall be designed and constructed such that the audible noise is reduced to a typical 38 to 40 decibels, measured on the A scale at 1 meter from the front of the cabinet.
- 2.3.14. Battery Cabinet
 - .1 The ELI shall be designed to operate with any common lead-acid or nickel-cadmium battery type. The installed battery type and rating shall be programmed into the ELI at the factory, and the ELI charger shall select the proper charging regimen based on the actual installed battery type. This will maximize the life of the battery. The ELI shall include a circuit breaker and battery test feature that will automatically test the battery every thirty (30) days. The user shall have the ability to manual test the battery as well.
- 2.3.15. Output Isolation Transformer
 - .1 The output shall be completely isolated from the input on all wires.
 - .2 The output neutral and ground wires shall be bonded on the output terminal strip.
 - .3 The transformer windings shall be vacuum impregnated to reduce audible noise and increase heat dissipation.
 - .4 The transformer shall have a cUL/UL recognized insulation system and shall be so located within the equipment to ensure that the hottest spot shall not exceed the rated insulation temperature and to ensure a low center of gravity.
- 2.3.16. Optional External Maintenance Bypass Cabinet

- .1 An external maintenance bypass cabinet shall be provided to allow the ELI system to be completely isolated and removed from the electrical system while the load is maintained through the external maintenance bypass. This optional cabinet shall provide make-before-break operation for transfers to and from the external maintenance bypass output. The following components shall be standard: input, ELI and bypass breakers, inter-cabinet wiring and mounting feet. Optional voltage matching transformers, isolation transformers and Kirk-Key interlock are to be offered.
- .2 Output Breakers
 - .1 Allows for loads to be disconnected for load maintenance, without UPS shutdown.

2.4. ACCEPTABLE MANUFACTURERS

- 2.4.1. BeLuce – Borealis or approved equal.

3. Execution

3.1. INSTALLATION

- 3.1.1. The equipment shall be installed in accordance with the manufacturer's recommendations as well as electrical code.
- 3.1.2. Install on flat floor only.
- 3.1.3. Tie-in general trouble and running alarms into fire alarm panel.
- 3.1.4. The inverter to be tested on site as defined in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE and herein. Contractor to oversee all testing and correct any deficiencies noted.

3.2. TEST REPORTS

- 3.2.1. Submit all test reports as part of the O&M manuals.

3.3. MANUFACTURER'S FIELD SERVICE

3.3.1. Service personnel

- .1 The ELI manufacturer shall employ a nationwide service organization, consisting of factory trained field service personnel dedicated to the start-up, maintenance, and repair of ELI and power equipment.

3.3.2. Maintenance contracts

- .1 A full service maintenance contract for both the ELI system and battery system shall be available to the end user. Factory-trained service personnel shall perform all warranty and maintenance.

END OF SECTION

26 52 01.02 Single Phase Inverters 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.

1.2. 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.

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

1.3.4. Ensure runtime capacity of battery is sized accordingly to meet the runtimes and loads specified within this section and/or on the Drawings or Schedules. Indicate runtime on Shop Drawings.

1.3.5. Include inverter heat rejection, weight, and dimensional data.

1.3.6. Include inverter single line diagram and wiring diagrams.

1.4. WARRANTY

1.4.1. Provide minimum 1 year warranty for inverter system from Substantial Performance of the Work.

1.4.2. For batteries, provide 120 months warranty period from Substantial Performance of the Work., with a no-charge replacement during the first 5 years and a pro-rated charge on the second 5 years.

1.5. TESTING

1.5.1. Factory test the inverter(s) prior to shipment.

1.6. OPERATING AND MAINTENANCE

1.6.1. Include operating and maintenance instructions as part of Project O&M manuals.

2. Products

2.1. EQUIPMENT

2.1.1. Provide single phase inverter system that:

- .1 Meets the requirements of CSA C22.2 No. 141.

- .2 Is 120 V in and 120 V out, 277 V in and 277 V out, or 347 V in and 347 V out, as indicated on the Drawings or Schedules.
- .3 Has power rating as indicated on the Drawings or Schedules.
- .4 Has number of output breakers as indicated on the Drawings or Schedules.
- .5 Includes connections for input and output bonding conductors.
- .6 Is rated for 60 Hz.
- .7 Is fully (100 %) rated for load power factors between 0.9 lagging and 0.9 leading.
- .8 Is suitable for powering LED luminaires at their full lumen rating.
- .9 Has peak overload capacity suitable for accommodating LED luminaire inrush currents.
- .10 Has run time of **Choose an item..**
- .11 Has integral valve regulated lead acid (VRLA) battery system that: acts as the source of power in the event of a utility power failure, is maintenance free, and has a 10 year design life.
- .12 Has a pure sine wave output.
- .13 Is capable of powering emergency power luminaires that are normally on, normally off, switched, or dimmed.
- .14 Includes enclosure that is appropriately rated for use in a sprinklered building and has powder coat paint finish.
- .15 Is complete with weekly, monthly, and yearly, non audible auto test feature, as well as manual push button test switch. Indicate malfunctions or auto-test failures. Log and time stamp auto-testing and allow Owner to extract data.
- .16 Forces emergency lights to full brightness during a utility power failure.
- .17 Can override 0-10 V dimming systems.
- .18 Is complete with overcurrent protection for the output circuit.
- .19 Is configured for wall, ceiling, floor, or stand mount installations, as shown on the Drawings.
- .20 Includes a charger; a battery system; an inverter; a control relay; supporting electronics for control, monitoring, and alarms; and supporting protection components.
- .21 Is complete with battery breaker.
- .22 Includes diagnostic / pilot LEDs for AC On and charge.
- .23 Includes charger that is fully automatic and is current limited.
- .24 Has hard wired input/output connections.
- .25 Is rated to operate between 20 and 30 degrees C and only requires front access.
- .26 Is appropriately rated for the available short circuit current shown on the Single Line Diagram.
- .27 Includes battery status indicator and audible signal when battery is low.
- .28 Has 24 hour or less battery recharge time.
- .29 Includes terminal blocks.

