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END OF SECTION 00 00 00

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.46-[M1988], Electric Air-Heaters.
- .2 Underwriters' Laboratories (UL) Inc.
 - .1 UL 1042-[1994], Electric Baseboard Heating Equipment.

1.2 PRODUCT DATA

- .1 Submit product data sheets for baseboard convectors. Include:
 - .1 Product characteristics.
 - .2 Performance criteria.
 - .3 Mounting methods.
 - .4 Physical size.
 - .5 kW rating, voltage, phase.
 - .6 Cabinet material thicknesses.
 - .7 Limitations.
 - .8 Colour and finish.
- .2 Manufacturer's Instructions: Provide to indicate special handling, installation and maintenance procedures.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit operation and maintenance data for baseboard convectors in accordance with Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Products:
 - .1 Stelpro []
 - .2 Dimplex []
 - .3 Ouellet [].

2.2 BASEBOARD CONVECTORS

- .1 Heaters: to [CSA C22.2 No.46] [UL 1042] [low] [standard] [high] wattage density [as indicated] with connection box [one] [both] end[s].
 - .1 Element through-type fitted with [aluminum] [steel, zinc plated] convector vanes and resistor wire enclosed in mineral insulation in [copper] [aluminum] sheath.

- .2 Element: locked to cabinet and supported at additional points throughout length to allow for linear expansion [with non metallic supports].
- .3 Cabinet: to CSA C22.2 No.46 pre-drilled back for securing to wall. Integral air diffusion reflector with wireway at bottom [and built-in clamps].
 - .1 Bottom inlet/top outlet.
 - .2 Bottom inlet/front outlet.
 - .3 Front inlet/front outlet.
 - .4 Sloping inlet/sloping front outlet.
 - .5 Panel: [steel] [aluminum], metal thickness, bottom [1] [0.8] mm, front [1.6] [1.2] mm thick.
 - .6 Finish: phosphatized and finished with [] coats [air-dry] [[baked] enamel] [powder coated finish], [] colour.
- .4 Blank cabinet sections and [outside] [inside] corners complete with wireway in sections including splice plates, to match heater cabinets in respects for continuous baseboard effect as indicated.

2.3 CONTROLS

- .1 Wall mounted thermostats: type [[line] [low] voltage] [electronic], [Energy Star certified], to Section [23 09 33 - Electric and Electronic Control System for HVAC].
- .2 Integral thermostats 2 pole to control load or as indicated on Mechanical Drawing
- .3 Relays [and transformers] [temperature controller and power module] [contactors] to switch loads in excess of thermostat rating.
- .4 Double pole, double throw switch and receptacle terminal box assembly for combination heater and air conditioner power supply.

Part 3 Execution

3.1 INSTALLATION

- .1 Install baseboard convector heaters, blank sections and controls.
- .2 When wireway is used, remove knock-outs and insert insulating bushing between units.
- .3 Install grounding wire to maintain ground integrity between heating, blank, and auxiliary sections.
- .4 Install thermostats in locations [indicated].
- .5 Make power and control connections.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Ensure heaters and controls operate correctly.

END OF SECTION 23 82 33

Part 1 General

1.1 SECTION INCLUDES

- .1 This Section describes the Common Work Results applicable to electrical disciplines.

1.2 GENERAL

- .1 The general conditions and general requirements together with all amendments and supplements contained in the General Specifications shall form an integral part of the electrical specification and will be made part of this contract.
- .2 Reference to "Electrical Divisions" shall mean all Divisions 26, 27, 28, 33, 34 and 48 in the Master Format or the Canadian Master Specifications.
- .3 The word "Provide" shall mean "Supply and Install" the products and services specified. "As Indicated" means that the item(s) specified are shown on the drawings.
- .4 Confirm with the architectural plans and specifications the extent and nature of the work and how it will affect the electrical work. Include in the tender sum for any complications or additional work described therein.
- .5 Review mechanical plans and specifications for the extent of electrical work required to make mechanical systems complete and include this work in the tender sum.
- .6 Review structural plans for limitations of penetrations or inclusions of electrical equipment. In the tender sum, allow for avoiding critical areas with electrical equipment.
- .7 Review existing record plans and site conditions for limitations of penetrations or inclusions of electrical equipment. In tender sum, allow for avoiding critical areas with electrical equipment.
- .8 Comply with the requirements of the General Contract, and coordinate the installation with all other trades on site.
- .9 Confirm on-site the exact location of equipment, outlets, and fixtures and the location of outlets for equipment supplied by other trades.

1.3 WORK INCLUDED

- .1 This work shall include the supply and installation of all the necessary materials and apparatus for complete operating systems as indicated on the plans or mentioned in this specification, with the exception of materials or apparatus specifically mentioned to be omitted or to be supplied by owner.
- .2 Items obviously necessary or reasonably implied to complete the work, shall be included as if shown on drawings and noted in the specifications.
- .3 All materials, tools, appliances, scaffolding, apparatus and labour necessary for the execution, erection and completion of the systems described herein shall be furnished. This includes providing lighting and power for own work.
- .4 This contract shall include, but is not confined to, the following scope of work:
 - .1 Underground services
 - .2 All electrically related civil works, trenching, backfilling, resurfacing
 - .3 Underground ducts including concrete encasement, pullboxes, manholes and transformer pads
 - .4 Main power service
 - .5 Unit sub station

- .6 Power distribution equipment
- .7 Power connections and outlets
- .8 Power factor correction system
- .9 Surface wireways and floor boxes
- .10 Emergency generator system
- .11 UPS system
- .12 Metering system
- .13 Mechanical equipment connections
- .14 Lighting system
- .15 Wireless lighting controls system
- .16 Light pole foundations
- .17 Exit signs
- .18 Emergency lighting
- .19 Fire alarm system
- .20 Data/Communications system
- .21 Fiber Optic System
- .22 Audio/Visual raceway system
- .23 Paging/Sound system
- .24 Card reader/door access system
- .25 Video Surveillance system
- .26 Asbuilt drawings
- .5 Complete all electrical connections to equipment and accessories pertaining to this contract and leave all in operating condition to the electrical Consultant's satisfaction.
- .6 Remove all existing electrical equipment and material made redundant by this contract or in conflict with work to be carried out. Reroute, reinstall or replace existing electrical material that becomes necessary due to work carried out by this contract so a complete working electrical system will be retained in all areas affected by this installation.
- .7 Whether indicated or not on electrical plans, provide a dedicated 120 volt circuit fed from a 15 amp 1-pole circuit breaker to all DDC control panels. Confirm final locations and quantities with Mechanical Contractor and Mechanical Drawings.**
- .8 Provide 120 volt power source to mechanical equipment for internal lights and receptacles, whether indicated on electrical plans or not. Confirm final locations and quantities with Mechanical Contractor and Mechanical Drawings.**

1.4 WORK EXCLUDED

- .1 The contract scope of work shall not include the following:
 - .1 Low voltage mechanical systems control wiring where indicated in electrical and mechanical specifications to be done by controls contractor shall be excluded from the electrical contractor work as noted.

1.5 DRAWINGS AND SPECIFICATIONS

- .1 The drawings and specifications compliment each other and what is called for by one is binding as if called for by both. If there is any doubt as to meaning or true intent due to a discrepancy between the electrical drawings and specifications, and all other contract documents, obtain written ruling from Consultant prior to tender closing. **Failing this, the most expensive alternative is to be allowed for.**
- .2 The plans show the approximate location of outlets and apparatus but the right is reserved to make such changes in location as may be necessary to meet the emergencies of construction in any way. No extra will be allowed for such changes to any piece of electrical equipment unless the distance exceeds 3 metres, or if the relocation is required after initial installation is complete.
- .3 It is imperative that the contractor visit the site and completely familiarize himself as to the work to be undertaken.

1.6 CODES AND STANDARDS

- .1 All electrical work shall be carried out in accordance with the latest edition of the CEC C22.1 (Canadian Electrical Code) as amended and adopted by the Province of British Columbia and to the satisfaction of the Electrical Inspection Authority having jurisdiction, except where specified or specifically stated otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 latest edition, except where specified or specifically stated otherwise.
- .3 All work shall be carried out in accordance with the National Building Code current edition (including all local amendments) to the satisfaction of local building inspector authority having jurisdiction.
- .4 Any electrical material and/or equipment supplied by any contractor or sub-contractor for installation on this project must bear evidence of CSA approval or special CSA certification acceptable to the Chief Electrical Inspector for the Province of [British Columbia].

1.7 CARE, OPERATION AND START-UP

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

1.8 VOLTAGE RATINGS

- .1 Operating voltages: to CAN3-C235 latest edition.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.9 PERMITS, FEES AND INSPECTION

- .1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2 Pay all associated fees.
- .3 Fees will cover all routine inspections by the District Electrical Inspector. Any fees for follow-up inspections found to be necessary by the District Electrical Inspectors as a result of incorrect work shall be borne by this contractor without any cost to the owner.
- .4 Notify Consultant of changes required by Electrical Inspection Department prior to making changes.
- .5 Furnish Certificates of Acceptance from Electrical Inspection Department [authorities having jurisdiction] on completion of work to Consultant.
- .6 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work. Obtain electrical permit and pay associated fees.
- .7 Consultant will provide drawings and specifications required by Electrical Inspection Department and Supply Authority at no cost to the Contractor.
- .8 Furnish to Consultant on completion of work Certificates of Acceptance from Electrical Inspection Department.

1.10 UTILITY WORK

- .1 Work performed on behalf of the Authority (Utility). All references to Utility include Power Supply, Communications and any other Utility that requires coordination.
 - .1 The electrical contract, including the drawings and specifications, describe the general intent of the electrical systems as they pertain to the private (non-Utility) infrastructure. The drawings and specifications describe these systems in detail and should be executed in accordance with all applicable Codes, Standards and Regulations to satisfy the Authority Having Jurisdiction.
 - .2 The electrical contract also describes the general intent of the work required by the power supply authority. This work is not governed by the same Codes, Regulations and Standards as the privately installed infrastructure. The electrical contractor is hereby responsible for the following with respect to work performed on behalf of the utility:
 - .1 For work performed by the electrical contractor on behalf of the Utility, the Electrical Contractor shall:
 - .1 Include in this contract all applicable Utility charges and costs to meet the utilities Codes, Standards, and Regulations.
 - .2 The Contractor shall refer to the Utility standard for specific details applicable to that part of the project which is executed on behalf of the Utility. The Contractor shall obtain these standards from the Utility prior to submitting tender and setting out with the work. Should the Contractor have any concerns or questions, as to which standard applies to a given project, they shall bring this matter to the attention of the Consultant and the Utility prior to submitting tender for a written ruling on the applicable regulations. Failing this, the Electrical Contractor shall allow the most expensive alternative according to the Utility regulation.

- .3 The work on behalf of the Utility is to be executed in accordance with all Utility Codes, Standards, and Regulations without deviation. Where, due to site conditions, the Utility infrastructure cannot be installed exactly as provided in the Utility Standards, the Contractor shall bring the condition to attention of the Utility designer and Consultant for their express written permission and approval of any deviation prior to setting out with the work.
- .4 All shop-drawings depicting equipment that interfaces with the supply Utility are subject to review by the Utility and shall be submitted to the supply authority for approval prior to submission for review by the Consultant under the general electrical contract.
- .5 All work performed on behalf of the utility shall be inspected and approved by a representative from the Utility with notification to the Consultant before cover or activation. Any corrections or alteration arising from this review are the responsibility of the electrical contractor to meet the utility inspectors notice.
- .6 All work performed on behalf of the Utility, for Utility owned infrastructure under this contract is exempt from electrical permit requirements or fees. Any monies, costs or allowances are free from permit fee calculation for that part of the installation performed on behalf of the Utility.

1.11 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with the Construction Waste Management Plan as established by the Construction Manager.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal: paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Consultant.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.12 SINGLE LINE ELECTRICAL DIAGRAMS

- .1 Provide single line electrical diagrams under plexiglass [in glazed frames] as follows:
 - .1 Electrical distribution system: locate in main electrical room.
 - .2 Electrical power generation and distribution systems: locate in power plant rooms.
- .2 Drawings: 600mm x 600mm minimum size.

1.13 FIRE ALARM RISER

- .1 Provide fire alarm riser diagram, plan and zoning of building in glazed frame [under plexiglass] at fire alarm control panel.
- .2 Drawings: 600mm x 600mm minimum size.

1.14 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with these specifications and as indicated on the Architectural and Electrical drawings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.
- .4 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.
- .5 Provide 120 volt power to all Direct Digital Control (DDC) panels indicated on Mechanical Drawings and Specifications, where shown or not on Electrical Drawings.

1.15 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise on the Architectural and Electrical drawings.
 - .1 Local switches: 1400 mm.
 - .2 Wall receptacles:
 - .1 General: 300 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical rooms: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and interphone outlets: 300 mm.
 - .5 Pay Telephone Outlets: 1194mm
 - .6 Wall mounted telephone and interphone outlets: 1500 mm.
 - .7 Fire alarm stations: 1050 -1150 mm.
 - .8 Fire alarm bells: 2300 mm (or if in conflict with ceiling, 300mm below ceiling).
 - .9 Television outlets: 300 mm.
 - .10 Wall mounted speakers: 2100 mm.
 - .11 Clocks: 2100 mm.
 - .12 Door bell pushbuttons: 1500 mm.

1.16 LOAD BALANCE

- .1 Measure phase current to panelboards with normal loads (lighting and mechanical) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

- .3 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State voltage, time and date at which each load was measured.

1.17 CONDUIT AND CABLE INSTALLATION

- .1 Install flashing and gooseneck assembly for all roof penetrations for running cables to serve roof mounted equipment.
- .2 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete shall be [schedule 40 steel pipe] [plastic] [sheet metal], sized for free passage of conduit, and protruding 50mm each side.
- .3 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .4 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .5 For all stacked communications rooms, provide 100mm square STI EZ-PATH 2-hour rated sleeves for running communications cables through floors. Also provide a minimum of two spare sleeves.

1.18 EXTRA WORK

- .1 Any extra work ordered to be done shall be governed by this specification unless specific instructions or clauses are contained in the Change Order. In such cases, these instructions or clauses shall supersede those of the specification for this particular application only.

1.19 FIELD QUALITY CONTROL

- .1 All electrical work to be carried out by qualified, licensed electricians or supervised apprentices as per the conditions of the Provincial Act respecting manpower vocational training and qualification. Employees registered in a provincial apprentices program shall be permitted, under the direct supervision of a qualified licensed electrician, to perform specific tasks. The activities permitted shall be determined based on the level of training attained and the demonstration of ability to perform specific duties.
- .2 The work of this division to be carried out by a contractor who holds a valid Master Electrical Contractor License as issued by the Province that the work is being conducted.
- .3 Conduct and pay for following tests:
 - .1 Power [generation] [and] [distribution] system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and lighting control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: [fire alarm system], [communications].
- .4 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .5 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350V with a 500V instrument.
 - .2 Megger 350V - 600 V circuits, feeders and equipment with a 1000V instrument.

- .3 Check resistance to ground before energizing.
- .6 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .7 Submit test results for Consultant's review.

1.20 CO-ORDINATION OF TRADES

- .1 Consult with Construction Manager and all subtrades involved to confirm the location of the various outlets and equipment, and cooperate fully to ensure that no conflict arises during the installation.
- .2 Special care shall be taken that equipment, outlets, junction boxes or pullboxes will not be obstructed by other structure, equipment, pipes or ducts installed under this general contract by other trades.
- .3 Check drawings of all trades to verify space and headroom limitations for work to be installed. Coordinate work with all trades and make changes to facilitate a satisfactory installation. Make no deviations to the design intent involving extra cost to the Owner, without the Consultant's written approval.
- .4 The drawings indicate the general location and route to be followed by the electrical services. Where details are not shown on the drawings or only shown diagrammatically, the services shall be installed in such a way as to conserve head room and interfere as little as possible with the free use of space through which they pass. Service lines shall run parallel to building lines. All services in the ceiling shall be kept as tight as possible to beams or other limiting members at high level. All electrical services shall be coordinated in elevation to ensure that they are concealed in the ceiling or structural space provided unless detailed otherwise on drawings.
- .5 Work out jointly all interference problems on the site and coordinate all work before fabricating, or installing any material or equipment. Where necessary, produce interference/coordination drawings showing exact locations of electrical systems or equipment within service areas, shafts and the ceiling space. Distribute copies of the final interference/coordination drawings to the Architect and the Consultant and all affected parties.
- .6 Ensure that all materials and equipment fit into the allotted spaces and that all equipment can be properly serviced and replaced, if and when required. Advise the Consultant of space problems before installing any material or equipment. Demonstrate to the Consultant on completion of the work that all equipment installed can be properly, safely serviced and replaced, if and when required.