2.1.2. Acceptable manufacturers:

- .1 ABB / Lumacell
- .2 Stanpro
- .3 Beluce
- .4 Acuity / IOTA Engineering

.5 Aimlite

3. Execution

3.1. INSTALLATION

- 3.1.1. Install inverters in accordance with manufacturer's written installation instructions and all applicable codes and standards.
- 3.1.2. Setup and commission inverters to work with lighting control strategy indicated on the Drawings, in the Specifications, or in the Lighting Control Sequence of Operations document.

3.2. TESTING AND COMMISSIONING

- 3.2.1. Commission and test the entire system and adjust as necessary.
- 3.2.2. Trip breaker(s) feeding inverter(s) to simulate power failure. Test the operation of each inverter system to document the duration of runtime. Perform testing during non-daylight hours.
- 3.2.3. Inform Engineer's Representative 10 days in advance of 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 confirming that each inverter successfully operated for the required duration of time.
- 3.2.5. Re-test voltage of inverters 24 hours after initial testing to verify rated nominal voltage of inverter system. If battery has not recharged properly, replace system and re-test as stated above at no additional cost to Owner.

END OF SECTION

28 05 00.00 Raceways for Security System

1. General

1.1. WORK INCLUDED

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

1.2. DESCRIPTION OF SYSTEM

1.2.1. Provide raceways and back boxes only for this security system. A complete security system shall be supplied and installed by others.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. SECURITY SYSTEM

2.1.1. The security system will be tendered by Division 28, security contractor. Coordinate with the security consultant, which division supplies and installs the wiring and cables, and which division installs and terminates the devices.

3. Execution

3.1. INSTALLATION

3.1.1. Install conduits and back boxes only.

END OF SECTION

28 31 02.00 Multiplex Fire Alarm System

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 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- 1.1.4. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.
- 1.1.5. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.

1.2. REFERENCES

- 1.2.1. CAN/ULC-S524, Installation of Fire Alarm Systems, latest edition.
- 1.2.2. CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems, latest edition.
- 1.2.3. CAN/ULC-S537, Verification of Fire Alarm Systems, latest edition.
- 1.2.4. CAN/ULC-S1001, Integrated Systems Testing of Fire Protection and Life Safety Systems, latest edition.
- 1.2.5. CAN/ULC-S553, Standard For Installation of Smoke Alarms, latest edition.
- 1.2.6. CSA C22.2 No. 124, Mineral-Insulated Cable, latest edition.
- 1.2.7. CAN/ULC-S559, Standard for Equipment for Fire Signal Receiving Centres and Systems, latest edition.
- 1.2.8. CAN/ULC-S561, Standard for Installation and Services for Fire Signal Receiving Centres and Systems, latest edition.

1.3. SYSTEM DESCRIPTION

- 1.3.1. All equipment and components shall be new, and the manufacturer's current model.
- 1.3.2. Spare modules will be provided for future tenant tie ins. Panels will be tied into emergency standby generators, fire pumps, security panels, and auxiliary and ancillary devices.
- 1.3.3. Elevator shafts will have a weather proof heat detector located in the pit along with a smoke detector located at the top of the shaft.
- 1.3.4. Emergency power feed from generator(s) shall have two supervisory zones each, monitoring Generator Running and Generator General Trouble.
- 1.3.5. Emergency power feed from inverter(s) shall have three supervisory zones each, monitoring Inverter Running, Inverter on Bypass and Inverter General Trouble.
- 1.3.6. Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- 1.3.7. System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general and two-stage alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to monitoring agency.
- 1.3.8. Zoned, non-coded single stage or two stage, as indicated.
- 1.3.9. Modular in design to allow for future expansion.

- 1.3.10. Operation of system shall not require personnel with special computer skills.
- 1.3.11. System to include:
 - .1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.
 - .2 Data Gathering Panels/Transponders with stand-alone capabilities.
 - .3 Power supplies.
 - .4 Initiating/input circuits.
 - .5 Indication/output circuits.
 - .6 Auxiliary circuits.
 - .7 Wiring.
 - .8 Manual and automatic initiating devices.
 - .9 Audible and visual signalling devices.
 - .10 End-of-line resistors.
 - .11 Local and remote annunciators.
 - .12 Printer and event log memory chip.
 - .13 Historic event recorder.
 - .14 Isolation modules.
 - .15 Central alarm monitoring.
 - .16 Programmed features.
- 1.4. REQUIREMENTS OF REGULATORY AGENCIES
- 1.4.1. System components shall be listed by ULC/CSA and comply with applicable provisions of the building code, and meet requirements of local authority having jurisdiction.
- 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.
- 1.5.2. Include:
 - .1 Detail assembly and internal wiring diagrams for control units and auxiliary cabinets.
 - .2 Overall system riser wiring diagram identifying control equipment, initiating zones, signaling circuits; and identifying terminations, terminal numbers, conductors and raceways.
 - .3 Details for devices.
 - .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
 - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.
 - .6 Submit battery sizing calculations and battery selection.
- 1.6. OPERATION AND MAINTENANCE DATA
- 1.6.1. Provide operation and maintenance data for fire alarm system for incorporation into the O&M manual.

1.6.2. Include:

- .1 Instructions for complete fire alarm system to permit effective operation and maintenance.
- .2 Technical data - illustrated parts lists with parts catalogue numbers.
- .3 Copy of approved Shop Drawings with corrections completed and marks removed except review stamps.
- .4 List of recommended spare parts for system.
- .5 Detailed sequence of operation or operational matrix.
- .6 Full fire alarm verification inspection report.
- .7 USB stick, containing electronic version of fire alarm passive graphic both in PDF and CAD, as part of O&M manual.

1.7. MAINTENANCE MATERIALS

1.7.1. Include:

- .1 Spare glass rods for manual pull stations, if applicable.
- .2 Key for fire alarm panel, remote annunciator, and pull stations.
- .3 Specialty tool for resetting sprinkler supervisory, if applicable.
- .4 Spare fuses for control circuits.
- .5 Beam detector calibrated test filters (if applicable).

1.8. WARRANTY

- 1.8.1. Provide a one-year warranty, starting at Substantial Performance of the Work, including all materials, parts, and labour. Be responsible for correcting any deficiencies that are discovered during the one year warranty period, including any that are discovered by the Owner's first annual inspection and test to CAN/ULC-S536.

1.9. TRAINING

- 1.9.1. Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

2. Product

2.1. MATERIALS

- 2.1.1. Equipment and devices: ULC listed, labelled and supplied by single manufacturer.
- 2.1.2. Power supply: to CAN/ULC-S524.
- 2.1.3. Audible signal devices: to ULC-S525.
- 2.1.4. Visual signal devices: to CAN/ULC-S526.
- 2.1.5. Control unit: to CAN/ULC-S527.
- 2.1.6. Manual pull stations: to CAN/ULC-S528.
- 2.1.7. Thermal detectors: to CAN/ULC-S530.
- 2.1.8. Smoke detectors: to CAN/ULC-S529.
- 2.1.9. Smoke alarms: to CAN/ULC-S531.

- 2.1.10. Signal Transmitting Units and Monitoring: to CAN/ULC-S559 and CAN/ULC-S561.
- 2.2. SYSTEM OPERATION: SINGLE STAGE SIGNALS ONLY
- 2.2.1. Actuation of any alarm initiating device to:
- .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.
 - .2 Indicate zone of alarm at central control unit and at the remote annunciator.
 - .3 Cause audible signalling devices to sound continuously throughout building and at central control unit.
 - .4 Transmit signal to fire department via central station.
 - .5 Except for air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings, cause air conditioning and ventilation fans serving more than 1 storey or 1 suite in a storey to shut down.
 - .1 Air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings shall only shutdown upon activation of the duct smoke detector(s) associated with that specific mechanical unit. On general alarms activated by other initiating devices (i.e. sprinkler, pull station, smoke/heat detector, etc.), the air handling unit shall continue to operate in order to maintain corridor pressurization.
 - .6 For high rise buildings, provide manual 'OFF' switches at the main fire alarm panel in the CACF to manually stop air moving fan units that serves more than 2 storeys.
 - .7 Cause supply and/or exhaust fans to function automatically to provide required control of smoke movement per the mechanical smoke control matrix.
 - .8 Cause fire doors and smoke control doors, if normally held open, to close automatically.
 - .9 Cause the release of all mag-lock devices on doors that are secured closed.
- 2.2.2. Emergency elevator recall:
- .1 Actuation of any alarm initiating devices in elevator lobbies, elevator machine room, elevator pit, or top of hoistway to cause elevators to return to primary recall floor, or to alternate recall floor, as required. Elevator recall shall not be activated upon alarms from manual pull stations or on general fire alarm condition.
- 2.2.3. Acknowledging alarm: indicated at central control unit.
- 2.2.4. Actuation of supervisory devices to:
- .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
 - .2 Indicate respective supervisory zone at central control unit and at remote annunciator.
 - .3 Cause audible signal at central control unit to sound.
 - .4 Activate common supervisory sequence.
- 2.2.5. Resetting of alarm or supervisory device shall not return system indications/functions back to normal until control unit has been reset.
- 2.2.6. Trouble on system to:
- .1 Indicate circuit in trouble at central control unit.
 - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.
- 2.2.7. Trouble on system: suppressed during course of alarm.

2.2.8. Trouble condition on any circuit in system not to initiate alarm conditions.

2.3. SYSTEM OPERATION: TWO STAGE SIGNALS ONLY

2.3.1. Actuation of any alarm initiating device on first stage to:

- .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.
- .2 Indicate zone of alarm at central control unit and at the remote annunciator.
- .3 For low rise buildings:
 - .1 Cause audible devices throughout building to sound at 20 strokes per minute.
- .4 For high rise buildings:
 - .1 Cause audible signaling devices to sound continuously in ALARM tone on floor of alarm, floor above, and floor below, at 20 strokes per minute in ALERT tone on other floors of building.
- .5 Transmit signal to fire department via central station.
- .6 Except for air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings, cause air conditioning and ventilation fans serving more than 1 storey or 1 suite in a storey to shut down.
 - .1 Air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings shall only shutdown upon activation of the duct smoke detector(s) associated with that specific mechanical unit. On general alarms activated by other initiating devices (i.e. sprinkler, pull station, smoke/heat detector, etc.), the air handling unit shall continue to operate in order to maintain corridor pressurization.
- .7 For high rise buildings, provide manual 'OFF' switches at the main fire alarm panel in the CACF to manually stop air moving fan units that serves more than 2 storeys.
- .8 Cause supply and/or exhaust fans to function automatically to provide required control of smoke movement per the mechanical smoke control matrix.
- .9 Cause fire doors and smoke control doors, if normally held open, to close automatically.
- .10 Cause the release of all mag-lock devices on doors that are secured closed.

2.3.2. Emergency elevator recall:

- .1 Actuation of any alarm initiating devices in elevator lobbies, elevator machine room, elevator pit, or top of hoistway to cause elevators to return to primary recall floor, or to alternate recall floor, as required. Elevator recall shall not be activated upon alarms from manual pull stations or on general fire alarm condition.

2.3.3. Actuation of any alarm initiating device on second stage to:

- .1 Cause audible signalling devices to sound in alarm tone throughout building.

2.3.4. If first stage alarm is not acknowledged within 5 min, system to automatically go into second stage.

2.3.5. Acknowledging alarm: indicated at central control unit.

2.3.6. Possible to silence signals by "alarm silence" switch at central control unit, after minimum 20 minutes period of operation.

2.3.7. Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.

2.3.8. Actuation of any supervisory device to:

- .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.