1.21 SUBSTITUTIONS

- .1 Unless otherwise noted on the plans or specifications, substitutions may be approved by the Consultant if requested by the contractor or by equipment suppliers, for items specified by the manufacturer's catalogue number.
- .2 Requests for approval of such substitutions shall be submitted at least five (5) working days prior to the tender closing date.
- .3 Complete description and data sheets of proposed substitution shall accompany the application and supplier must be prepared to submit samples for approval on short notice.

- .4 Proposed substitutions must be at least of equal quality to that of the specified item. The manufacturer's specification of the specified item shall apply for comparison if no other clause of this specification applies. The decision of the Consultant to accept or reject shall be final.
- .5 Off-the-shelf items such as standard boxes, EMT, which are specified by description only or indicated on the drawings, without any manufacturer, model, type or catalogue number, do not require approval prior to the tender closing date.
- .6 Submit list of alternates used, within one week after acceptance of tender.

1.22 PROTECTION OF EQUIPMENT

- .1 This contractor shall provide and ensure maximum protection of electrical equipment on the site. Electrical equipment, including existing electrical equipment, shall be kept clean and dry at all times and caution shall be taken to ensure no mechanical damage is done to the equipment. Equipment shall not be delivered to the site until it can be stored safely or placed in final position and the space is clean.

1.23 DAMAGES

- .1 If the finish of electrical equipment is damaged either when received or during installation, have such equipment completely refinished and restored to its original condition at no cost to the owner.
- .2 Irreparably damaged equipment shall be replaced at no cost to the owner.

1.24 SHOP DRAWINGS

- .1 Submit shop drawings, product data and samples in accordance with the contract specifications.
- .2 Shop drawings and product data shall indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.
- .3 Where applicable, include wiring, single line and schematic diagrams.
- .4 Include wiring drawings or diagrams showing interconnection with work of other sections.
- .5 Prior to manufacture of any item made specifically for this job, submit detailed drawings of the item through the Construction Manager.
- .6 Shop drawings must be received by the Consultant at a date early enough to permit reasonable study prior to approval and manufacture, or to permit alterations where necessary. Late submissions of shop drawings will be sufficient reason for a stoppage of construction pending approval, or removal and replacement of any unsatisfactory item at the contractor's expense.
- .7 Shop drawings/product data content:
 - .1 Shop drawings submitted title sheet.
 - .2 Data shall be specific and technical.
 - .3 Identify each piece of equipment.
 - .4 Information shall include all schedule data.
 - .5 Advertising literature will be rejected.
 - .6 The project and equipment designations shall be identified on each document.
 - .7 The shop drawings/product data shall include:

- .1 Dimensioned construction drawings with plans and sections showing size, arrangement and necessary clearances, with all equipment weights and mounting point loads.
- .2 Mounting arrangements.
- .3 Control explanation and internal wiring diagrams for packaged equipment.
- .4 A written description of control sequences relating to the schematic diagrams.

1.25 CUTTING AND PATCHING

- .1 This contractor is responsible for all cutting or blocking out required to install electrical equipment.
- .2 If this contractor makes excessive cuts or does not coordinate work so that finished work requires cutting or patching, then this contractor shall pay for all patching to original condition.
- .3 Any dispute resulting from this shall be referred to the Consultant for decision.
- .4 Prior to any major cutting of walls or floor, review the proposed location, size and method with the Consultant. This includes notification when cutting or coring into any fire rated construction.

1.26 FIRE STOPPING

- .1 Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of ULC or cUL firestop systems to be used and manufacturer's installation instructions to comply with Section 01 33 00.
- .2 Submit material safety data sheets provided with product delivered to job-site.
- .3 Contractor shall provide complete fire stopping installation in compliance with the current edition of the BC Building Code. Refer to architectural drawings for locations and ratings of all fire rated assemblies and membranes.
- .4 Contractor shall engage and pay for services of an experienced installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary training to install manufacture's products per specified requirements. A supplier's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
- .5 Installer shall have minimum 3 years of experience with fire stop installation.
- .6 Seal all openings for conduit or sleeve penetrations in fire rated and smoke rated separations using approved materials.
- .7 All block outs and access slots to be sealed using approved fire stopping assembly. Provide full details for all fire stopping applications as they relate to each application.
- .8 Provide shop drawings for all fire stopping products, including assembly details as it relates to each application. Products shall be ULC approved as an assembly.
- .9 Allow for the destructive testing of 10% of fire stopping applications. Should installations not conform to manufacturer's details, an additional 25% of installation will be destructively tested and should there be more failures, the contract OR will be responsible to remove all fire stopping products and reinstall products correctly, at no additional cost to the owner.
- .10 The work is to be installed by a contractor with at least one of the following qualifications:
 - .1 FM 4991 Approved Contractor

- .2 UL Approved Contractor
- .3 Hilti Accredited Fire Stop Specialty Contractor
- .11 Contractor shall provide signed and sealed schedule S-B and S-C (professional design and field review by supporting Professional Engineer) signed by supporting Professional Engineer to the Engineer of Record.
- .12 Supporting registered Professional Engineer shall submit to the Engineer of Record complete design documentations, copies of reviewed shop drawings and submittals related to fire stopping installations, and complete field review reports with suitable photographs. Contractor shall ensure all shop drawing reviews, field reviews etc shall be performed in a timely fashion and all supporting documentation provided to the Engineer of Record as required during the course of the project (ie, to comply with the requirements of Building Inspection Department).
- .13 All documentation provided by the fire stopping contractor shall be included in operation and maintenance manuals.

1.27 PROTECTION OF EXPOSED LIVE EQUIPMENT

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

1.28 SPRINKLER PROTECTION

- .1 Provide drip covers or CSA Type 2 enclosure for all new surface mounted panelboards and cabinets in sprinklered rooms.
- .2 Provide drip covers for all communications backboards in sprinklered rooms.
- .3 Provide sprinkler covers for all communications racks in sprinklered rooms.

1.29 INSPECTIONS AND TESTS

- .1 Notify the Consultant and authorities having jurisdiction at least five (5) working days in advance when the installations will be ready for inspection or testing.
- .2 Test reports, signed by all attending authorities, shall be submitted to the Consultant through the General Contractor after successful completion of an inspection or test.
- .3 Conduct all tests in a thorough and complete manner to the satisfaction of the Consultant and pay for any fees incurred to complete tests.
- .4 Furnish the Consultant with a copy of Certificate of Inspection from B.C. Electrical Safety Branch indicating that all work has been satisfactorily completed and issued prior to final connection.

1.30 CLEAN UP

- .1 Vacuum clean all new raceways and any electrical equipment. Ensure that no debris or spare parts are left in any electrical equipment.
- .2 Any scrap material shall be removed from the site and disposed of by the Contractor.
- .3 At time of final cleaning, clean lighting reflectors, lenses and other lighting surfaces that have been exposed to construction dust and dirt.

1.31 SURPLUS MATERIALS

- .1 All material removed from existing site and not being reused in this contract shall be the property of the owner and delivered as directed by the owner's representative. Material as it becomes surplus shall be reviewed by the owner or owner's representative and that part considered of value to the owner shall be classed as surplus material, all other becomes scrap material, and shall be disposed of by the contractor.

1.32 SPARE PARTS

- .1 This contract calls for spare parts or material. These are to be provided new in unopened cartons to the owner at the time of substantial completion of the contract.
- .2 Provide owner with spare lamps in unopened cartons. Quantity of each lamp source type to be 10% of total project amount.
- .3 Obtain a signed receipt from the owner's representative for all these parts or materials and include a copy in the front of the maintenance manual. Without this receipt these items will be treated as a deficiency and the cost withheld at twice the estimated value by the Consultant.

1.33 AS BUILT DRAWINGS

- .1 Obtain two (2) sets of white prints for the sole purpose of recording changes in installation as they occur. One (1) set is to be used in the field for day-to-day recording, and one (1) set for submittal after completion.
- .2 These plans shall be kept up-to-date as changes occur and shall be available to be inspected by the Consultant.
- .3 Arrange and pay for the incorporation of any "as-built" changes to digital PDF plans and AutoCAD (Revit) plans on disks. These changes shall be of similar quality of presentation as the original plans. NOTE: All plans whether requiring as-built changes or not, shall be included in this disk.
- .4 **Should the contractor require the Electrical Consultant to prepare the as-built CAD (Revit) disk, the cost would be \$275 per plan, unless excessive changes have been required. Costs associated with such excessive changes should be included with the change orders.**
- .5 Update costs for the Revit model will be determined based on the extent of the work required.
- .6 These amended drawings shall be given to the Consultant at time of final inspections.
- .7 "As-built" drawings shall include the location and circuit numbers of junction boxes in ceiling spaces, and all conduit placed in or under poured concrete. Note normal depth of conduits below top of concrete slab.

1.34 OPERATING AND MAINTENANCE MANUALS

- .1 Submit **four sets** of operating and maintenance manuals for equipment or as requested by the general section of the contract. Include descriptive and technical data, all shop drawings, operating procedures, routine and preventative maintenance, wiring diagrams, spare parts lists, warranties, service companies, suppliers for replacement parts, test results, fire alarm certificate of verification, electrical inspection authority certificate and contract guarantee.

- .2 Submit documentation in **green colored** heavy duty three ring binders, with lettering on spine identifying: "OPERATING AND MAINTENANCE MANUAL", project title and system names.
- .3 Submit one copy for approval by Consultant prior to assembly of final sets.

1.35 DEMONSTRATION OF SYSTEMS

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

1.36 WARRANTY

- .1 Within a period of one year from the date of final acceptance of work, replace or repair at own expense any defect in workmanship or material. Reused material shall be operating satisfactorily at the time of final acceptance but subsequent failures are not the responsibility of this contractor.
- .2 Warranties for equipment having more than one year guarantee shall be made out to owner, and copies shall be provided in the maintenance manuals.
- .3 Maintenance from manufacturer and contractor of all equipment shall be included for first year, including all lamps except incandescent.

1.37 PAINTING

- .1 Arrange and pay for the painting of the devices noted in these specifications, in particular:
 - .1 exposed conduits and conduit fittings.
- .2 Painting shall be to match colour and finish of adjacent walls, with at least two coats of sprayed enamel paint to the satisfaction of the Consultant and architect.

1.38 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Provide a coordination/protective study and short circuit study of all equipment specified herein and submit for review.
- .2 Include the following:
 - .1 12/25 kV and 600V air circuit breaker overcurrent, overload, and ground fault devices
 - .2 347/600 and 120/208V panelboards, MCCs, emergency generator and switchgear, connecting feeder cables
 - .3 25 kV and 600V transformer damage curves, magnetizing currents for the transformer
 - .4 Locked rotor currents, acceleration times and damage curves for motors 75 HP and larger
 - .5 Generator overcurrent device, generator short circuit curves
 - .6 Any additional data necessary for successful completion of the coordination and short circuit study

- .3 Data shall clearly state the operating time in cycles of each breaker and indicate whether the time current curves for relays are inclusive of breaker trippings time or otherwise.
- .4 Prepare a summation chart showing all ratings and settings with easy reference to the appropriate curve.
- .5 Symmetrical and asymmetrical fault current calculations shall be submitted to verify the correct choice of the protective elements of the system.
- .6 Prepare a systems single line diagram on which the resultant short circuit values, device numbers and equipment ratings are shown.
- .7 Include a list of recommended settings for each relay.
- .8 Prepare an arc fault analysis including all labelling for equipment.
 - .1 Arc fault labels to indicate system voltage, fault level and PPE level required.
- .9 Qualifications
 - .1 This study shall be provided by the supplier of the main switchboard.
 - .2 This study shall be performed by and bear the stamp and signature of a Professional Engineer registered in the Province of British Columbia.
 - .3 Relay style, CT ratios and fuse sizes have been selected on a preliminary basis for design purposes. Final selection shall be based on the results of this study and shall be included at no extra cost.
- .10 Submittals
 - .1 Submit the complete study for review prior to carrying out calibration and verification.
 - .2 Submit typed results of coordination and short circuit study in maintenance manuals.

1.39 ARC FLASH HAZARD ASSESSMENT

- .1 The Electrical Contractor is to include in tender sum a cash allowance to retain the services of an Electrical Engineer to perform an arc flash hazard assessment of electrical power distribution equipment installed under this contract in accordance with NFPA-70E requirements and IEEE-1584 Guidelines. Refer to "Cash Allowances and Separate Prices" in this Section.
- .2 Arc flash hazard assessment is to take place at time of completion of power distribution equipment installation and is to include power system wide short circuit and protective device coordination study of the electrical equipment installed to determine arc flash hazard threshold incident energy level boundaries and PPE requirements at each distribution panel installed.
- .3 Printed warning labels to be provided for installation by the Electrical Contractor at each panel indicating the following:
 - .1 Flash hazard boundary (inches)
 - .2 Cal/cm² Flash hazard at 18 inches
 - .3 PPE level and required protective equipment
 - .4 Shock hazard in KV when cover is removed
 - .5 Available fault current level in KA

- .4 Single line drawing of the power distribution system indicating let-through energy level of each protective device and required PPE at each piece of equipment will be provided by the Engineer for posting by the Electrical Contractor under clear polycarbonate cover in the main electrical room.
- .5 Include copy of arc flash assessment in with maintenance manuals.

1.40 BUILDING MANAGEMENT SYSTEM INTERFACE

- .1 The lighting control system interface with the security and Building Management System (BMS) and energy monitoring system is part of this contract. The division of work is as follows:
 - .1 For the lighting control system, provide all the lighting control units, switches, dimmers, occupancy sensors, photo cells, etc. for a completely operational system. Provide interface cards and controllers for each relay cabinet and network them together and connect to the BMS and program the lighting control zones to function as per the grouping indicated.
 - .2 The relay cabinets and controllers provided must be able to provide two-way communications with the BMS to indicate the status of relays to the BMS and change the status of relays by receiving signal from the BMS. Contractor to allow for supplying relay cabinets with the same protocol (BACNET, LONWORK, etc.) as the BMS. No gateway allowed for interfacing between lighting relay panels and BMS. It must be the same protocol and this contractor must provide the relay cabinet from the manufacturer which can provide the same protocol as BMS system.
 - .3 For energy monitoring system, provide CT, PT and transducers as indicated on the single line diagram along with ½"C to the BMS. Confirm exact manufacturer and requirements for the above devices with Division 15 (and allow in the bid submission) before ordering and installing the devices and make sure the devices meet the specification required by Division 15.
 - .4 Provide power to all BMS/DDC panels and provide voice and data outlets as indicated on mechanical equipment schedule and mechanical drawings.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Refer to Section 01 35 18 of the General Requirements.

2.2 MANUFACTURERS AND CSA LABELS

- .1 Visible and legible, after equipment is installed.

2.3 MATERIALS AND EQUIPMENT

- .1 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Department.
- .2 Factory assemble control panels and component assemblies.

2.4 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on the electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule.
- .2 Control wiring and conduit is specified in [Division 16] [Divisions 26, 27, 28, 33, 34 and 48] except for conduit, wiring and connections below 50 V which are related to control systems specified in Mechanical Specifications and shown on mechanical drawings.

2.5 WARNING SIGNS

- .1 As specified and to meet the requirements of the BC Electrical Inspection Authority and the Consultant.
- .2 Decal signs, minimum size 175mm x 250mm.

2.6 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

2.7 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with [nameplates] [and] [labels] as follows:
- .2 Nameplates:
 - .1 Lamicoid 3mm thick plastic engraving sheet, mechanically attached with self tapping screws.
 - .2 Nameplate colors shall be as follows:
 - .1 Normal power: Black face with white letters;
 - .2 Life safety emergency power: Red face with white letters;
 - .3 Standby power: Blue face with white letters.
 - .3 Nameplate sizes shall be as follows

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters
- .3 Labels:
 - .1 Embossed plastic labels with 6mm high letters unless specified otherwise.
- .4 Wording on nameplates and labels to be approved by Consultant prior to manufacture.
- .5 Allow for average of twenty-five (25) letters per nameplate and label.
- .6 Identification to be English
- .7 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

- .8 *Identify equipment with Size 3 labels engraved "ASSET INVENTORY No. [___]".*
Number as and if directed by Consultant.
- .9 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .10 Terminal cabinets and pull boxes: indicate system and voltage.
- .11 Transformers: indicate capacity, primary and secondary voltages.