- .2 Indicate respective supervisory zone at central control unit and remote annunciator
- .3 Cause audible signal at central control unit to sound.
- .4 Activate common supervisory sequence.
- 2.3.9. Resetting alarm or supervisory device not to return system indications/functions back to normal until control unit is reset.
- 2.3.10. Trouble on system to:
 - .1 Indicate circuit in trouble at central control unit.
 - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; visual indication to remain until trouble is cleared and system is back to normal.
- 2.3.11. Troubles on system: suppressed during course of alarm.
- 2.3.12. Trouble condition on any circuit in system not to initiate alarm conditions.
- 2.4. CONTROL PANEL
- 2.4.1. Central control unit (CCU):
 - .1 Suitable for Data Communication Link style C (DCL-C) unless otherwise noted on the drawings: to CAN/ULC-S524.
 - .2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.
 - .3 Minimum capacity of 1000 addressable monitoring and 500 addressable control/signal points. Points may be divided between 2 communication channels in distributed system, each channel operating independently of other. Faults on one communication channel not to affect operation of other channel.
 - .4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.
 - .5 Integral power supply, battery charger and standby batteries.
 - .6 Basic life safety software: retained in non-volatile Erasable Programmable Read-Only-Memory (EPROM). Extra memory chips: easily field-installed. Random-Access-Memory (RAM) chips in panel to facilitate password-protected field editing of simple software functions (e.g. zone labels, priorities) and changing of system operation software.
 - .7 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.
 - .8 Communication between CCU and remote DGP's/TPR's to be supervised, DCLA. Should communications fail between CCU and remote units, audible and visual trouble to be indicated at CCU. Data communication to be binary DC, baseband, time-division multiplex, half-duplex. Each data channel: capable of communicating up to distance of 3,000 m.
 - .1 Communication between nodes in networked system to be supervised, DCLA. Should communications fail between any 2 nodes, other nodes on loop to continue to communicate with each other and programmed functions on communicating nodes to continue operating.
 - .9 Support up to 4 RS-232-C I/O ports. CCU output: parallel ASCII with adjustable baud rates to allow interface of any commercially available printer, terminal or PC.

- .10 Equipped with software routines to provide Event-Initiated-Programs (EIP); change in status of one or more monitor points, may be programmed to operate any or all of system's control points.
- .11 Software and hardware to maintain time of day, day of week, day of month, month and year.
- .12 On-board, 20-column, DC strip printer, thermal head with automatic paper take-up, and silent operation; operational while system is operating on standby power. Expanded font available for selected printing conditions.
- .13 Printer to record activities on system controlled by EIA RS-232-C link from within CCU.
- .14 Software to operate variable sensitivity addressable smoke detectors and annunciate their status and sensitivity settings at control panel.

2.5. DATA GATHERING PANELS (DGP'S) /TRANSPONDERS

- 2.5.1. Fire control modules: distributed throughout building complex in separately enclosed units (DGP'S) and interconnected to central control unit utilizing multiplex data transmission techniques.
- 2.5.2. Fire alarm integrated DGP's: microprocessor based, provide interface between standard alarm input/output devices and central control unit.
- 2.5.3. Each DGP: circuitry with ability to detect failure in communication with CCU resulting from faults in communication wiring. In event of loss of communication with CCU, DGP capable of operating in stand-alone mode. In this mode, DGP capable of reacting to connected input devices, and apply stand-alone programming to determine state of connected outputs. Stand-alone programming instructions: independent of, but capable of executing same type of algorithms as that of CCU.
- 2.5.4. Each DGP: self-contained unit, with integral power supply, battery charger and standby batteries. Short circuit, over voltage, and brown-out monitoring to protect powered components by automatically switching to standby batteries whenever trouble condition exists in power supply.
- 2.5.5. Addressable DGP's:
 - .1 DGP's are to be of the addressable type which provide two-way data communication with up to 128 addressable devices/interface modules, utilizing digital poll/response protocol communication format. Each addressable device: uniquely identified by own address, set at time of installation.
 - .2 Addressable DGP's must have stand-alone operating capability.
 - .3 Interface modules: facilitate connection of non-addressable devices (e.g. flow switch) to addressable DGP; provided in different types for connection to monitoring devices (e.g. flow/tamper switch), signalling devices (e.g. bells, horns), and control functions (e.g. fan shutdown, door release); communicate with addressable DGP over minimum number of wires (specified by manufacturer).
 - .4 Possible to connect all 3 types of addressable interface modules (monitoring, signal and control) to same addressable communication loop.
 - .5 Possible to connect variable-sensitivity addressable smoke detectors together with other addressable devices to same addressable communication loop.

2.6. POWER SUPPLIES

- 2.6.1. 120V, 60 Hz as primary source of power for system. The circuit shall be labelled at the main power distribution panel as FIRE ALARM. The fire alarm disconnect must be locked, a locked electrical room or panel door does not constitute the lock for the disconnect.

- 2.6.2. Voltage regulated, current limited distributed system power.
- 2.6.3. Primary power failure or power loss (less than 102 V) will activate common trouble sequence.
- 2.6.4. Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
- 2.6.5. Abnormal operating conditions such as a fault in battery charging circuit, short or open in the battery leads, shall activate a common trouble sequence and standby power trouble indicator.
- 2.6.6. Standby batteries: 5 year NiCad sealed, maintenance free.
- 2.6.7. Continuous supervision of wiring for external initiating and alarm circuits are to be maintained for 24 hrs with capability of maintaining alarm activation for a minimum of 2 hrs, immediately following 24 hrs of supervision.

- 2.7. INITIATING/INPUT CIRCUITS
 - 2.7.1. Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCL-C, as per CAN/ULC-S524, configuration to central control unit or DGP's/transponders.
 - 2.7.2. Alarm receiving circuits (active and spare) are to be compatible with smoke detectors and open contact devices.
 - 2.7.3. Actuation of alarm initiating device is to cause system to operate as specified in "System Operation".
 - 2.7.4. Receiving circuits for supervisory devices are to be wired in DCL-A configuration to central control unit or DGP's/transponders.
 - 2.7.5. Actuation of supervisory initiating device is to cause the system to operate as specified in "System Operation".
 - 2.7.6. Sprinkler devices such as pressure switches and flow switches are to have the tamper switch wired after the switch and before the EOL, to create a trouble condition while still allowing the device to electrically initiate its respective zone.
 - 2.7.7. Low room temperature devices are to be provided in sprinkler rooms whenever a dry sprinkler system is provided.

- 2.8. ALARM OUTPUT CIRCUITS
 - 2.8.1. Alarm output circuits are to be connected to signals, wired in class B configuration to the central control unit or DGP's/transponders.
 - 2.8.2. The signal circuits' operation is to be capable of sounding bells, horns as required. Each signal circuit: rated at 2 A, 24 VDC; fuse-protected from overloading/overcurrent.
 - 2.8.3. Manual alarm silence, automatic alarm silence and alarm silence inhibit is to be provided by system's common control.
 - 2.8.4. Separate circuits shall be provided for audible signal devices on each floor area.
 - 2.8.5. Audible signal devices within dwelling units or suites of residential occupancy shall be wired on separate signal circuits from those not within suites of residential occupancy or dwelling units.
 - 2.8.6. Provide 25% spare capacity in visual signal device circuits to allow for site adjustments of visual signal device candela ratings.

- 2.9. AUXILIARY CIRCUITS
 - 2.9.1. Auxiliary contacts for control functions.

- 2.9.2. Actual status indication (positive feedback) from controlled device.
- 2.9.3. Alarm or supervisory trouble on system to cause operation of programmed auxiliary output circuits.
- 2.9.4. Five sets of separate contacts for elevator fire alarm recall, for each elevator or bank of elevators sharing a common shaft and common fire detectors:
 - .1 Elevator recall to primary floor, from elevator lobby smoke detectors on all floors except primary recall floor.
 - .2 Elevator top of shaft detection signal to elevator controller.
 - .3 Elevator pit detection signal to elevator controller.
 - .4 Elevator machine room detector signal to elevator controller.
 - .5 Elevator recall to alternate floor, from elevator lobby smoke detector(s) at primary recall floor.
- 2.9.5. Upon resetting system, auxiliary contacts are to return to normal or to operate as pre-programmed.
- 2.9.6. Fans: stagger-started upon system reset; timing circuit to separate starting of each fan or set of fans connected to auxiliary contact on system. Timing circuit: controlled by CCU.
- 2.9.7. Auxiliary circuits: rated at 2 A, 24 V dc or 120 V ac, fuse-protected.
- 2.10. WIRING
 - 2.10.1. All fire alarm system wiring must be new.
 - 2.10.2. Twisted copper conductors: 300 V CSA FAS minimum 105°C with FT4 rating and in mechanical protection i.e. EMT or flex as specified under Section 26 05 34.00 - CONDUITS, CONDUIT FASTENERS AND FITTINGS.
 - 2.10.3. To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
 - 2.10.4. To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
 - 2.10.5. To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.
 - 2.10.6. All initiating circuits are to be wired in a DCL-C (i.e. Class A) configuration.
 - 2.10.7. All output circuits are to be wired in a Class B configuration, unless otherwise shown on drawings.
 - 2.10.8. All wiring between junction boxes and water flow switch, pressure switch, or supervisory switches will be in liquid tight flexible conduit.
 - 2.10.9. Where a fire alarm transponder or annunciator located in one fire compartment is connected to a central processing unit or another transponder or annunciator located in a different fire compartment, the data communication link conductors connecting them shall be fire rated for at minimum one (1) hour. Where fire alarm system branch circuits connect transponders and individual fire alarm devices located on another storey, the branch circuits shall be fire rated for at minimum one (1) hour between the transponder and the first fire alarm device located on another storey than the transponder. Provide twisted, shielded pair Mineral-Insulated fire rated cables configured to eliminate interference and cross-talk, except where fire alarm riser diagram clearly illustrates another fire rating approach for particular conductors.
- 2.11. MANUAL ALARM STATIONS
 - 2.11.1. Addressable manual pull station.

- .1 Pull lever, break glass rod, semi-flush wall mounted type, single stage, or 2 stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.
 - .2 Provide two pole for direct disconnect of magnetic locking devices local to the devices.
- 2.12. AUTOMATIC ALARM INITIATING DEVICES
- 2.12.1. Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 deg. C., rate of rise 8.3 deg. C. per minute:
- .1 Electronics to communicate detector's status to addressable module/transponder.
 - .2 Detector address to be programmed on site.
- 2.12.2. Addressable Smoke detector: photo electric:
- .1 Twistlock plug-in type with fixed base.
 - .2 Wire-in base assembly with integral red alarm LED.
 - .3 Auxiliary output contact.
- 2.12.3. Addressable Duct type smoke detectors: photo-electric with sampling tubes:
- .1 Twistlock plug-in type with fixed base.
 - .2 Wire-in base assembly with integral red alarm LED.
 - .3 Auxiliary output contact.
 - .4 Properly sized air sampling tubes.
- 2.12.4. Addressable Beam type detectors: long range and short range:
- .1 Complete with transmitter and receiver.
 - .2 Short range operating distance of 9-30 meters.
 - .3 Long range operating distance of 30-100 meters.
 - .4 Operating temperatures shall be of -5 to 55 deg. C.
 - .5 The beam detector shall feature alignment LEDs on both the receiver and the transmitter and automatic gain control.
 - .6 Beam detector calibrated test filters, if applicable.
- 2.12.5. Addressable variable-sensitivity smoke detectors:
- .1 Photo-electric type.
 - .2 Electronics to communicate detector's status to addressable module/transponder.
 - .3 Detector address to be set on detector head in field.
 - .4 Sensitivity settings: 3 settings determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.
 - .5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.
 - .6 Auxiliary output contact.
- 2.12.6. Water flow switches: lever and pressure type:
- .1 Shall have a mechanical alarm transmitted delay adjustable from 0-60 seconds. Initial settings shall be 30-45 seconds. Times will be recorded and submitted to Engineer's Representative.