2.8 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code: to CSA C22.1 [latest edition].
- .4 Use colour coded wires in communication cables, matched throughout system.

2.9 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at [15] m intervals.
- .3 Colours: [25] mm wide prime colour and [20] mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION 26 05 00

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for seismic restraint systems for electrical installations.

1.2 REGULATORY REQUIREMENTS

- .1 Restraints shall meet the requirements of the latest edition of the British Columbia Building Code and amendments.
- .2 The Seismic Engineer shall be able to provide a proof of professional insurance and the related practice credentials, upon request. The Seismic Engineer shall be familiar with SMACNA, ECABC & NFPA guidelines as well as the BC Building Code requirements.
- .3 The Contractors Seismic Engineer shall submit original signed BC Building Code "Letters of Assurance" "Schedules B and C-B" to the Prime Consultant or Electrical Consultant.
- .4 The above requirements shall not restrict or supplant the requirements of any local bylaws, codes, or other certified agencies which may have jurisdiction over all or part of the installation.

1.3 SCOPE

- .1 Arrange and pay for services of a B.C. Registered professional structural engineer. This structural engineer, herein referred as the seismic engineer shall provide all required engineering services related to seismic restraints of electrical equipment.
- .2 It is the responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.
- .3 Manufacturer's shop drawings to be submitted with seismic information on equipment structure, bracing and internal components and as required by Division 01.
- .4 Provide restraint on all equipment and machinery, which is part of the building electrical services and systems, to prevent injury or hazard to persons and equipment in and around the structure. Restrain all such equipment in its normal position in the event of an earthquake.
- .5 The total electrical seismic restraint design and field review and inspection will be by a B.C. registered professional structural engineer who specializes in the restraint of building elements. Contractor to allow for coordination, provision of seismic restraints, as well as all costs for the services of the Seismic Restraint Engineer. This Engineer, herein referred to as the Seismic Engineer, will provide normal engineering functions as they pertain to seismic restraint of electrical installations.

- .6 The Contractor shall be aware of, and comply with, all current seismic restraining requirements and make provision for those that may come into effect during construction of the project. Make proper allowance for such conditions in the tender.
- .7 The Seismic Engineer shall provide detailed seismic restraint installation shop drawings to the Contractor. Copies of the shop drawings to be included in the final project manual.
- .8 Provide seismic restraints on all equipment, and/or installations or assemblies, which are suspended, pendant, shelf mounted, freestanding and/or bolted to the building structure or support slabs.
- .9 The Seismic Engineer shall provide inspections during and after installation. The Contractor shall correct any deficiencies noted without additional cost to the contract.
- .10 Include all costs associated with the Seismic installation and certification in the base tender.

1.4 SHOP DRAWINGS & SUBMITTALS

- .1 Submit shop drawings of all seismic restraint systems including details of attachment to the structure, either tested in an independent testing laboratory or approved by the seismic Engineer.
- .2 Submit all the proposed types and locations of inserts or connection points to the building structure or support slabs. Follow the directions and recommendations of the Seismic Engineer.

Part 2 Products

2.1 SLACK CABLE SYSTEMS

- .1 Slack cable restraint systems shall be as designed and supplied by Vibra-Sonic Control or equal.
- .2 Slack cable restraints shall be provided on suspended and shelf mounted transformers along with associated equipment and assemblies connected to them at the points of vertical support (4 points). The restraint wires shall be oriented at approximately 90° to each other (in plan), and tied back to the ceiling slab or its structure at approximately 45° to the slab or basic structure. The restraints shall be selected for a 1 g earthquake loading, i.e. each wire shall have a working load capacity equal to the weight of the transformer. The anchors in the structure shall be selected for a load equal to the weight of the transformers at a 45° pull.
- .3 Slack cable systems to allow normal maintenance of equipment and shall not create additional hazard by their location or configurations. Contractor shall rectify any such installations at no additional cost, all to the satisfaction of the engineer and inspection authority having jurisdiction.
- .4 Coordinate requirements of slack cables with suppliers prior to installation.

Part 3 Execution

3.1 GENERAL

- .1 All seismic restraints systems shall conform to local authority having jurisdiction and all applicable code requirements.

3.2 CONDUITS

- .1 Provide restraint installation information and details on conduit and equipment as indicated below:
- .2 Vertical Conduit:
 - .1 Attachment - Secure vertical conduit at sufficiently close intervals to keep the conduit in alignment and carry the weight of the conduits and wiring. Stacks shall be supported at their bases and, if over 2 stories in height, at each floor by approved metal floor clamps.
 - .2 At vertical conduit risers, wherever possible, support the weight of the riser, at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 9.2 m o.c.
 - .3 Riser joints shall be braced or stabilized between floors.
- .3 Horizontal Conduits:
 - .1 Supports - Horizontal conduit shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.
 - .2 EMT tubing - tubing shall be supported at approximately 1.2 m intervals for tubing.
- .4 Provide transverse bracing at 12.2 m intervals maximum unless otherwise noted. Provide bracing at all 90° bend assemblies, and pull box locations.
- .5 Provide longitudinal bracing at 24.4 m intervals maximum unless otherwise noted.
- .6 Do not brace conduit runs against each other. Use separate support and restraint system.
- .7 Support all conduits in accordance with the capability of the pipe to resist seismic load requirements indicated.
- .8 Trapeze hangers may be used. Provide flexible conduit connections where conduits pass through building seismic or expansion joints, or where rigidly supported conduits connect to equipment with vibration or seismic isolators.
- .9 A conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
- .10 Provide large enough conduit sleeves through walls or floors to allow for anticipated differential movements with firestopping where required.

- .11 It is the responsibility of the contractor to ascertain that an appropriate size restraint device be selected for each individual piece of equipment. Submit details on shop drawings. Review with seismic Engineer and submit shop drawings to consultants for their reference.

3.3 FLOOR MOUNTED EQUIPMENT

- .1 Bolt all equipment, e.g. transformers, switchgear, generators, motor control centres, free standing panelboards, control panels, capacitor banks, etc. to the structure. Design anchors and bolts for seismic force applied horizontally through the center of gravity to a seismic force of 0.5g. For equipment which may be subject to resonances, use a nominal 1.0 g seismic force.
- .2 Provide flexible conduit connections between floor mounted equipment to be restrained and its adjacent associated electrical equipment.

3.4 LIGHT FIXTURES

- .1 LED fixtures in suspended ceilings shall be hung independently of the ceiling system. Fixtures shall be secured to concrete or structural deck above by at least two seismic cables which are connected to the fixture at diagonal points.
- .2 Surface and recessed style fixtures shall be hung independently of the ceiling system. Fixtures shall be secured to concrete or structural deck above by seismic cables.
- .3 Fixtures which are hung independently of ceiling systems shall have minimum of one seismic cable in addition to the chain or cable used to support the fixture. Seismic restraint cables shall be secured into the concrete or structural deck above.
- .4 Cables shall be corrosion resistant and approved for the application.
- .5 Fixtures which are rod hung shall have seismic ball alignment fittings at the ceiling and fixture.

END OF SECTION 26 05 01

Part 1 General

1.1 DESCRIPTION

- .1 The purpose of this section is to guide the electrical contractor with responsibilities in the commissioning process, which are being directed by the Commissioning Authority. Other electrical systems testing is specified in other electrical sections.
- .2 Commissioning requires the participation of the Electrical Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in the Commissioning Authority's Commissioning Plan. The Electrical Contractor shall be familiar with all parts of the commissioning plan issued by the Commissioning Authority, and shall execute all commissioning responsibilities assigned to them in the Contract Documents.
- .3 Electrical systems requiring testing and commissioning include the following:

	Commission for Commissioning Authority	Commission Under General Contract
.1 Lighting Controls	Yes	Yes
.2 Back-up Generator	Yes	Yes
.3 Fire Alarm System	No	Yes
.4 Data/Communications System	No	Yes
.5 Information Digital Metering System	Yes	Yes
.6 Power Distribution Equipment	No	Yes
.7 Exit Signs & Emergency Lighting	No	Yes
.8 Public Address System	Yes	Yes
.9 Metering System	Yes	Yes
.10 Automatic Transfer Switches	Yes	Yes
.11 Access Controls System	Yes	Yes
.12 Video Surveillance System	Yes	Yes
.13 Fire Alarm System	Yes	Yes

1.2 RESPONSIBILITIES

- .1 Electrical Contractors. The commissioning responsibilities applicable to the electrical contractor are as follows (*all references apply to commissioned equipment only*):
 - .1 Construction and Acceptance Phases
 - .1 Include the cost of commissioning in the contract price.
 - .2 In each purchase order or subcontract written, include requirements for submittal data, O&M data, and training.
 - .3 Attend a commissioning scoping meeting and other necessary meetings scheduled by the Commissioning Authority to facilitate the commissioning process.
 - .4 Electrical shop drawings to be reviewed by the Consultants and forwarded to the Commissioning Authority via the Architect.

- .5 Provide additional requested documentation, prior to normal O&M manual submittals, to the Commissioning Authority for development of start-up and functional testing procedures.
- .6 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, performance expectations, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
 - .1 The Commissioning Authority may request further documentation necessary for the commissioning process.
 - .2 This data request may be made prior to normal submittals.
 - .3 Provide a copy of the O&M manual submittals of commissioned equipment, through normal channels, to the Consultant, who will review and reject or approve, then forward the approved manual to the Commissioning Authority for review and approval.
 - .4 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - .5 Provide to the Consultant and the Commissioning Authority the specific functional performance test procedures required for the commissioning. Subs shall review test procedures to ensure feasibility, safety, and equipment protection and provide necessary written alarm limits to be used during the tests.
 - .6 Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the pre-functional checklists. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to Commissioning Authority for review.
- .7 Conduct and Record Equipment and System Commissioning:
 - .1 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present in accordance with the agreed-upon schedules, and for sufficient duration, to complete the necessary tests, adjustments and problem solving.
 - .2 During the startup and initial checkout process, execute and document the electrical-related portions of the pre-functional checklists for all commissioned equipment.
 - .3 Perform and clearly document all completed startup and system operational checkout procedures, and provide a completed and signed copy to the Consultant and the Commissioning Authority.
 - .4 Address current A/E punch list items before functional testing.

- .5 Perform functional performance testing under the direction of the Consultant and the Commissioning Authority for the specified equipment. Assist the Consultant and Commissioning Authority in interpreting the monitored data and test results, as necessary.
 - .6 Correct deficiencies (differences between specified and observed performance) as interpreted by the Consultant and the Commissioning Authority, PM and A/E and retest the equipment.
 - .7 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original equipment, performance and sequences of operation to as-built conditions.
 - .8 Prepare red-line, as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.
 - .9 Provide training of the Owner's operating personnel as specified.
 - .10 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
 - .11 Prior to Final Completion of the Work, the responsible contractors shall certify that they have provided all the materials, installation and/or services specified in the Contract Documents, Addendums and Change Orders. Completion of the following sheet, with signatures of the contractually responsible parties, is required and represents such certification.
- .2 Warranty Period
- .1 Execute seasonal or deferred functional performance testing, witnessed by the Commissioning Authority, according to the specifications.
 - .2 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

Part 2 Products

2.1 TEST EQUIPMENT

- .1 The Electrical Contractor shall provide all test equipment necessary to fulfil the testing requirements of this Division.

Part 3 Execution

3.1 SUBMITTALS

- .1 The Electrical Contractor shall provide the required commissioning submittal documentation to the Consultant and the Commissioning Authority, as indicated and requested by the Commissioning Authority.

3.2 STARTUP

- .1 The electrical contractors shall follow the start-up and initial checkout, as approved by the Commissioning Authority. The Electrical Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design and performance objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Authority or Owner.

- .2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the Commissioning Authority. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all pre-functional checklists as soon as possible.

3.3 FUNCTIONAL PERFORMANCE TESTS

- .1 Perform function performance tests for all electrical systems.

3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

- .1 Provide testing documentation as required by the Consultant and Commissioning Authority.
- .2 Collect shop drawings for equipment, maintenance procedures and recommended maintenance schedules for equipment, switchgear schedules, and warranties from all contractors.
- .3 Compile 3 copies of all the items mentioned in the preceding sentence. Enclose these in labelled 3-ring binders. Submit 3 copies to Consultant for review. Make modifications until consultant and Commissioning Authority approve these O&M Manuals.

3.5 OPERATIONS AND MAINTENANCE (O&M) MANUALS

- .1 The Electrical Contractor shall compile and prepare documentation for all equipment and systems covered in the Electrical contract for inclusion in the O&M manuals.
- .2 The Commissioning Authority shall receive a copy of the O&M manuals (after approval by the Consultant) for review.

3.6 TRAINING OF OWNER PERSONNEL

- .1 The Commissioning Authority and the Consultant and shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment or systems.
- .2 Electrical Contractor. The electrical contractor shall have the following training responsibilities:
 - .1 Provide the Commissioning Authority with a training plan two weeks before the planned training.
 - .2 Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
 - .3 Training shall start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
 - .4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 - .5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise, as well as in-depth knowledge of all modes of operation of the specific piece of equipment, are required. More than one party may be required to execute the training.

- .6 The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
- .7 Training shall include:
 - .1 Use the printed installation, operation, and maintenance instruction material included in the O&M manuals.
 - .2 Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance; special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover, and any emergency procedures.
 - .3 Discuss relevant health and safety issues and concerns.
 - .4 Discuss warranties and guarantees.
 - .5 Cover common troubleshooting problems and solutions.
 - .6 Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
 - .7 Discuss any peculiarities of equipment installation or operation.
 - .8 Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and maintenance of all pieces of equipment.
 - .9 The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not *controlled* by the central control system.
- .8 Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

END OF SECTION 26 05 03

Part 1 General

1.1 SECTION INCLUDES

- .1 This section includes materials and installation for tested firestopping systems as follows:
 - .1 Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
 - .2 Openings between structurally separate sections of wall or floors.
 - .3 Gaps between the top of walls and ceilings or roof assemblies.
 - .4 Expansion joints in walls and floors.
 - .5 Openings and penetrations in fire-rated partitions or walls containing fire doors.
 - .6 Openings around structural members which penetrate floors or walls.

1.2 REFERENCES

- .1 Test Requirements: ULC-S115-M or CAN4-S115-M, "Standard Method of Fire Tests of Through Penetration Fire Stops".
- .2 Test Requirements: UL 2079, "Tests for Resistance of Building Joint Systems" or ASTM E 1966, "Standard test method for Fire Resistive Joint Systems" . These test requirements provide more guidelines for testing moving joints than that given in CAN4-S115-M. UL tests that meet the requirements of ULC-S115-M are given a cUL listing and are published by UL in their "Products Certified for Canada (cUL) Directory
- .3 Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops."
- .4 Test Requirements: ASTM E 2307, "Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus"
- .5 International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments
- .6 CAN/ULC-S102-M, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .7 All major building codes: NBC, BCBC, and VBBL.
- .8 NFPA 101 - Life Safety Code
- .9 Canadian Electrical Code

1.3 QUALITY ASSURANCE

- .1 A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- .2 Firestop System installation must meet requirements of CAN4-S115-M, ULC S-115-M or UL 2079 tested assemblies that provide a fire rating as shown in Section 2.03 Clauses P, Q & R below.
- .3 Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

- .4 Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

1.4 SUBMITTALS

- .1 Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of ULC or cUL firestop systems to be used and manufacturer's installation instructions to comply with Section 01 33 00.
- .2 Submit material safety data sheets provided with product delivered to job-site.

1.5 INSTALLER QUALIFICATIONS

- .1 Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary training to install manufacture's products per specified requirements. A supplier's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
- .2 The work is to be installed by a contractor with at least one of the following qualifications:
 - .1 FM 4991 Approved Contractor
 - .2 UL Approved Contractor
 - .3 Hilti Accredited Fire Stop Specialty Contractor
- .3 Installer shall have minimum 3 years of experience with fire stop installation. Submit project names.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and ULC or cUL label where applicable.
- .2 Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.
- .3 Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
- .4 Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- .5 Do not use damaged or expired materials.