- .2 The tamper switch located within the water flow switch shall be wired as per manufacturer's recommendations such that if the housing is open a latching trouble will be initiated.
- 2.12.7. Sprinkler and standpipe valve supervisory switches:
 - .1 The tamper switch located within the supervisory switch shall be wired as per manufacturer's recommendations such that if the housing is open a latching trouble will be initiated.
- 2.12.8. Smoke alarms: ionization and photo electric.
 - .1 Twistlock plug-in type with fixed base.
 - .2 Wire-in base assembly with integral red and green LEDs for alarm/normal status.
 - .3 Silence button to silence nuisance alarms.
 - .4 Test button to verify circuitry and alarm operation.
 - .5 Electrical Rating: 120VAC, 60Hz and Battery Backup
 - .1 Battery capacity to provide power for minimum 7 days in normal condition, followed by 4 minutes of alarm.
 - .6 Visual signal device light with the following performance requirements:
 - .1 The flash rate shall not exceed two flashes per second (2 Hz) nor be less than one flash every second (1 Hz) throughout the listed voltage range of the appliance.
 - .2 Maximum pulse duration in accordance with NFPA 72 "National Fire Alarm and Signaling Code."
 - .3 Shall be clear or nominal white and shall be minimum 175 cd but not exceed 1000 cd (effective intensity).
 - .4 The visual signal device light shall be synchronized where multiple smoke alarm visual signal devices are installed within the same area and/or viewpoint.
- 2.12.9. Combination Smoke/Carbon Monoxide alarms:
 - .1 Smoke Detection: ionization.
 - .2 Twistlock plug-in type with fixed base.
 - .3 Wire-in base assembly with integral red and green LEDs for alarm/normal status.
 - .4 Silence button to silence nuisance alarms.
 - .5 Test button to verify circuitry and alarm operation.
 - .6 Electrical Rating: 120 VAC, 60 Hz and Battery Backup
 - .1 Battery capacity to provide power for minimum 7 days in normal condition, followed by 4 minutes of alarm.
 - .7 Visual signal device with the following performance requirements:
 - .1 The flash rate shall not exceed two flashes per second (2 Hz) nor be less than one flash every second (1 Hz) throughout the listed voltage range of the appliance.
 - .2 Maximum pulse duration in accordance with NFPA 72 "National Fire Alarm and Signaling Code."
 - .3 Shall be clear or nominal white and shall be minimum 175 cd but not exceed 1000 cd (effective intensity).
 - .4 The visual signal device shall be synchronized where multiple smoke alarm visual signal devices are installed within the same area and/or viewpoint.

2.13. AUDIBLE SIGNAL DEVICES

- 2.13.1. In sleeping rooms in a building of residential (Group C) or care (Group B, Division 3) occupancy, provide audible signal devices that emit a low frequency signal in the range of 470 Hz to 570 Hz, in accordance with Building Code requirements.
- 2.13.2. Bells: flush or surface mounted, as indicated, single stroke, polarized, 24 V dc, 150 mm or 250 mm, as indicated.
- .1 Vibrating type, gongs of special alloy steel, 24 V dc, 150 mm or 250 mm, as indicated.
- 2.13.3. Signal chimes: heavy duty, single stroke, 24 V dc, with solid striking plunger and resonating chamber.
- 2.13.4. Horns: 24 V dc, indoor horn type with compression driver, surface mounted.
- .1 Corrosion, vibration and vermin resistant.
- .2 Taps: multiple, adjustable with maximum tap output sound level of 100 dB at 3 m.
- .3 Frequency response: 400 to 4000 Hz.
- 2.13.5. Weatherproof Horns: 24 V dc, for use primarily in mechanical equipment areas, both indoor and outdoor. Horn type with compression driver, surface mounted.
- .1 Corrosion, vibration and vermin resistant.
- .2 Frequency response: 400 to 4000 Hz.
- .3 Complete with weatherproof box as recommended by manufacturer.
- .4 High output 40 mA @ 24 Vdc, Low output 20 mA @ 24 Vdc.
- 2.13.6. Residential, In-Suite, Mini-Horns: 24 V dc, horn type.
- .1 Complete with signal silence feature, including integral push button or touch to silence, and LED that indicates active signal circuit when lit. Provide signal silence feature that silences mini-horn for a period of not more than 10 minutes.
- .2 Mountable within a single-gang backbox.
- .3 Capable of continuous and temporal tones.

2.14. VISUAL ALARM SIGNAL DEVICES

- 2.14.1. Visual signal device type: white flashing light, wall mount or ceiling mounted as per drawings.
- .1 Synchronized at one flash per second.
- .2 Flash tube enclosure in clear LEXAN.
- .3 "FIRE" installed red letters.
- .4 Operating on 20-24 V dc.
- .5 Field adjustable for 15 cd, 30 cd, 75 cd, 95 cd, 110 cd, and 115 cd, unless specified otherwise.
- 2.14.2. Fire do not enter signs and their accessories:
- .1 Compliant with CAN/ULC-S527 "Standard for Control Units for Fire Alarm Systems" and/or CAN/ULC S526 "Standard for Visual Signal Devices for Fire Alarm and Signaling Systems, Including Accessories."
- .2 Powered by fire alarm system; operating on 24 V dc.
- .3 Fire alarm signaling device.

2.15. COMBINATION AUDIBLE AND VISUAL SIGNAL DEVICES

- 2.15.1. Combination Horn Strobes, complying with the requirements noted above for: Audible Signal Devices and Visual Alarm Signal Devices.

2.16. END-OF-LINE DEVICES

- 2.16.1. End-of-line devices to control supervisory current in alarm circuits and signalling circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.

2.17. REMOTE ANNUNCIATORS

- 2.17.1. LED type, with designation cards to indicate zones.

2.17.2. Display:

- .1 Alarms for alarm initiating circuits.
- .2 Common supervisory alarm for supervisory initiating circuits.
- .3 Common system trouble.

2.17.3. Trouble buzzer:

- .1 Acknowledging trouble at main panel to silence trouble buzzers in system.