1.7 PROJECT CONDITIONS

- .1 Do not use materials that contain flammable solvents.
- .2 Scheduling
 - .1 Schedule installation of CAST IN PLACE firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.
 - .2 Schedule installation of Drop-In firestop devices after placement of concrete but before installation of the pipe penetration. Diameter of sleeved or cored hole to match the listed system for the device
 - .3 Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.
- .3 Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

- .4 Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.
- .5 During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

Part 2 PRODUCTS

2.1 FIRESTOPPING, GENERAL

- .1 Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- .2 Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- .3 Firestopping Materials are either "cast-in-place" (integral with concrete placement) or "post installed." Provide cast-in-place firestop devices prior to concrete placement.

2.2 ACCEPTABLE MANUFACTURERS

- .1 Hilti (Canada) Corporation
- .2 EZ-Path

2.3 MATERIALS

- .1 Use only firestop products that have been ULC or cUL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

Part 3 EXECUTION

3.1 PREPARATION

- .1 Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
 - .1 Verify penetrations are properly sized and in suitable condition for application of materials.
 - .2 Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
 - .3 Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
 - .4 Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
 - .5 Do not proceed until unsatisfactory conditions have been corrected.

3.2 COORDINATION

- .1 Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

- .2 Responsible trade is to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interference.

3.3 INSTALLATION

- .1 Regulatory Requirements: Install firestop materials in accordance with ULC Fire Resistance Directory or UL Products Certified for Canada (cUL) Directory or Omega Point Laboratories Directory.
- .2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration and construction joint materials.
 - .1 Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
 - .2 Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of ULC or cUL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
 - .3 Protect materials from damage on surfaces subjected to traffic.

3.4 FIELD QUALITY CONTROL

- .1 Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
- .2 Keep areas of work accessible until inspection by authority having jurisdiction.
- .3 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard.
- .4 Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

3.5 IDENTIFICATION

- .1 Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
 - .1 The words: "Warning -Through Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
 - .2 Contractor's Name, address, and phone number.
 - .3 Through-Penetration firestop system designation of applicable testing and inspecting agency.
 - .4 Date of Installation.
 - .5 Through-Penetration firestop system manufacturer's name.
 - .6 Installer's Name.

END OF SECTION 26 05 10

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies the materials and installation for wire and box connectors, rated to 1000V.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2No.18 latest edition, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2No.65 latest edition, Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, latest edition, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for stranded copper conductors.
 - .2 Clamp for stranded copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors.
 - .5 Sized for conductors as indicated.
- .4 Clamps or connectors for armoured cable as required to CAN/CSA-C22.2No.18.

Part 3 Execution

3.1 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
 - .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
 - .3 Install fixture type connectors and tighten. Replace insulating cap.
 - .4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

END OF SECTION 26 05 20

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies copper, ACM alloy and aluminum conductors rated 0-1000 Volts and the most common electrical insulation and covering materials.
- .2 This section does not include fire rated building wire to ULC S139 and CSA C83, marine, hazardous, mining, instrumentation, communication and fire alarm wiring.

1.2 REFERENCES

- .1 CSA C22.2 No .0.3 latest edition, Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 131 latest edition, Type TECK 90 Cable.

1.3 GENERAL REQUIREMENTS

- .1 Typically use insulated 98% conductivity copper conductor wiring enclosed in EMT (steel) conduit for the general wiring systems unless otherwise indicated.
- .2 Aluminium conductors only permitted where indicated on drawings and then typically only for feeder conductors larger than 100 A. All conductor sizes indicated on drawings are based on copper conductors unless otherwise noted.
- .3 Teck cable may only be used where specifically indicated on the drawings or in the specifications. Where permitted, Teck wiring up to 750 system volts to be PVC jacketed armoured cable, multi-copper conductor type Teck90 1000 volt having a PVC jacket with FT-4 flame spread rating.
- .4 Flexible AC90 armoured cabling (BX) **shall not** be used for the general wiring system other than final drops to recessed light fixtures in concealed locations.
- .5 Cabling indicated to be 2-Hour Fire-Rated shall be compliant to CAN/ULC-S139 and CSA 38-95 (Draka Lifeline, Raychem RHW, or Shawflex). Cabling shall be low smoke halogen free. Conduit to be sized and installed as per manufacturers' requirements for these specialized cables and assemblies regardless of the size indicated on drawings.
- .6 Provide all control wiring except HVAC controls as specified in Mechanical Divisions.
- .7 Refer to Equipment Schedule(s) for detailed responsibilities.
- .8 Non-metallic sheathed wiring is not to be used on this project.

Part 2 Products

2.1 WIRE AND CABLE GENERAL

- .1 Conductors: stranded for 10 AWG and larger. Minimum size #12 AWG.
- .2 Insulation to be 600volt RW90XLPE (X link) for the general building wiring in conduit.
- .3 Use RWU90XLPE for underground installations.
- .4 Site services sub-circuits, including site lighting, to be minimum #10 AWG for power and #12 for controls. Increase wiring size for lengthy and/or loaded circuits so that system will not exceed the maximum voltage drop as recommended by the Canadian Electrical Code CSA 22.1 [latest edition].
- .5 Main feeders to be conduit and copper insulated wiring unless otherwise noted on drawings. Provide ground wiring for all conduits in or below slabs. Increase conduit size as required.

- .6 Armoured AC90 (BX) cable may only be utilized for recessed tee bar luminaire drops from ceiling mounted outlet boxes. "Tite Bite" connectors and their counterparts of other manufacturers shall not be used. Use anti-short connectors. Cable from luminaire to luminaire is discouraged. Allow nominally 900mm [3'] extra cable looped and supported in the ceiling space to permit fixture relocations of one tile space.
- .7 TBS90 #14 AWG stranded shall be used in all switchgear assemblies. Current transformer secondary wiring shall be #12 AWG stranded. Current transformer leads shall incorporate ring type tongues for termination purposes.
- .8 Conductors to be colour-coded. Conductors No.10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No.8 gauge and larger may be colour-coded with adhesive colour coding tape, but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible. Where colour-coding tape is utilized, it shall be applied for a minimum of 50 mm at terminations, junctions and pullboxes and conduit fittings. Conductors not to be painted.

2.2 TECK CABLE

- .1 Cable: to CAN/CSA-C22.2 No. 131-17.
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
 - .1 Type: ethylene propylene rubber.
 - .2 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking galvanized steel or aluminum.
- .6 Overall covering: polyvinyl chloride material.
- .7 Fastenings:
 - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables at 1000 mm centers.
 - .3 Threaded rods: 6 mm dia. to support suspended channels.
- .8 Connectors:
 - .1 Watertight approved for TECK cable.

2.3 ARMoured CABLES

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from galvanized steel or aluminum strip.

2.4 ARMoured FIRE ALARM CABLE

- .1 Use flexible armoured fire alarm cable from junction box to ceiling mounted fire alarm device.
- .2 Type: SECUREX® II cable, fire rated to CSA FT4 requirements.
- .3 Armour: interlocked aluminum tape armour. Cable armour shall be colour coded "red".

2.5 CONTROL CABLES

- .1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.
- .2 Low energy 300 V control cable: solid annealed copper conductors sized as indicated, with TWH over each conductor and overall covering of PVC jacket.
- .3 600 V type: stranded copper conductors, sizes as indicated with R90 (x-link) ethylene-propylene rubber insulation type over each conductor and overall covering of PVC jacket.

Part 3 Execution

3.1 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings.
 - .2 In cable trays for electrical systems in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.
 - .3 In underground ducts in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings.
 - .4 In trenches in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings.
 - .5 In underfloor distribution system in accordance with Section 26 05 39 - Underfloor Raceways for Electrical Systems.
 - .6 In surface and lighting fixture raceways in accordance with Section 26 05 35 - Surface and Lighting Fixture Raceways.
 - .7 In wireways and auxiliary gutters in accordance with Section 26 05 37 - Wireways and Auxiliary Gutters.
 - .8 All wires are to be pulled in together in a common raceway, using liberal amounts of Compound 77 lubricant.
 - .9 All power circuits connected to isolated ground type receptacles are to have individual separate neutral c/w insulated bonding conductor.
 - .10 No combining of circuits onto common neutral will be permitted. Use 2 pole or 3 pole breakers for combined circuits, no connector clips will be allowed.
 - .11 Ensure that all single phase loadings are reasonably closely balanced over the main feeders.
 - .12 All dimmer circuits are to have individual neutral conductors for each circuit.

3.2 INSTALLATION OF TECK CABLE 0 -1000 V

- .1 Install cables.
 - .1 Group cables wherever possible on channels.
- .2 Install cable in trenches in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings.
- .3 Lay cable in cable trays for electrical systems in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.

- .4 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

3.3 INSTALLATION OF ARMOURED CABLES

- .1 Group cables wherever possible.
- .2 Install cable in trenches in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings.
- .3 Lay cable in cable trays for electrical systems in accordance with Section 05 36 - Cable Trays for Electrical Systems.
- .4 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

3.4 INSTALLATION OF ALUMINUM SHEATHED CABLE

- .1 Group cables wherever possible on channels.
 - .1 Install cable in trenches in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings.
- .2 Lay cable in cable trays for electrical systems in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.
- .3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

3.5 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in conduit.
- .2 Ground control cable shield.

END OF SECTION 26 05 21

Part 1 General

1.1 SECTION INCLUDES

- .1 This section includes materials and installation for connectors and terminations.

1.2 REFERENCES

- .1 CSA C22.2 No.41- Grounding and Bonding Equipment.

1.3 CERTIFICATES

- .1 Obtain inspection certificate of compliance covering high voltage stress coning from Inspection Authority and include it with maintenance manuals].

Part 2 Products

2.1 CONNECTORS AND TERMINATIONS

- .1 [Copper] [Aluminum] compression connectors as required sized for conductors.
.2 Contact aid for aluminum cables where applicable.
.3 Joint boxes in accordance with Section [26 05 33 - Raceway and Boxes for Electrical Systems].
.4 Junction boxes with respective pothead for cables [for enclosing stress - cone within] [for [paper-insulated lead-sheathed]

Part 3 Execution

3.1 INSTALLATION

- .1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.
.2 Bond and ground as required to CSA C22.2 No.41.

END OF SECTION 26 05 22

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies the materials and installation for grounding electrical systems rated 750V or less.

1.2 REFERENCES

- .1 ANSI/IEEE 837- 2004 – Standard for Qualifying Permanent Connections Used in Substation Grounding.
- .2 CSA C22.2 No. 41 - 2007 – Grounding and Bonding Equipment.

Part 2 Products

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .2 Copper conductor: minimum 3 m long for each concrete encased electrode, bare, stranded, soft annealed, size [as indicated].
- .3 Rod electrodes: copper clad steel 19 mm dia by 3 m long.
- .4 Plate electrodes: galvanized steel, surface area 0.2 m², 1.6 mm thick.
- .5 Grounding conductors: bare stranded copper, soft annealed, size as indicated.
- .6 Insulated grounding conductors: green, type RW90.
- .7 Ground bus: copper, size as required, complete with insulated supports, fastenings, connectors.
- .8 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Thermit welded type conductor connectors.
 - .5 Bonding jumpers, straps.
 - .6 Pressure wire connectors.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where conduit is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to conductive water main, electrodes, using permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.

- .6 Soldered joints not permitted.
- .7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Install separate ground conductor to outdoor lighting standards.
- .10 Connect building structural steel and metal siding to ground.
- .11 Make grounding connections in radial configuration only. Avoid loop connections.
- .12 Bond single conductor, metallic armoured cables to cabinet at supply end and load end.
- .13 Ground secondary service pedestals.

3.2 ELECTRODES

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter.
- .2 Install water meter shunt.
- .3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
- .4 Install rod electrodes and make grounding connections.
- .5 Bond separate, multiple electrodes together.
- .6 Use size 3/0 AWG copper conductors for connections to electrodes.
- .7 Make special provision for installing electrodes that will give resistance to ground values that meet CEC requirements where rock or sand terrain prevails. Ground as indicated.

3.3 SYSTEM AND CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to neutral of secondary system.

3.4 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting.

3.5 GROUNDING BUS

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical room.
- .2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 3/0 AWG.

3.6 COMMUNICATION SYSTEMS

- .1 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:
 - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
 - .2 Sound, fire alarm, intercommunication systems as indicated.

3.7 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

END OF SECTION 26 05 28

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies U shape support channels either surface mounted. Suspended or set in poured concrete walls or ceilings.

Part 2 Products

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41mm, 2.5mm thick, surface mounted, suspended, or set in poured concrete walls and ceilings.

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to surfaces with lead anchors or nylon shields as required.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels at 1.5m on centre spacing.

- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION 26 05 29

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for splitters, junction boxes, pull boxes and cabinets.

1.2 PRODUCT DATA

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: submit manufacturer's product data sheets indicating dimensions, materials, and finishes, including classifications and certifications.
- .3 Shop Drawings: submit shop drawings for custom manufactured items showing materials, finish, dimensions, accessories, layout, and installation details.

Part 2 Products

2.1 SPLITTERS

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2 JUNCTION AND PULL BOXES

- .1 Welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.3 CABINETS

- .1 Sheet steel cabinet, with full length hinged door, latch, lock, 2 keys, containing 19mm G1S fir plywood backboard (if required) for surface or flush mounting as required.
- .2 Include filtered vents and/or fan-cooling when enclosed equipment is heat producing.

Part 3 Execution

3.1 SPLITTER INSTALLATION

- .1 Install splitters and mount plumb, true and square to the building lines.

- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor.
- .3 Install terminal blocks as required.
- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

3.3 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.
- .2 Install size 2 identification labels indicating system name, voltage and phase, as appropriate to clearly indicate the enclosure use.

END OF SECTION 26 05 31

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies rigid and flexible fasteners, fittings and installation.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES - GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped. Do not use sectional boxes.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347V outlet boxes for 347V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. Larger 102 mm square x 54mm deep outlet boxes (No. 52151 or 52171) to be used when more than one conduit enters one side. Provide extension and plaster rings as required.
- .2 For larger boxes use GSB solid type as required.
- .3 Boxes for surface mounted switches, receptacles, communications, telephone to be 100mm square No. 52151 or 52171 with Taylor 8300 series covers.
- .4 Lighting fixture outlets: 102 mm square outlet boxes (No 52151, 52171 or 72171) or octagonal outlet boxes (No 54151 or 54171).
- .5 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster and/or tile walls.

2.3 MASONRY BOXES

- .1 Electro-galvanized steel masonry single and multi gang type MDB boxes for devices flush mounted in exposed block walls.
- .2 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.4 FLOOR BOXES (POKE-THROUGHS)

- .1 Floor boxes shall have 8" poke-throughs below table, locations and quantities as indicated on plan, for power and data. Each poke-through shall have a minimum of five-gang capacity. Boxes shall be suitable for installation within a cored hole with access from below or come with removable cast-in-place pre-pour sleeve to avoid coring. Boxes shall maintain a minimum 2-hour fire rating at the floor and shall have adjustable, hinged, gasketed auto-close egress cover which can be closed while devices are connected. Standard of acceptable: Legrand Wiremold 8AT series with flanged solid cover or approved equivalent. Satin Nickel Finish. Confirm the finish with the Architect during shop drawing.

2.5 SURFACE CONDUIT BOXES

- .1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

2.6 FITTINGS – GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of foreign materials.
- .3 Conduit outlet bodies for conduit up to 35 mm. Use pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

- .1 Typical outlet box mounting heights are indicated in Section 26 05 00 or refer to wiring device and communication specification sections and to architectural layouts for particular mounting heights of outlet boxes where indicated.
- .2 Support boxes independently of connecting conduits.
- .3 Ceiling outlet boxes to be provided for each surface mounted fixture or row of fixtures installed in other than T bar ceilings with removable tiles.
- .4 Fill open boxes with paper, sponges, foam or similar approved material to prevent entry of construction material. Remove upon completion of work.
- .5 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .6 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not to be used.

- .7 All outlet boxes to be flush mounted in all areas, excluding mechanical rooms, electrical rooms, and above removable ceilings.
- .8 Adjust position of outlets in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes. All cutting of masonry work for installation of electrical fittings to be done using rotary cutting equipment.
- .9 No sectional or handy boxes to be installed.
- .10 Provide vapour barrier wrap or boots behind outlets mounted in exterior walls. Maintain integrity of the vapour barrier and insulation to prevent condensation through boxes.
- .11 Coordinate location and mounting heights of outlets above counters, benches, splash-backs and with respect to heating units and plumbing fixtures. Coordinate with architectural details.
- .12 Outlets installed back to back in party stud walls to be off-set by one stud space.
- .13 Back-boxes for all communications systems equipment to be provided in accordance with specific manufacturer's recommendations and as specified in the communications sections of these specifications.
- .14 Separate outlets located immediately alongside one another to be mounted at exactly the same height above finished floor. Similarly, outlets mounted on a wall in the same general location at varying heights to be on the same vertical centre-line unless otherwise noted.
- .15 Where outlet boxes penetrate through a fire separation, ensure that the boxes are externally tightly fitted with an approved non-combustible material to prevent passage of smoke or flame in the event of a fire.

END OF SECTION 26 05 32

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies rigid and flexible conduits, fasteners, fittings and installation.

1.2 REFERENCES

- .1 Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware: to CSA C22.2 No. 18.
- .2 Rigid metal conduit (RMC): to CSA C22.2 No. 45.
- .3 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .4 Electrical metallic tubing (EMT): to CSA C22.2 No. 83.
- .5 Rigid PVC conduit: to CSA C22.2 No. 211.2.
- .6 PVC (DB2) conduit: to CSA #C22.1 211-1.
- .7 Flexible metal conduit (FMC): to CSA C22.2 No. 56.
- .8 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3.

1.3 BASIC WIRING METHODS

- .1 Underground or in concrete exterior to building:
 - .1 All wiring shall be in Schedule 40 RPVC conduit.
- .2 Concrete walls and slabs interior to building:
 - .1 All wiring shall be in Schedule 40 RPVC conduit.
- .3 Partition walls and ceilings:
 - .1 All wiring to be run in EMT conduit for:
 - .1 Branch circuits.
 - .2 Fire alarm.
 - .3 Low voltage systems.
 - .4 Distribution feeders and sub-feeders.
 - .5 Surface wiring in electrical and mechanical rooms.
- .4 T-bar ceilings:
 - .1 EMT to junction box with flexible armoured cable drops for individual luminaires. No feed through wiring to luminaires allowed, except for where luminaires butted together. Allow adequate cable to relocate luminaire one T-bar space in any direction.
- .5 Motors, transformers and all vibrating equipment:
 - .1 Short (600mm to 1200mm) PVC jacketed flexible conduit with liquid tight connectors shall be used. Allow sufficient slack to avoid strain on connectors at extreme extension of equipment movement.
- .6 Surface raceways - interior:
 - .1 All surface raceways shall be EMT, except if located without protection in areas susceptible to damage, which shall be rigid steel conduit.

- .7 Surface raceways - exterior:
 - .1 All surface raceways shall be UV compensated Schedule 40 RPVC conduit, protected from damage and excessive heating to the Consultant's satisfaction.

1.4 LOCATION

- .1 Electrical drawings are diagrammatic and do not show all conduits, wire, cable, etc. Electrical contractor to provide conduit, wire cable, etc., for a complete operating job to meet in all respects the intent of the drawings and specifications.
- .2 Outlet positions shown on architectural drawings (plans and elevations) to take precedence over locations and mounting heights indicated on electrical plans or in specifications.
- .3 Locate electrical devices on walls with regard given for convenience of operation and conservation of wall space. Switches, receptacles, fire alarm pull stations, etc. generally to be vertically lined up where items are in the same general location. Adjacent common devices to be installed in common outlet box.
- .4 Review the exact location criteria of each electrical outlet and device with the Architect and Consultant prior to rough-in. Relocate any item installed without architectural confirmation as required by the architect or Consultant at no cost to the owner as long as the relocation is within 3m of the location originally shown on the electrical drawings.
- .5 Do not install outlets back-to-back in party walls; allow a minimum of one stud space horizontal clearance between boxes. Install behind all outlets in party walls a Lowry Acoustic backing pad.
- .6 Locate light switches on latch side of doors. Locate disconnect devices in mechanical rooms on latch side of door.
- .7 All outlets located on exterior walls to be complete with moulded plastic vapour barriers to maintain integrity of wall vapour barrier system.
- .8 All raceways and wiring shall be installed concealed in building fabric, except for mechanical and electrical rooms where they shall be installed on the surface.
- .9 All outlet boxes, junction boxes, and cabinets to hold electrical devices shall be mounted so the equipment can be flush mounted unless indicated otherwise.
- .10 All junction boxes and other raceway access devices shall be mounted to avoid being visible from public areas. Obtain approval from Architect or Consultant for any and all junction boxes that, due to the building design, cannot be concealed.
- .11 All junction boxes mounted, out of necessity, on surface of solid walls shall be painted to match adjacent surface, with junction boxes painted to match designated systems.

Part 2 Products

2.1 RIGID PVC RACEWAY SYSTEM

- .1 Rigid PVC fittings shall be of the same manufacturer as the conduit.
- .2 PVC boxes and covers shall be Sceptre "F" Series or equivalent complete with all components and adaptors.
- .3 PVC junction boxes exceeding the size of "F" Series shall be Sceptre: "JB" Series boxes and be complete with junction box adaptors.
- .4 All fittings with removable covers shall be complete with VC gaskets and brass securing screws and inserts. All metal components shall be brass or stainless steel.

2.2 PVC DUCT RACEWAY

- .1 PVC duct fittings shall be of the same manufacturer as duct.
- .2 PVC duct shall be colour coded white for communications, grey for power.

2.3 EMT RACEWAY

- .1 Electrical Metallic Tubing (EMT) shall be galvanized steel of sufficient quality and thickness to allow smooth field formed bends.
- .2 EMT couplings, connectors and fittings shall be steel. Cast type units shall not be used on this installation.

2.4 PVC JACKETED FLEXIBLE CONDUIT

- .1 PVC jacketed flexible conduit (liquid tight) shall be interlocking spiral aluminum conduit with continuous extruded PVC jacket.
- .2 Conduit fittings shall be steel liquid tight type that fit over PVC jacket and seal uniformly all round.

2.5 FLEXIBLE ELECTRIC NON-METALLIC (ENT) TUBING

- .1 Flexible electrical non-metallic tubing (ENT) **shall not** be used on this project.

2.6 OUTLET BOXES AND JUNCTION BOXES

- .1 Except as noted for rigid PVC raceways, all outlet boxes and junction boxes shall be one piece formed or welded.
- .2 Outlet boxes to be galvanized steel.
- .3 Junction boxes to be galvanized steel or aluminum.

2.7 INNERDUCTS

- .1 Provide and install innerducts in underground conduits where called for on plans.
- .2 Innerducts to be outdoor corrugated high density polyethylene type complete with pullstring, cable plugs, blank plugs for unused innerducts, and quadraplex sealing plugs.

2.8 ACCESS HATCHES

- .1 Provide and install access hatches in drywall ceilings to access junction boxes. Coordinate with other trades and check locations with architect before installing.
- .2 Access hatches shall have the following specifications:
 - .1 Door: aluminum frame with gypsum board inlay.
 - .2 Frame: Recessed aluminum
 - .3 Finish: to receive the same finish and paint as the surrounding surface.
 - .4 Hinge: concealed, non-corroding.
 - .5 Latch: flush screwdriver cam latch.
- .3 Access hatches to be of a size to suit but not less than 305mm square.

2.9 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.

- .3 Channel type supports for two or more conduits at 1500mm oc.
- .4 Threaded rods, 6 mm dia., to support suspended channels.

2.10 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90° bends are required for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT in all exterior applications. Set-screws are not acceptable.

2.11 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.12 FISH CORD

- .1 Polypropylene.

Part 3 Execution

3.1 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 **Conceal conduits except in mechanical and electrical service rooms.**
- .3 Use rigid galvanized steel threaded conduit except [where specified otherwise].
- .4 Use epoxy coated conduit underground corrosive areas.
- .5 Use electrical metallic tubing (EMT) except in cast concrete and above 2.4 m not subject to mechanical injury.
- .6 Use rigid PVC conduit underground, in corrosive areas, and surface mounted in wet areas not subject to damage.
- .7 Use flexible metal conduit for connection to motors in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.
- .8 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .9 Use explosion proof flexible connection for connection to explosion proof motors.
- .10 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .11 Minimum conduit size for lighting and power circuits: 19mm.
- .12 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .13 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .14 Install fish cord in empty conduits.

- .15 Run 2-25 mm spare conduits up to ceiling space and 2-25 mm spare conduits down to ceiling space from each flush panel. Terminate these conduits in junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in [flush concrete] [surface] type box.
- .16 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .17 Dry conduits out before installing wire.
- .18 Conduits shall be installed mechanically continuous from outlet to outlet and without pockets. All the necessary standard bushings, elbows and bends shall be provided. All conduit bends shall have a radius of not less than six (6) times the internal diameter of the conduit and in no case shall the equivalent of more than four quarter bends from outlet to outlet be made. For all conduit sizes to be used for low voltage raceway, the conduits shall have a minimum bending radius of 230mm.
- .19 Conduit bends shall be made with no more than 10% flattening of the conduit. Bends shall be smooth throughout deformations.
- .20 On surface wall runs, all conduit shall be installed in true vertical or horizontal direction and on ceilings in true 90 degree angles or parallel to the walls. Crossings of conduits shall also be made at 90 degree angles. Parallel running conduit shall be kept on equal spacing on the entire length of run including bends.
- .21 All conduits shall be fastened to structure with steel straps (no cast type straps allowed).
- .22 Where more than three conduits are run parallel in ceiling cavity, they shall be installed on cantruss type channel, complete with all manufacturer's fittings to secure channel to structure and to conduit.
- .23 Raceways extending out concrete slabs shall be securely protected using rebar stubs or similar material. All duct stubs are to be kept sealed during construction

3.2 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.3 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

3.4 CONDUITS IN CAST-IN-PLACE CONCRETE

- .1 Locate to suit reinforcing steel. Install in centre one third of slab.
- .2 Protect conduits from damage where they stub out of concrete.
- .3 Install sleeves where conduits pass through slab or wall.
- .4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.

- .5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.
- .8 Do not install conduits in slabs/concrete floors in lab areas.

3.5 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

- .1 Run conduits 25 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.
- .2 Do not install conduits in slabs/concrete floors in lab areas.

3.6 CONDUITS UNDERGROUND

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

3.7 FIRE STOPPING

- .1 Apply ULC approved fire stopping assembly to all conduit penetrations passing through fire rated walls and floors.
- .2 Provide shop drawings showing details for each type of application on the project. Shop drawings shall include catalogue data and installation details.
- .3 For all communication sleeves accessible via ceilings or in stacked closets/rooms passing through floors, provide 2 hour rated STI EZ-PATH assembly. Where quantity is not indicated on plans, provide minimum two sleeves between each floor and each communication closet/room.

END OF SECTION 26 05 34

1.1 SECTION INCLUDES

- .1 This Section specifies materials and installation for metal and fiberglass cabletroughs and fittings.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.1 No.126.1, Metal Cable Tray Systems.
 - .2 CAN/CSA C22.1 No.126.2, Non Metallic Cable Tray Systems.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA FG 1, Fibreglass and Cable Tray Systems.
 - .2 NEMA VE 1, Metal Cable Tray Systems.
 - .3 NEMA VE 2, Cable Tray Installation Guidelines.

1.3 PRODUCT DATA

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.
- .3 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.
- .4 Identify types of cable trays used.

Part 2 Products

2.1 CABLE TRAY (MAIN COMMUNICATIONS AND IMIT ROOMS)

- .1 A flex or basket type cable tray shall be provided above equipment cabinets and around the perimeter of the room and shall be attached to the Communications cable tray infrastructure.
- .2 The tray shall be mounted @ 2.7M AFF unless otherwise noted.
- .3 Wall mounted tray brackets shall be bolted through any plywood backboards to the wall.
- .4 Cable tray to have rounded edges where in possible contact with cables.

2.2 CABLE TRAY (INTERIOR PATHWAYS)

- .1 All ventilated tray to be steel or aluminum, complete with angles, offsets, corners, saddles, tees, etc. as indicated and required to suit the installation. Radii on fittings shall be 300mm minimum.
- .2 All steel non-painted tray shall be hot dip galvanized after fabrication to CSA G164-1965 ASTM designation A386.
- .3 All tray shall have 45 degree corners at all vertical and horizontal corners, tees and width change locations.
- .4 Cable tray to have a minimum cable loading depth of 114mm. Cable tray width to be a minimum of 305mm wide for communications, or as indicated on drawings.
- .5 Suspended tray supports to be trapeze style hangers of minimum 40mm square "Unistrut" supported from 9.5mm threaded rod hangers from preset or afterset concrete inserts or direct steel support.

- .6 Barriers required where different systems are in same cable tray. Barriers to be continuous metal dividers for entire length of the tray.
- .7 Fire Barrier Pillows to be self contained firestop product for use in through-penetration firestops. Product to achieve up to three (3) hours fire rating in accordance with ASTM E 814 tests.

2.3 CABLE TROUGH

- .1 Cabletroughs and fittings: to NEMA FG 1/VE 1 and CAN/CSA C22.1 No. 126.1/2.
- .2 Ladder Ventilated & Non Ventilated wire mesh type, Class A C1 to CAN/CSA C22.2 No.126.1/2.
- .3 Solid covers for complete cabletrough system including fittings.
- .4 Barriers required where different voltage systems are in same cabletrough.
- .5 Ground cable trays with bare copper conductor attached to each tray section in accordance with CEC requirements.
- .6 Provide fire stop material at firewall penetrations.

2.4 SUPPORTS

- .1 Provide splices and supports for a continuously grounded system as required.

Part 3 Execution

3.1 GENERAL INSTALLATION – POWER & COMMUNICATIONS

- .1 Cable trays are usually installed in the false ceiling space of hallways and located to keep conduit lengths to a minimum.
- .2 Provide cable tray in approximate location and general routing as shown on drawings.
- .3 Provide dropouts when cables exiting all horizontal cable trays.
- .4 Support suspended cable tray from trapeze style hangers with hangers spaced as recommended by the manufacturer based on a maximum load capacity for the tray. Support trays at all corners, offsets and tee fittings
- .5 Where shown and appropriate, support cable tray from wall using a cantilever support arrangement. Cable trays may be supported using wall mounted support on masonry walls or from the building steel only.
- .6 Generally Cable Trays shall be separated at a minimum 450mm from the adjacent wall unless otherwise indicated.
- .7 Cable tray location and mounting heights to be coordinated on site with other trades to provide minimum headroom and serviceability. Verify drawing details to allow for all services run in ceiling spaces. Provide vertical and horizontal offsets as required to suit job site conditions.
- .8 Cable tray sections shall be joined by approved connector plates and rust-resistant (plated) hardware. Torque all hardware as per manufacturer's recommendations.
- .9 Unless otherwise indicated, bond all cable tray with a minimum #6 AWG copper bonding conductor installed continuously within the full length of all cable trays. Securely connect the bond wire to the tray at each end and at a minimum of 15m intervals. Connect bonding conductor to the building ground system at one or both ends.
- .10 Provide pulleys and rollers to install cables.

- .11 Install ventilated type tray in corridors and as vertical risers. Where cable trays pass through solid walls and floors, trays shall be solid type with cover and shall extend a minimum of 450 mm on each side of the wall or floor.
- .12 Where cable tray passes through fire separations install fire pillows as required to maintain proper fire rating.
- .13 Cable tray may require installation of risers, bend, etc. to adjust tray up or down as well as sideways for the tray routing to fit within limits of space available, and to clear other services, ducts, pipes etc. along the route. Routing may be adjusted somewhat as necessary to enable installation of services under other trades. These field adjustments are to be done at no extra cost to the Owner.
- .14 Where tray runs change elevation, trays shall overlay each other when manufactured waterfall assemblies can not be used. To prevent cables stress install drop-outs on the top tray when overlap method is to be used. Further, tray sections shall be coupled together to provide some rigidity. This coupling maybe made by using a short length of tray and adjustable elbows or may be coupled by means of common support rods at the tray overlap.
- .15 Sharp metal edges in cable trays which could cut the cable shall be smoothed and the cable dressed away from these edges. Manufacturer surface imperfections shall be touched up with a cold galvanizing coating before installing cable.
- .16 There shall be no wiring joints or splices within the cable tray.