2.17.4. Supervised, with LED test button.

2.17.5. Interconnected with main fire alarm panel at minimum.

2.18. REMOTE PRINTER

- 2.18.1. System printer: to give a hard copy record of system events c/w following features:

- .1 120V ac, 60 Hz.
- .2 80 columns.
- .3 160 cps.
- .4 Utilizes fan fold paper.
- .5 Connected to RS-232 output at central control panel.

2.19. ISOLATION MODULE

- 2.19.1. Provide isolation modules in accordance with CAN-ULC-S524.

- .1 Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an DCL-C branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the DCL segment branch.
- .2 If a wire-to-wire short occurs, the isolator module shall automatically disconnect the DCL-C segment. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- .3 The isolation module will provide a single LED that flashes to indicate the isolation module is operating and illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.20. CENTRAL ALARM MONITORING

- 2.20.1. Provide Signal Transmitting Unit that utilizes internet connection as primary communications method and cellular network as secondary (back-up) communications method.

- .1 Provide remote antenna for cellular network reception for Signal Transmitting Unit, if location of Signal Transmitting Unit in the building does not facilitate adequate cellular network strength.
- 2.20.2. Provide a demarcation point; refer to CAN-ULC-S524 Annex E.
- 2.20.3. Provide monitoring of the system including alarm zones, supervisory zones, trouble signals (excluding primary power failure), and a separate and distinct output for primary power failure (i.e. 120 V power to system). Provide 1 minute delay for transmission of primary power failure signal, to avoid unnecessary signals to signal receiving centre during brief utility company power outages.
- 2.21. PROGRAMMED FEATURES:
 - 2.21.1. By-pass feature for signalling devices:
 - .1 Bypassing of audible devices shall be provided through the programmable keys. The use of the feature is intended for personnel with programming access.
 - 2.21.2. Evacuation feature.
 - .1 Evacuation key will be programmed and accessible for any personnel working on the fire alarm panel.
- 2.22. REMOTE TERMINAL
 - 2.22.1. CRT screen: 120 V, 60 Hz, to incorporate 100% solid state circuitry, with 30 cm screen and front mounted controls for brightness, contrast, vertical and horizontal hold and power ON/OFF switch.
- 2.23. FIRE ALARM ZONE PASSIVE GRAPHIC DISPLAY:
 - 2.23.1. Layout
 - .1 The fire alarm zone passive graphic display shall be completed in the latest version of AutoCAD. The drawing shall indicate all the building floor plans and respective fire alarm zones with the description corresponding to the zone indication at the fire alarm control panel and annunciator.
 - .2 The fire alarm zones indicated for each floor shall be clearly defined with borders to indicate zone separation.
 - .3 The general font style shall be Helvetica upper case. Text size:
 - .1 6 mm in height for building name and 4.5 mm for municipal address and floor plans all coloured green.
 - .2 Main entrance arrow and text shall be Romans forward slant style 3 mm in height coloured cyan.
 - .3 Fire alarm zones and equipment notes shall be 3 mm in height coloured red.
 - .4 Fire hose cabinets shall be Romans forward slant style 3 mm in height coloured cyan.
 - .4 Graphic display colours.
 - .1 Outline of building plan to be black line on white background.
 - .2 All egress corridors shall be clearly defined with Red colour #13 solid hatch pattern.
 - .3 All stairs and elevators shall be indicated using yellow solid hatch pattern.
 - .5 Include the following information on the graphic display:

- .1 A north arrow on the upper left corner of the zone graphic.
- .2 "You are here" location in Red and properly orientated to the viewer when standing in front of the graphic.
- .3 A drawing scale graph and drawing file number located in the lower right of the zone graphic.
- .4 Building name and number at the bottom centre of the graphic display with municipal address indicated on the next line below.
- .5 The main building entrance and street reference.
- .6 Location of fire alarm control panel and annunciators, fire department connections, fire pumps, fire hose cabinets and associated standpipe and sprinkler valves.
- .7 Location of main gas valve, suppression systems, chemical storage vaults, major mechanical equipment and duct smoke detectors indicating zone number.
- .8 Substation and transformer locations indicating primary and secondary voltages.

2.23.2. Construction

- .1 The graphic display shall be:
 - .1 Printed on white heavy weight 40lb. coated bond with colour UV inks, laminated on 1.5 mm styrene board and covered with clear Lexan.
 - .2 Standard passive graphic display size ranges from 8.5"x11" to 23"x35". The final size of the graphic may vary depending on the layout requirements and site conditions.
- .2 Trim to be No. 4 stainless steel finish.

2.23.3. Location

- .1 Install graphic display adjacent to each fire alarm annunciator panel and the fire alarm control panel.
- .2 Graphic display to be fixed to the building structure or fire alarm control panel enclosure using tamper proof screws at each corner and at the midpoint on all four sides.

2.23.4. Approval Drawings

- .1 Submit three full colour print copies of the passive display graphic for review by the Owner, the Engineer's Representative and the local fire department.
- .2 Include the final approved zone graphic drawing in electronic format with the as-built drawings.

2.24. ANCILLARY DEVICES

- 2.24.1. Remote relay unit to initiate fan shutdown, magnetic door locks and door hold open devices.

2.25. STI STEEL WEB STOPPERS, DETECTOR COVERS.

- 2.25.1. Provide STI 9600 series detector cover for areas where sporting events or similar activities avail. STI STOPPER 2 & WEATHER PROOF STOPPER 2, COVERS FOR MANUAL STATIONS.

- 2.26.1. Provide STI Stopper 2 1100 series manual station covers for all vandal resistant locations identified on the electrical and architectural drawings.

- 2.26.2. Provide Weather Proof Stopper 2 1200 (flush mount) or 3100 (surface mount) series manual station covers for all weather proof locations and outdoor applications identified on the electrical and architectural drawings.

2.27. RELAY BASE, FOR FIRE DETECTORS.

- 2.27.1. Provide power along with the relay base detector such that the device that is being controlled with the normally open or normally closed relay base may operate or function. Power requirements and relay condition to be determined on site.