3.2 INSTALLATION - COMMUNICATIONS

- .1 Use ventilated cable tray for Voice/Data service cable down drops in the Communication Rooms.
- .2 Cables shall be secured in place in tray with tie wraps where in horizontal runs and with cable clamps in vertical runs. Low tension cabling shall be secured to tray by use of Velcro style straps. Support cables routed vertically through a service riser with a basket type wire grip equal to Hubbell Kellems grip for power cables and data cables including fiber optic cables.
- .3 The "communications" cable tray system is for extra-low voltage cabling only. There shall be no cables within the tray that has a voltage exceeding 36V.
- .4 Power distribution conduits shall not be located within 200mm of the cable tray.

END OF SECTION 26 05 36

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies wireways, auxiliary gutters and associated fittings and installation.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSAC22.2No.26-[R1999], Construction and Test of Wireways, Auxiliary Gutters and Associated Fittings.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 00 Common Work Results - Electrical.

Part 2 Products

2.1 WIREWAYS

- .1 Wireways and fittings: to CSA C22No.26.
- .2 Sheet steel with bolted cover to give uninterrupted access.
- .3 Finish: baked grey enamel.
- .4 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

Part 3 Execution

3.1 INSTALLATION

- .1 Install wireways and auxiliary gutters.
- .2 Keep number of elbows, offsets, connections to minimum.
- .3 Install supports, elbows, tees, connectors, fittings.
- .4 Install barriers where required.
- .5 Install gutter to full length of equipment.

END OF SECTION 26 05 37

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials, components, cabinets, instruments and installation for metering and switchboard Instruments. Metering in this section is for owners use (non-revenue).
- .2 Text to complete Section 26 13 18 - Primary Switchgear Assembly to 15kV.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI C39.1- latest edition, Requirements, Electrical Analog Indicating Instruments.
- .2 Canadian Standards Association, (CSA International)
 - .1 CAN3-C17- latest edition, Alternating - Current Electricity Metering.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Indicate meter and/or instrument, outline dimensions, panel drilling dimensions and include cutout template.

Part 2 Products

2.1 METER

- .1 Polyphase kilowatt-hour energy meter: to CAN3-C17.
- .2 Polyphase, kilowatt demand recording meter: to CAN3-C17.
- .3 Combination energy and demand meter: to CAN3-C17.
- .4 Accuracy: 2%.
- .5 Ratings: as indicated on the drawings.
- .6 Provision for remote sensing.

2.2 METER SOCKET

- .1 Meter socket[s] to suit meter[s] and to have automatic current transformer shorting devices when meter removed.

2.3 METER CABINET

- .1 Sheet steel CSA enclosure to be EEMAC-1 unless otherwise indicated with meter backplate, to accommodate meter, test terminal block and associated equipment, factory installed and wired.

2.4 METERING INSTRUMENT TRANSFORMER CABINET

- .1 Sheet steel CSA enclosure EEMAC-1 unless otherwise indicated to accommodate potential and current transformers as required.

2.5 TEST TERMINAL BLOCKS

- .1 Test terminal blocks: as required.

2.6 INDICATING INSTRUMENTS

- .1 Indicating instruments: to ANSI C39.1, 1% accuracy, switchboard mounting:
 - .1 Ammeter: true RMS, range as indicated.
 - .2 Voltmeter: true RMS, range as indicated.
 - .3 Wattmeter: range as indicated.
 - .4 Varmeter: range as indicated.
 - .5 Frequency meter: range as indicated.
 - .6 Power factor meter: range as indicated.

2.7 INSTRUMENT SELECTOR SWITCHES

- .1 Voltmeter and Ammeter selector switches: rotary, multi-position, maintained contacts, panel mounting, rated to suit instrument[s], nameplate marked as indicated to coincide with each rotary position. Ammeter selector switches designed to preclude opening of current circuits.
- .2 Four position ammeter selector switches identified "off-A-B-C".
- .3 Four position voltmeter selector switches identified "A-B, B-C, C-A, off".
- .4 Seven position voltmeter selector switches identified "A-B, B-C, C-A, off, A-N, B-N, C-N".

2.8 RECORDING INSTRUMENTS

- .1 Recording instruments: 1% accuracy switchboard mounting:
 - .1 Ammeter: range as indicated.
 - .2 Voltmeter: range as indicated.
 - .3 Wattmeter: range as indicated.
 - .4 Varmeter: range as indicated.
 - .5 Frequency meter: range as indicated.
 - .6 Power factor meter: range as indicated.

2.9 SHOP INSTALLATION

- .1 Install meters and instrument transformers in separate compartment of switchboard.
- .2 Install instruments on switchboard.
- .3 Ensure adequate spacing between current transformers installed on each phase.
- .4 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources, electrical supplies.

Part 3 Execution

3.1 METERING INSTALLATION

- .1 Install meters and instruments in location free from vibration and shock.
- .2 Make connections in accordance with instrument diagrams.
- .3 If applicable, ensure power factor corrective equipment connected on load side of meter.
- .4 Connect meter and instrument transformer cabinets to ground.
- .5 Locate meters within 9 m of instrument transformers. Use separate conduit for each set of current transformer connections, exclusive for metering.

3.2 FIELD QUALITY CONTROL

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results - Electrical and in accordance with manufacturer's recommendations.
- .2 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.
- .3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.
- .4 Perform tests to obtain correct calibration.
- .5 Do not dismantle meters and instruments.

END OF SECTION 26 09 23

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for a wireless, low voltage control systems for lighting equipment.

1.2 SCOPE OF WORK

- .1 Provide a wireless lighting control system as shown on the drawings and as specified herein, complete with all hardware, software, commissioning and programming required for a complete and fully operating system.

1.3 SYSTEM DESCRIPTION

- .1 System shall utilize proven wireless networking technology and shall be able to operate as a stand-alone entity with the option of using a web server device so that programming and viewing of status can be accomplished by any PC connected to the same LAN.
- .2 Wireless lighting control system designed to provide remote switching of lighting loads by use of:
 - .1 Wireless Dimming switches
 - .2 Wireless Occupancy sensor lighting control
 - .3 Wireless Vacancy sensor lighting control
 - .4 Wireless Photosensitive daylighting control
 - .5 Interior lighting time clock control
 - .6 Manual switch control.
 - .7 Wireless control station.
 - .8 Network switch.
 - .9 Wireless and wired LED drivers (refer to luminaire schedule).
 - .10 Wireless Hub and antenna.

1.4 PRODUCT DATA

- .1 Submittal package: Submit shop drawings and product data as specified below in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide a composite wiring and wireless schematic diagram of the complete lighting control system complete with all components, indicating Hubs, drivers, switches, local switches, occupancy sensors and daylight sensors. Indicate the building location reference for all components.
- .3 Provide catalogue sheets, specifications, and installation instructions for all system components.

1.5 MANUFACTURERS

- .1 Shall have a minimum of 10 years experience in the manufacture of networked low voltage and wireless lighting control systems.
- .2 Acceptable Manufacturers:
 - .1 Lutron Vive Wireless lighting control system.
 - .2 Osram Enceluum Wireless lighting control system.

- .3 Acuity nLight AIR Wireless lighting control system.

Part 2 Products

2.1 COMPONENTS

- .1 Contractor shall be responsible for wireless occupancy/vacancy and daylight sensor placement and quantity to provide full room/space coverage.
- .2 Provide products listed, classified, and labeled ULC or CSA as suitable for the purpose indicated.
- .3 Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, programming, etc. as necessary for a complete operating system that provides the control intent indicated.
- .4 Typical dimming equipment is rated for 40 degrees C (104 degrees F). This is the maximum ambient temperature that can exist while the dimming equipment is operating at full load conditions. Include the following paragraph to ensure that the operating equipment is designed to operate at worst case environmental conditions without affecting product life.
- .5 Design lighting control equipment for 10 year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C) and 90 percent non-condensing relative humidity.
- .6 Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.
- .7 Power dropouts occur frequently. The momentary interruption of power should not cause extended periods without lighting or require some manual intervention to reset the lighting system.
- .8 Power Failure Recovery: When power is interrupted for periods of time and subsequently restored, lights to automatically return to same levels (dimmed setting, full on, or full off) as prior to power interruption.
- .9 Wireless Devices:
 - .1 Wireless device family includes area or fixture level sensors, area or fixture level load controls for dimming or switching, and load controls that can be mounted in a wallbox, on a junction box, or at the fixture.
 - .2 Wireless devices including sensors, load controls, and wireless remotes or wall stations, can be set up using simple button press programming without needing any other equipment (e.g. central hub, processor, computer, or other smart device).
 - .3 Wireless hub adds the ability to set up the system using any smart device with a web browser (e.g. smartphone, tablet, PC, or laptop).
 - .4 System does not require a factory technician to set up or program the system.
 - .5 Capable of determining which devices have been addressed.
 - .6 RF Range: 60 feet (18 m) line-of-sight or 30 feet (9 m) through typical construction materials between RF transmitting devices and compatible RF receiving devices.
 - .7 The FCC sets limits on EMI/RFI for both non-consumer (commercial and industrial) and consumer (residential) applications. The class B, consumer limits are more stringent than the class A, non-consumer limits.

- .8 Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits:
Comply with FCC requirements of CFR, Title 47, Part 15, for Class B application.
- .10 Wireless Network:
 - .1 RF Frequency: 434 MHz; operate in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.
 - .1 Wireless sensors, wireless wall stations and wireless load control devices do not operate in the 2.4 GHz frequency band where high potential for RF interference exists.
 - .2 Wireless devices operate in an uncongested frequency band providing reliable operation.
 - .3 Fixed network architecture to ensure that all associated lights and load controls respond in a simultaneous and coordinated fashion from a button press, sensor signal, or command from the wireless hub (i.e. no popcorning).
 - .2 Distributed Architecture: Local room devices communicate directly with each other. If the wireless hub is removed or damaged, local control, sensing, and operation continues to function without interruption.
 - .3 Local room devices communicate directly with each other (and not through a central hub or processor) to ensure:
 - .1 Reliability of system performance.
 - .2 Fast response time to events in the space (e.g. button presses or sensor signals).
 - .3 Independent operation in the event of the wireless hub being removed or damaged.
- .11 Device Finishes:
 - .1 Wall Controls: Match finishes for Wiring Devices, unless otherwise indicated.
 - .2 Wall Controls: as indicated on the drawings.
 - .3 Standard Colors: Comply with NEMA WD1 where applicable.
 - .4 Color Variation in Same Product Family: Maximum delta E of 1, CIE L*a*b color units.
 - .5 Daylight or fluorescent lighting generate ultraviolet light which can cause parts that do not meet ASTM D4674 to discolor/yellow over time.
 - .6 Visible Parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.
 - .7 Use the following paragraph if interface with building automation system will be required. Any specific requirements can be added as subparagraphs below.
 - .8 Interface with building automation system and motorized blinds
- .12 Interface with building automation system: contractor shall provide all required gateways, interface modules to connect to the office DDC panel and motorized roller shades.

2.2 WIRELESS SENSORS

- .1 General Requirements:
 - .1 Operational life of 10 years without the need to replace batteries when installed per manufacturer's instructions.

- .2 Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.
- .3 Does not require external power packs, power wiring, or communication wiring.
- .4 Capable of being placed in test mode to verify correct operation from the face of the unit.
- .2 Occupancy/vacancy sensors:
 - .1 Sensors shall be wireless, battery-powered passive infrared (PIR) sensors that automatically control lights via RF communication to compatible dimming and switching devices. These sensors detect the heat from people moving within an area to determine when the space is occupied. The sensors then wirelessly transmit the appropriate commands to the associated dimming and switching devices to turn the lights on or off automatically. They combine both convenience and exceptional energy savings along with ease of installation.
 - .2 Wireless Occupancy/Vacancy Sensors:
 - .3 General Requirements:
 - .4 Provides a clearly visible method of indication to verify that motion is being detected during testing and that the unit is communicating to compatible RF receiving devices.
 - .1 Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
 - .5 Sensing Mechanism: Passive infrared coupled with technology for sensing fine motions. Signal processing technology to detect fine-motion passive infrared (PIR) signals without the need to change the sensor's sensitivity threshold.
 - .6 Provide readily accessible, user-adjustable controls for timeout, automatic/manual-on, and sensitivity.
 - .1 Turns off lighting after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area. Provide adjustable timeout settings of 1, 5, 15, and 30 minutes.
 - .2 Capable of turning dimmer's lighting load on to an optional locked preset level selectable by the user. Locked preset range to be selectable on the dimmer from 1 percent to 100 percent.
 - .7 Color: White.
 - .8 Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
 - .9 Provide temporary mounting means for drop ceilings to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.
 - .10 Sensor lens to illuminate during test mode when motion is detected to allow installer to place sensor in ideal location and to verify coverage prior to permanent mounting.
 - .11 Ceiling-Mounted Sensors:
 - .1 Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
 - .2 Provide recessed mounting bracket compatible with drywall and compressed fiber ceilings.

- .12 Wall-Mounted Sensors: Provide wall or corner mounting brackets compatible with drywall and plaster walls.
- .3 Wireless Combination Occupancy/Vacancy Sensors:
 - .1 Wireless occupancy sensor has three settings available: Auto-On/Auto-Off, Auto-On Low-Light/Auto-Off, and Manual-On/Auto-Off
 - .2 Auto-On Low-Light feature will only turn lights on automatically if there is less than approximately 1 fc (10 lux) of ambient light
 - .3 Simple and intuitive adjustments available for Timeout, Auto-On, and Activity settings
 - .4 Supports advanced occupancy features, such as dependent occupancy groups and customizable occupied/unoccupied presets in some systems
- .4 Ceiling-Mounted Sensors:
 - .1 Programmable to operate as an occupancy sensor (automatic-on and automatic-off), an occupancy sensor with low light feature (automatic-on when less than one footcandle of ambient light available and automatic-off), or a vacancy sensor (manual-on and automatic-off).
 - .2 Wireless occupancy sensor has two settings available: Auto-On/Auto-Off, and Manual-On/Auto-Off
 - .3 Simple and intuitive adjustments available for Timeout, Activity, and Auto-On settings
 - .4 Supports advanced occupancy features, such as dependent occupancy groups and customizable occupied/unoccupied presets in some systems.
 - .5 Refer to product specification submittal of receiving device to determine system limits
 - .6 Wall-Mounted Sensors: Programmable to operate as an occupancy sensor (automatic-on and automatic-off), or a vacancy sensor (manual-on and automatic-off).
- .5 Wireless Vacancy-Only Sensors:
 - .1 Operates only as a vacancy sensor (manual-on and automatic off)
- .6 Wireless Daylight Sensors:
 - .1 Wireless daylight sensor is a battery-powered sensor that automatically controls lights via RF communication to compatible dimming or switching devices. This sensor mounts to the ceiling and measures light in the space. The sensor then wirelessly transmits the light level to the associated dimming or switching devices that automatically control the lights to balance light level in the space. The sensor combines both convenience and exceptional energy savings along with ease of installation.
 - .2 Open-loop basis for daylight sensor control scheme.
 - .3 Stable output over temperature from 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C).
 - .4 Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
 - .5 Provide linear response from 2 to 150 footcandles.
 - .6 Color: White.

- .7 Mounting:
 - .1 Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
 - .2 Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
 - .3 Provide temporary mounting means for drop ceilings to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.

2.3 LOAD CONTROL MODULES

- .1 Provide wireless load control modules as required to control the loads.
- .2 Junction Box-Mounted Modules:
 - .1 Plenum rated.
 - .2 Dimming module with 0-10 V control is a radio frequency (RF) control that operates 0-10 V controlled LED drivers based on input from wireless controls and Radio wireless occupancy/vacancy sensors and wireless daylight sensors.
 - .3 0-10 V Dimming Modules:
 - .1 Product(s):
 - .1 8 A dimming module with 0-10V control, without emergency lighting mode.
 - .2 8 A dimming module with 0-10V control, with emergency lighting mode.
 - .2 Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
- .3 Certain applications, such as hallways, may require that the lights never turn off. For these areas, select the minimum light level option and the load will lower to programmed low-end level. Default operation lowers to OFF.
- .4 Selectable minimum light level.
- .5 Configurable high- and low-end trim.
- .6 Relay module is a radio frequency (RF) device that to control up to 16 A of general-purpose load based on input from wireless occupancy/vacancy sensors and wireless daylight sensors. A low-voltage dry contact closure output is to be provided to communicate occupancy status to 3rd-party systems such as HVAC controllers.
- .7 Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
- .8 Relay:
 - .1 Rated Life of Relay: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
 - .2 Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
 - .3 Fully rated output continuous duty for inductive, capacitive, and resistive loads.

- .9 Fixture Control Modules/Sensors:
 - .1 Fixture Control Modules:
 - .1 Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
 - .2 Communicates via wired input with one combination occupancy/daylight or vacancy/daylight fixture sensor.
 - .2 Coordination between Wired and Wireless Sensors:
 - .1 Occupancy/Vacancy Sensing: Wired and wireless sensors work in conjunction (occupancy detected by either sensor turns lights on and vacancy detected by both sensors turns lights off).
 - .2 Daylight Sensing: Wireless sensor takes precedence over wired sensor.
 - .3 Certain applications, such as hallways, may require that the lights never turn off. For these areas, select the minimum light level option and the load will lower to programmed low-end level. Default operation lowers to OFF.
 - .4 Selectable minimum light level.
 - .5 Configurable high- and low-end trim.
 - .6 Plenum rated.
 - .7 Mounts to fixture or junction box through ½ inch (16 mm) trade size knockout.
 - .3 LED Driver Fixture Control Modules:
 - .1 Product(s):
 - .1 LED driver fixture control module, without emergency lighting mode.
 - .2 Supports reporting of energy measurement to wireless hub at accuracy of plus/minus 2 percent or 0.5 W (whichever is higher).
 - .3 Single integral controller with Class 1 or Class 2 isolated digital output signal conforming to IEC 60929; capable of direct control without interface.
 - .4 Control of LED drivers requires the ability to address, program, and assign zone and sensor control to the digital lighting loads. Doing so can be achieved directly from the integral power and control module. Direct control of 120V and/or 277V lighting usually requires a power interface that couples both power and control. With the integral digital ballast control output, no additional interfaces are required.
 - .4 0-10 V Dimming Fixture Control Modules:
 - .1 Product(s):
 - .1 0-10 V dimming fixture control module, without emergency lighting mode.
 - .2 Supports reporting of energy measurement to wireless hub at accuracy of plus/minus 2 percent or 0.5 W (whichever is higher).

- .3 Single low voltage dimming module with Class 1 or Class 2 isolated 0-10V output signal conforming to IEC 60929 Annex E.2; source or sink automatically configures.
- .4 Provides 0-10 V control for up to 3 ballasts/LED drivers (1 A load at 120-277 V, 6 mA max control current).
- .5 Rated for switching 0-10 V ballasts, LED drivers, or fixtures that conform with NEMA 410.

2.4 LUMINAIRE COMPONENTS (FACTORY-INSTALLED)

- .1 Wireless fixture control components to be factory-installed in luminaires as specified in Luminaires schedule.
- .2 Wireless Fixture Control Dongle:
 - .1 Product(s):
 - .1 RF only (no integral sensing capability).
 - .2 RF with occupancy/vacancy and daylight sensing.
 - .2 Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
 - .3 Certain applications, such as hallways, may require that the lights never turn off. For these areas, select the minimum light level option and the load will lower to programmed low-end level. Default operation lowers to OFF.
 - .4 Selectable minimum light level.
 - .5 Supports configurable high- and low-end trim.
 - .6 Plenum rated in accordance with UL 2043.
 - .7 Mounts to fixture through hole.
- .3 Wireless Fixture Control Dongle with Integral Sensing Capabilities:
 - .1 Occupancy/Vacancy Sensing:
 - .1 Passive infrared coupled with technology for sensing fine motions. Signal processing technology detects fine-motion passive infrared (PIR) signals without the need to change the sensor's sensitivity threshold.
 - .2 Coverage: 300 square feet (28 sq m) with mounting height of 8 to 12 feet (2.4 to 3.7 m); 360 degree field of view.
 - .3 Sensor Timeout: 15 minutes.
 - .1 Sensor timeout adjustable via wireless hub.
 - .2 Daylight Sensing:
 - .3 Automatic calibration.
 - .4 Provide linear response to changes in perceived light level.
 - .1 Response adjustable via wireless hub.
 - .2 Closed loop proportional control scheme.
 - .3 Sensor Range: 0 to 150 footcandles (0 to 1600 lux).
 - .5 Coordination between Integral and Wireless Sensors:
 - .1 Occupancy/Vacancy Sensing: Integral and wireless sensors work in conjunction (occupancy detected by either sensor turns lights on and vacancy detected by both sensors turns lights off).

- .2 Daylight Sensing: Wireless sensor takes precedence over integral sensor.
- .6 Digital Bus Interface:
 - .1 Provides power for wireless fixture control dongle and up to four LED drivers (60mA at 17-19 VDC).
 - .2 DALI compliant.
 - .3 UL listed.

2.5 WIRELESS CONTROL STATIONS

- .1 The wireless control can function as a tabletop control on a pedestal, or wall-mounted, to mimic a traditional keypad. The battery-operated control requires no external power or communication wiring. Models are available with integral night light.
 - .1 Single Pedestal.
 - .2 Double Pedestal.
 - .3 Triple Pedestal.
 - .4 Quadruple Pedestal.
 - .5 Screw Mounting Kit.
 - .6 Wall box Adapter.
 - .7 Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.
 - .8 Does not require external power packs, power or communication wiring.
 - .9 Controls can be programmed with different functionality through system software without any hardware changes.
 - .10 Allows for easy reprogramming without replacing unit.
- .2 Button Programming:
 - .1 Single action.
 - .2 Toggle action.
- .3 Includes LED to indicate button press or programming mode status.
- .4 Mounting:
 - .1 Capable of being mounted with a table stand or directly to a wall under a faceplate.
 - .2 Faceplates: Provide concealed mounting hardware.
- .5 Power: Battery-operated with minimum ten-year battery life (3-year battery life for night light models).

2.6 LED DRIVERS

- .1 General Requirements:
 - .1 Include the following paragraph to ensure that the driver is designed to operate at worst case environmental conditions without affecting product life.
 - .2 Operate for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

- .3 Provide thermal fold-back protection by automatically reducing power output (dimming) to protect LED driver and LED light engine/fixture from damage due to over-temperature conditions that approach or exceed the LED driver's maximum operating temperature at calibration point.
- .4 Provide integral recording of operating hours and maximum operating temperature to aid in troubleshooting and warranty claims.
- .5 The following means that the driver will be inaudible in a general office space (30dBA is a quiet whisper at 5 feet).
- .6 Class A sound rating; Inaudible in a 27 dBA ambient.
- .7 Line voltage fluctuates throughout the day as equipment (i.e. equipment or other buildings in the vicinity) come on line. Line voltage fluctuations will cause noticeable changes in light output. The driver automatically compensates for variations in voltage to provide constant light output.
- .8 Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.
- .9 LED drivers of the same family/series to track evenly across multiple fixtures at all light levels.
- .10 To meet the lighting density requirements of a job, the fixture OEM needs to deliver fixtures with custom lumen output levels. Programmable LED drivers allow the OEM to easily customize their fixtures. Full dimming range 100%-5% or 100%-1% must be achieved at any programmed level.
- .11 Offer programmable output currents in 10 mA increments within designed driver operating ranges for custom fixture length and lumen output configurations, while meeting a low-end dimming range of 100 to 0.1 percent, 100 to 1 percent or 100 to 5 percent as applicable.
- .12 LED drivers with fault protection ensure that a wiring mistake that results in up to 277 V being applied to the communication links on the driver will not damage the driver and require the fixture to be replaced at significant cost.
- .13 Employ integral fault protection up to 277 V to prevent LED driver damage or failure in the event of incorrect application of line-voltage to communication link inputs.
- .14 Sometimes, the driver cannot be installed within the fixture, e.g. a chandelier. A driver that is remote mountable allows you to place the driver in a convenient location, without affecting the dimming performance of the driver.
- .15 LED driver may be remote located up to 100 feet (30 m) from LED light engine depending on power outputs required and wire gauge utilized by installer.
- .16 include fault protection circuitry in its drivers to survive common mis-wires.
- .17 Provide integral fault protection to prevent driver failure in the event of a mis-wire.
- .18 Operate from input voltage of 120 V through 277 V at 50/60 Hz.
- .19 After a power interruption, the lights in the space should go back to where they were prior to the interruption without flashing to full, or requiring a manual intervention. Power failure memory prevents annoying interruption to work after a power interruption.
- .20 Employ power failure memory; LED driver to automatically return to the previous state/light level upon restoration of utility power.
- .21 Operate from input voltage of 120 V through 277 V at 50/60 Hz.

- .22 Automatically go to 100 percent light output upon loss of control link voltage and lock out system commands until digital control link voltage is restored.
- .23 When normal power is lost, drivers fed with emergency power go to emergency mode.
- .24 Replacement of single driver during maintenance does not require reprogramming.
- .2 Product(s):
 - .1 Dimming Range: 100 to 0.1 percent measured output current.
 - .2 Features smooth fade-to-on and fade-to-black low end dimming performance for an incandescent-like dimming experience.
 - .3 Typically dissipates 0.25 W standby power at 120 V and 0.40 W standby power at 277 V.
 - .4 Total Harmonic Distortion (THD): Less than 20 percent at
 - .5 meets CSA C22.2 No. 223.
 - .6 Driver outputs to be short circuit protected, open circuit protected, and overload protected.
- .2 Constant Voltage Drivers:
 - .1 Support for cove and under-cabinet fixtures at 24 V.
 - .2 Support LED arrays from 2 W to 96 W.
 - .3 Meets solid state requirements for power factor, transient protection, standby power consumption, start time, and operating frequency in Energy Star for Luminaires Version 2.0.

2.7 WIRELESS HUBS

- .1 Product(s):
 - .1 Wireless hub with BACnet.
 - .2 Flush-mount wireless hub; supports up to 700 total paired devices.
 - .3 Surface-mount wireless hub; supports up to 700 total paired devices.
 - .4 Integrated multicolor LED provides feedback on what mode the hub is in for simple identification and diagnosis.
 - .5 Integrated processor and web server allows hub to set up and operate the system without any external connections to outside processors, servers, or the internet.
- .2 Utilizes Ethernet connection for:
 - .1 Networking up to 64 hubs together to create a larger system.
 - .2 Integration with Building Management System (BMS) via native BACnet; does not require interface (wireless hub with BACnet only).
 - .3 Remote connectivity capabilities, including maintaining system date/time and receiving periodic firmware updates (requires internet connection).
 - .4 A single hub or network of hubs can operate on either a dedicated lighting control only network or can be integrated with an existing building network as a VLAN.
 - .5 Communicates directly to compatible RF devices through use radio frequency communications link; does not require communication wiring; RF range of 71 feet (23 m) through walls to cover an area of 15836 square feet (1471 sq m) (device and hub must be on the same floor).

- .6 Communicates directly to mobile device (smartphone or tablet) or computer using built-in Wi-Fi, 2.4 GHz 802.11b/g; wireless range of 71 feet (23 m) through walls (device and hub must be on the same floor).
- .7 Does not require external Wi-Fi router for connecting to the hub.
- .3 Allows for system setup, control, and monitoring from mobile device or computer using web-based software:
 - .1 Any given load device can be controlled by 10 occupancy sensors, 10 remote controls or 1 daylight sensor (Pico remote controls and sensors must be located within 30 ft (9 m) of the load device they are controlling).
 - .2 Supports paired devices up to maximum number indicated including compatible wireless sensors, wireless control stations, and wireless load devices.
 - .3 Allows for timeclock scheduling of events, both time of day and astronomic (sunrise and sunset).
 - .4 Timeclock is integrated into the unit and does not require a constant internet connection.
 - .5 Retains time and programming information after a power loss.
- .4 365-day schedulable timeclock allows for:
 - .1 Scheduling of events years in advance.
 - .2 Setting of recurring events with exceptions on holidays.
- .5 Time clock events can be scheduled to:
 - .1 Send lights to a desired level and select the fade rate desired to reach that level.
 - .2 Adjust level lights go to when occupied.
 - .3 Adjust level lights go to when unoccupied.
 - .4 Enable/disable occupancy.
 - .5 Adjust timeout of sensors (requires wired fixture sensor or wireless fixture control dongle with integral sensing capabilities).
 - .6 Control individual devices, areas, or groups of areas. Areas or groups of areas can be controlled with timeclock events.
- .6 Daylighting:
 - .1 Daylighting can be enabled/disabled. Can be used to override the control currently taking place in the space.
 - .2 The following is particularly useful when new departments move into a space.
 - .3 Daylight set point can be adjusted with the software to increase or decrease the electric light level in the room based on the same amount of natural light.
 - .4 Reports measured energy for wireless fixture control dongle when paired with driver that supports measured power (measurement accuracy defined by driver specification) or reports calculated power if driver does not have measurement capabilities.
 - .5 Allows for control, monitoring, and adjustment from anywhere in the world (wireless hub internet connection required).
 - .6 Uses RF signal strength detection to find nearby devices for quick association and programming without having to climb ladders.
 - .1 Association and setup does not require a factory technician to perform.

- .7 System using wireless hub(s) can operate with or without connection to the internet.
- .8 Supports energy reporting.
 - .1 Reports measured energy data for fixture control modules at accuracy of plus/minus 2 percent or 0.5 W (whichever is higher).
 - .2 Reports calculated energy data for junction box mounted modules at accuracy of 10 percent.
- .7 Support automatic generation of alerts in web-based application for designated events/triggers, including:
 - .1 Low-battery condition in battery-operated sensors and controls; alert cleared when battery is replaced.
 - .2 Missing device (e.g., control or sensor); alert cleared when device is detected by system.
- .8 Wireless hub can be firmware upgraded to provide new software features and system updates.
 - .1 Firmware update can be done either locally using a wired Ethernet connection or Wi-Fi connection, or remotely if the wireless hub is connected to the internet.
- .9 Web-Based Application:
 - .1 Accessibility and Platform Support:
 - .1 Web-based; runs on most HTML5 compatible browsers (including Safari and Chrome).
 - .2 Supports multiple platforms and devices; runs from a tablet, desktop, laptop, or smartphone.
 - .3 User interface supports multi-touch gestures such as pinch to zoom, drag to pan, etc.
 - .4 Utilizes HTTPS (industry-standard certificate-based encryption and authentication for security).
 - .5 Multi-level Password Protected Access: Individual password protection on both the integrated Wi-Fi network and web-based software.
 - .6 WPA2 security for Wi-Fi communication with wireless hub.
 - .2 System Navigation and Status Reporting:
 - .1 Area Tree View: Easy navigation by area name to view status and make programming adjustments through the software.
 - .2 Area and device names can be changed in real time.
 - .3 Setup app available for iOS and Android that allows for:
 - .1 Job registration to extend product warranty.
 - .2 Management of setup for multiple projects in different locations.
 - .3 Creation of handoff documents that are sent directly to a facility manager via email once setup is complete.
 - .4 Backup of wireless hub database to cloud for hub replacement.
 - .5 Access to native help and instructions to assist user with system setup.

- .10 BACnet Integration (wireless hub with BACnet only):
 - .1 Provide ability to communicate by means of native BACnet IP communication (does not require interface) to lighting control system from a user-supplied 10BASE-T or 100BASE-T Ethernet network.
 - .2 Requires only one network connection per hub.
 - .3 BACnet Integrator Capabilities:
 - .1 The BACnet integrator can command:
 - .1 Area light output.
 - .2 Area load shed level.
 - .3 Area load shed enable/disable.
 - .2 Enable/Disable:
 - .1 Area occupancy sensors.
 - .2 Area daylighting.
 - .3 Daylighting level.
 - .4 Area occupied and unoccupied level
 - .5 Occupancy sensor timeouts (for fixture sensors).
 - .4 The BACnet integrator can monitor:
 - .1 Area on/off status.
 - .2 Area occupancy status.
 - .3 Area load shed status.
 - .4 Area instantaneous energy usage and maximum potential power usage.
 - .5 Enable/Disable:
 - .1 Area occupancy sensors.
 - .2 Daylighting.
 - .3 Timeclocks.
 - .4 Daylighting level.
 - .5 Light levels from photo sensors.
 - .6 Area occupied and unoccupied level.
 - .7 Occupancy sensor timeouts.
 - .6 API Integration:
 - .1 Support communication, without requiring interface, between lighting control system and third-party systems via API.
 - .2 Requires one network connection per wireless hub.
 - .7 API Integration Capabilities:
 - .1 Control all zones or subset of zones.
 - .2 Set zones in designated area to specific level.
 - .3 Raise/lower dimmable lights in designated area.
 - .4 Control individual zones.