2.28. MANUFACTURERS

- 2.28.1. The following are acceptable manufacturers:

- .1 Chubb Edwards.
- .2 Johnson Controls Simplex.
- .3 Mircom.
- .4 Siemens.
- .5 Notifier.
- .6 Johnson Controls Autocall.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install systems in accordance with CAN/ULC-S524.
- 3.1.2. Install central control unit and connect to ac power supply.
- 3.1.3. Install manual alarm stations and connect to alarm circuit wiring.
- 3.1.4. Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts. Install duct type detectors complete with sampling tubes. Ensure duct type smoke detectors are installed far enough away from humidifiers to avoid false alarms; coordinate location of duct type smoke detector with Mechanical Contractor. If false alarms occur, relocate duct type smoke detector at no cost to the Owner.
- 3.1.5. Connect alarm circuits to main control panel.
- 3.1.6. Install bells, horns and visual signal devices and connect to signalling circuits.
- 3.1.7. Connect signalling circuits to main control panel.
- 3.1.8. Adjust visual signal device candela ratings upward, where required to meet coverage. Utilize spare visual signal device circuit capacity required in Part 2.
- 3.1.9. Install end-of-line devices.
- 3.1.10. Install remote annunciator panels and connect to annunciator circuit wiring.
- 3.1.11. Install door releasing devices.
- 3.1.12. Install remote relay units to control fan shut down.
- 3.1.13. Where smoke dampers or combination smoke and fire dampers are shown, terminate damper position monitoring wiring for both fire alarm system and building automation system on damper actuator position end switches. Building automation system wiring to damper location will be provided by Mechanical Division.
- 3.1.14. Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- .1 Sprinkler devices should be wired such that opening of a device will cause a trouble on an alarming device or a supervisory on a supervising device.

- .2 Where mechanical/sprinkler contractor makes revisions to the base design, electrical contractor shall coordinate any revisions to fire protection system directly with the mechanical/sprinkler contractor at no cost to the owner and update as-built drawings accordingly.
- 3.1.15. Room detection system (where applicable):
 - .1 Install detectors. Make necessary connections between room detection panel and main fire alarm panel.
 - .2 Locate and install audible signals and visual alarms.
 - .3 Locate and install detectors under raised floor. Fasten to steel brackets approximately 300 mm above sub-floor level to clear cables and conduits.
- 3.1.16. Connect fire suppression systems to control panel.
- 3.1.17. 'T-Tapping' is not permitted.
- 3.1.18. For audible and visual signal devices in spaces subject to future tenant renovations, install devices in surface mounted boxes and leave 3 m of extra wiring coiled up in the box to allow the devices to be lowered / relocated to suit the tenant fit up ceiling and wall locations.
- 3.1.19. Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- 3.1.20. Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- 3.1.21. Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
- 3.1.22. Install smoke and smoke/CO alarm in accordance with CAN/ULC-S553.
 - .1 Where more than one smoke (or smoke/CO) alarm is installed within a dwelling unit, interconnect the wiring such that actuation of one smoke (or smoke/CO) alarm will cause all the smoke (or smoke/CO) alarms within the dwelling unit to sound.
- 3.1.23. Where devices are to be installed in environments where the temperature can drop below 0°C (or below the addressable device temperature rating), an appropriately rated conventional device is to be installed.
 - .1 Provide and install an addressable input module remotely located in a conditioned environment suitable for the device temperature rating.
 - .2 Connect the conventional device(s) to addressable input module(s) as necessary to monitor the status of the conventional device.
 - .3
- 3.1.24. Where shown on Drawings, install "Fire do not enter signs" in accordance with the requirements of CAN/ULC-S524.
- 3.2. FIELD QUALITY CONTROL AND COMMISSIONING
 - 3.2.1. Perform tests and verification in accordance with Section 26 08 01.00 - TECHNICAL SERVICES DIVISION STARTUP SERVICE.
 - 3.2.2. The installing contractor is responsible for hiring and coordinating with the manufacturer to perform the following:
 - .1 Testing of system to CAN/ULC-S536 prior to performing verification.
 - .2 Partial verification inspection to CAN/ULC-S537 and reports as required for partial occupancy.

- .3 Complete an entire building test to CAN/ULC-S536 and provide detailed report. Provide a full verification inspection and test report at the end of the project. Cumulative partial verification reports do not constitute a full verification.
- 3.2.3. All fire alarm test and verification reports are to be submitted with a covering letter from the manufacturer clearly stating that there are no deficiencies with the installation prior to releasing the respective area for occupancy.
- 3.2.4. Include fire alarm audible signal device sound pressure levels, on a space by space / room by room basis, as part of the fire alarm verification report.
 - .1 Test sound pressure levels when any intervening doors between the device and the rest of the floor area are closed, in accordance with the intent and requirements of the Building Code.
- 3.3. LIFE SAFETY INTEGRATION TESTING
- 3.3.1. The fire alarm contractor and fire alarm manufacturer shall participate in the coordination and testing work associated with the Integrated Testing Plan (ITP), as described in more detail in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS. All work shall be coordinated with the Integrated Testing Coordinator (ITC). The work shall include but not be limited to:
 - .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
 - .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
 - .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001.
 - .4 Provide fire alarm verification report along with all other documentation requested by the ITC as it relates to the electrical systems in conformance with CAN/ULC-S1001.
- 3.4. CENTRAL ALARM MONITORING
- 3.4.1. Locate Signal Transmitting Unit in same room as main fire alarm panel or in CACF room, unless shown otherwise on Drawings.
- 3.4.2. Provide a data connection from the Owner's network for internet access for central monitoring.
- 3.4.3. Coordinate with the Owner's Fire Alarm Monitoring Company and install power, conduit and wiring to the Signal Transmitting Unit in compliance with CAN/ULC-S559 and CAN/ULC S561.
- 3.4.4. Facilitate conversation between Owner and Owner's preferred fire alarm central alarm monitoring service to ensure that central monitoring service is provided in time for completion of fire alarm scope and Project occupancy.

END OF SECTION

D