- .8 Subscribe to and Monitor:
 - .1 Area status changes (e.g., occupancy, light level, and instantaneous power).
 - .2 Individual zone changes in light level.
 - .3 Alerts (e.g., missing device and low battery).
 - .4 Contact closure inputs provide integration with devices by others including devices for Title 24 Automatic Demand Response
 - .5 • Contact closure inputs on multiple hubs can be wired in parallel. DO NOT wire inputs in parallel with other equipment as it can cause the inputs on either of the devices to falsely trigger.
 - .6 • To ensure proper operation of contact closure inputs, a PS-J-20W-UNV power supply may not be used to provide power to more than one hub.
 - .7 Contact Closure Interface: Provide two contact closure inputs; accepts both momentary and maintained contact closures that can be used for automatic demand response.
 - .8 Rated for use in air-handling spaces as defined in UL 2043.
 - .9 Visit www.lutron.com for more information on California Title 24 requirements.
 - .10 Wiring distance for any single inter-hub wiring link segment is 330 ft (100 m) max; use Ethernet switches for longer distances
 - .11 Provide Ethernet switch(es) as required for inter-hub network wiring per manufacturer's instructions; do not exceed manufacturer's required maximum wiring segment lengths.

2.8 SOFTWARE DATA AND ANALYTICS DASHBOARD

- .1 Control and Monitor Software:
 - .1 General Requirements:
 - .1 Web-based; runs on most HTML5 compatible browsers (including Internet Explorer, Chrome, and Safari).
 - .2 Supports multiple platforms and devices; runs from a tablet, desktop, laptop, or smartphone; optimized for displays of 1024 by 768 pixels or higher.
 - .3 User interface supports multi-touch gestures such as pinch to zoom, drag to pan, etc.
 - .4 Utilizes HTTPS (industry-standard certificate-based encryption and authentication for security).
 - .5 All functionality listed below must be available via a single application.
 - .2 System Navigation and Status Reporting:
 - .1 Performed using graphical floor plan view or a generic system layout.
 - .2 Graphical Floor Plan View: Utilizes customized CAD based drawing of the building. Pan and zoom feature allows for easy navigation; dynamically adjusts the details presented based on zoom level.
 - .3 Control of Lights:
 - .1 Control and monitor zone/area lights.

- .2 Area lights can be monitored for on/off status from a graphical floor plan or generic system layout.
- .3 All lights in an area can be turned on/off (dimmable lights can also be dimmed up/down from current level).
- .4 Occupancy:
 - .1 Area occupancy can be monitored.
 - .2 Can be monitored graphically if a graphical floor plan has been created.
 - .3 Can be monitored historically in space utilization reports.
- .5 Scheduled events can be created to change occupancy parameters as described under "Scheduling" below.
- .6 Load Shedding: View current load shed status (active/inactive) for each wireless hub and enable/disable load shed for the entire building/system.
- .7 Scheduling: Schedule time of day and astronomic time clock events to automate functions.
- .8 Scheduled events can control the following:
 - .1 Area light levels for all dimmable lights in an area.
 - .2 On/off status of all switched lights and contact-closure outputs in an area.
 - .3 On/off status of all switched receptacles in an area.
- .9 Scheduled events can be created to change the following occupancy parameters:
 - .1 Enable/disable sensors.
 - .2 Change occupancy mode (auto-on/auto-off versus manual-on/auto-off).
 - .3 Adjust occupied and/or unoccupied level.
 - .4 For compatible individual fixture sensors, sensor timeout can be adjusted.
- .10 Easily monitor and adjust scheduled events using a weekly calendar view.
- .11 Reporting: Provide reporting capability that allows the building manager to gather real-time and historical information about the system as follows:
 - .1 Energy Reports: Show a comparison of cumulative energy used over a period of time for one or more areas.
 - .2 Power Reports: Show power usage trend over a period of time for one or more areas.
 - .3 Space Utilization/Occupancy Reports: Show historical occupancy over a period of time for one or more areas using a graphical floor plan, generic system layout, and graphs and charts.
- .12 Administration:
 - .1 Users: Allows new user accounts to be created and existing user accounts to be edited.
 - .2 Supports Active Directory (LDAP) tying user accounts to network accounts.
 - .3 Area and feature access can be restricted based on login credentials.
 - .4 Supports up to 20 concurrent users and 10,000 user accounts.

- .13 Devices/Settings Adjustment:
 - .1 Users with appropriate permissions can navigate to the wireless hub setup screens in order to view and/or adjust specific settings for areas or devices (including load shed settings, daylighting settings, device associations and programming, occupancy settings, high-end/low-end trim settings, etc).
- .14 Control and Monitor for Multiple Systems:
 - .1 Allows user to view aggregate data from multiple connected systems spanning multiple buildings through a single user account:
 - .1 Space utilization/occupancy.
 - .2 Energy usage/savings.
 - .15 Allows user to view details and adjust settings for any connected system; supports system navigation through campuses and buildings using graphical floor plans.

2.9 SOURCE QUALITY CONTROL

- .1 Factory Testing:
 - .1 To ensure that 100 percent of the lighting control products work at installation, the manufacturer should test 100 percent of all assemblies at full rated load in the factory. This testing will assure that every product has been tested and guaranteed to work. Sampling would only prove that the samples work and should not be acceptable.
 - .2 Perform full-function factory testing on all completed assemblies. Statistical sampling is not acceptable.
 - .3 To ensure that 100 percent of the lighting control products work at installation, the manufacturer should test 100 percent of all drivers at the factory.
 - .4 Perform full-function factory testing on 100 percent of all drivers and LED drivers.
 - .5 Sample burn-in is used to verify the consistency of quality for the supplied devices and manufacturing processes so that they meet the design intent.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that field measurements are as shown on the drawings.
- .2 Verify that ratings and configurations of system components are consistent with the indicated requirements.
- .3 Verify that mounting surfaces are ready to receive system components.
- .4 Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- .1 Install products in accordance with manufacturer's instructions.
- .2 Sensor locations indicated are diagrammatic. Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage, in accordance with manufacturer's recommendations.

- .3 Interior sensors work mainly with diffused light, as such, they have a much higher lighting gain than exterior sensors. Electric light sources can affect these sensors unless the sensors are shielded from the light given off by electric light sources.
- .4 Ensure that daylight sensor placement minimizes sensor view of electric light sources. Locate ceiling-mounted and luminaire-mounted daylight sensors to avoid direct view of luminaires.

3.3 FIELD QUALITY CONTROL

- .1 On completion of installation, manufacturer representative shall be notified to carry out site inspection and report any inconsistencies in the installation or system operation to the Consultant. Corrections are to be implemented to comply with required installation and operational parameters defined in the drawings and specifications.

3.4 ADJUSTING

- .1 Allow for to two additional post-startup on-site service visits for fine-tuning of sensor calibration.

3.5 CLEANING

- .1 Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 COMMISSIONING

- .1 Provide Lighting control acceptance testing, performed by the lighting control specialist.

3.7 CLOSEOUT ACTIVITIES

- .1 Demonstrate proper operation of lighting control devices to and correct deficiencies or make adjustments as directed.
- .2 Contractor to provide on-site demonstration of system functionality
- .3 Training:
 - .1 Include two (2) on-site training sessions, four (4) hours, training sessions schedule shall be coordinated with end user group.

END OF SECTION 26 09 04

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for low voltage switchgear for controlling relatively large loads - 1200 A or larger.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2 No.31-18, Switchgear Assemblies.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC G8-3.3, Metal Enclosed Interrupter Switchgear Assemblies.

1.3 SHOP DRAWINGS PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate on shop drawings:
 - .1 Floor anchoring method and foundation template.
 - .2 Dimensioned bus entry and exit locations.
 - .3 Dimensioned position and size of bus.
 - .4 Overall length, height and depth of complete switchgear.
 - .5 Dimensioned layout of internal and front panel mounted components.
- .3 Indicate on product data:
 - .1 Time-current characteristic curves for circuit breakers.

1.4 QUALITY ASSURANCE

- .1 Submit 4 copies of certified factory test results.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for secondary switchgear for incorporation into manual in accordance with Section 26 05 00 – Common Work Results - Electrical.

1.6 STORAGE AND PROTECTION

- .1 Store switchgear on site in protected, dry location. Cover with plastic to keep off dust.
- .2 Provide energized strip heater in each cell to maintain dry condition during storage.

Part 2 Products

2.1 MATERIALS

- .1 Switchgear assembly: to CAN/CSA-C22.2No.31.

2.2 MANUFACTURER

- .1 Approved manufacturers: Eaton, Square D, Siemens.

2.3 RATING

- .1 Secondary switchgear: indoor, 1200Amp, 208V, 3 phase, 4 wire, 60 Hz, minimum short circuit capacity (rms symmetrical) and current capacity as indicated on drawings.

2.4 ENCLOSURE

- .1 Main incoming section to contain:
 - .1 BC Hydro approved pulling section, wireway
 - .2 Main breaker
 - .3 Provision for electrical power supply authority metering.
- .2 Distribution sections to contain:
 - .1 Air circuit breaker or moulded case circuit breaker sized as indicated.
 - .2 Copper bus, from main section to distribution sections including vertical bussing.
- .3 Blanked off spaces for future units.
- .4 Metal enclosed, free standing, floor mounted, dead front, indoor, CSA Enclosure 2 cubicle unit.
- .5 Ventilating louvres: vermin, insect proof with easily replaceable fibre glass filters.
- .6 Access from front and rear.
- .7 Steel channel sills for base mounting in single length common to multi-cubicle switchboard.
- .8 Provision for future extension on both sides.

2.5 BUSBARS

- .1 Three phase and full capacity neutral busbars, continuous current rating self-cooled, extending full width of multi-cubicle switch board, suitably supported on insulators.
- .2 Main connections between bus and major switching components to have continuous current rating to match major switching components.
- .3 Busbars and main connections: 99.30% conductivity copper.
- .4 Provision for extension of bus on both sides of unit without need for further drilling or preparation in field.
- .5 Tin plated joints, secured with non-corrosive bolts and Belleville washers.
- .6 Identify phases of busbars by suitable marking.
- .7 Busbar connectors, when switchboard shipped in more than one section.

2.6 GROUNDING

- .1 Copper ground bus not smaller than 50mm x 6 mm extending full width of multi-cubicle switchboard and situated at bottom.
- .2 Lugs at each end for size #3/0 AWG or larger grounding cable.

2.7 GROUND FAULT UNIT

- .1 See Section 26 28 18 – Ground Fault Equipment.

2.8 MOULDED CASE CIRCUIT BREAKERS

- .1 See Section 26 28 21 – Moulded Case Circuit Breakers.

2.9 POWER SUPPLY AUTHORITY METERING

- .1 See metering section.

2.10 FINISHES

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results - Electrical.
 - .1 Cubicle exteriors gray.
 - .2 Cubicle interiors gray.

2.11 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

2.12 SOURCE QUALITY CONTROL

- .1 Consultant to witness final factory tests.
- .2 Notify Consultant in writing 15 days in advance that switchgear assembly is ready for testing.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate switchgear assembly as indicated and bolt to base channels.
- .2 Connect main secondary power supply to main breaker.
- .3 Connect load side of breakers in distribution cubicles to distribution feeders.
- .4 Check factory made connections for mechanical security and electrical continuity.
- .5 Run one grounding conductor 4/0AWG bare copper in 25 mm conduit from ground bus to main ground bus in main electrical room.
- .6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

END OF SECTION 26 23 00

Part 1 General

1.1 SECTION INCLUDES

- .1 This Section specifies standard and custom panelboards and their installation.

1.2 SCOPE OF WORK

- .1 Provide and install panelboards as indicated on the drawings, single line diagram, panel schedules and these specifications.
- .2 Types of panelboards in this section include the following:
 - .1 CDP type Power distribution panelboards.
 - .2 Lighting and power panelboards

1.3 PRODUCT INFORMATION

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
- .3 Shop drawings to include matching tub and trim details for factory installed low voltage relay cabinets where specified.

1.4 PLANT ASSEMBLY

- .1 Install circuit breakers in panelboards before shipment from plant.
- .2 In addition to CSA requirements, manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .3 All panelboards to be of a common manufacturer.

1.5 FINISH

- .1 Apply finishes in accordance with Section 26 05 00 – Common Work Results - Electrical.
- .2 Panel finish in electrical and equipment rooms and closets to be standard ASA Grey baked enamel. Confirm with Consultant prior to shop finishing panels.
- .3 **Panels in finished and/or public areas to be either as clause .2 above or prepared to accept painting to closely match surroundings as directed by the Architect. In the later instance, the final paint coat to be done by Division 09 but coordinated by the Electrical Division, in particular for protection and masking of locks and sensitive parts. Confirm with Consultant prior to paint finishing panels.**

Part 2 Products

2.1 PANELBOARDS, DOORS AND TRIMS

- .1 Panelboards: to CSA C22.2 No. 29 and product of one manufacturer.
- .2 Bus and breakers unless otherwise indicated on the drawings and in the specifications, shall be rated for:
 - .1 Minimum 10 kA at 208Y/120V.
- .3 Copper bus with full size neutral.
- .4 Provide main breaker for each panelboard. Main breaker rating shall be same as panel bus ampacity rating.

- .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.
- .6 Mains capacity, number of circuits and number and size of branch circuit breakers as indicated.
- .7 Provide all necessary connectors and mounting hardware in every space to facilitate installation of future breakers. Provide blank fillers for all spaces.
- .8 Concealed hinges and concealed trim mounting screws, hinged locking door with flush catch.
- .9 Panelboards to have flush doors. (Gasketed where required for damp locations).
- .10 Provide two keys for each panelboard and key similar voltage and system panelboards alike.
- .11 Panel tubs to be typically 600mm wide.
- .12 Provide "sprinkler-proof" design in areas where sprinkler fire protection is installed. In any event, all surface mounted enclosures to be complete with sprinkler drip cover.
- .13 Provide door within door trims where indicated to facilitate ease of service maintenance. Each tub trim cover to be hinged and self supporting and to swing out to expose breaker cable terminations and wireways. Hinged trim shall be secured with cover screws on opening side by concealed machine screws. Hinged breaker cover shall be recessed into the hinged overall tub cover. Breaker cover shall have latch type closures. Submit details on shop drawings prior to manufacturing.
- .14 Panels to have integral Surge Protection Device (SPD) where indicated. See drawings for quantities and locations.
- .15 Provide 200% rated neutrals for panelboards with 5 conductor feeders, where indicated on single line diagram.

2.2 CUSTOM BUILT PANELBOARD ASSEMBLIES

- .1 Relay section(s) on side(s) of lighting panels as indicated or required for installation of low voltage control switching components. Coordinate with lighting controls equipment supplier
- .2 Double stack panels as indicated.
- .3 Contactors in mains as indicated.
- .4 Feed through lugs as indicated.
- .5 Provide ground bus as indicated. Ground bus to be similar to neutral.

2.3 BREAKERS

- .1 All breakers to be:
 - .1 For Lighting Panelboards: Bolt on type molded case, non-adjustable and non-interchangeable trip, single, two and three pole, 120/208V and with trip free position separate from "On" or "Off" positions.
 - .2 For Power Distribution Panelboards: Bolt on type molded case, adjustable and interchangeable trip, single, two and three pole, 120/208V and with trip free position separate from "On" or "Off" positions.
 - .3 For Mechanical Distribution Panelboards: Bolt on type molded case, adjustable and interchangeable trip, single, two and three pole, 120/208V and with trip free position separate from "On" or "Off" positions.

- .2 Two and three pole breakers to have common simultaneous trip and able to be located in any circuit position within the panelboard.
- .3 Main breaker (where required) to be separately mounted at top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Provide circuit breakers with indicated trip ratings as shown in the panelboard schedules or the Single Line Diagram.
- .5 Provide spare circuit breakers as indicated on panel schedules or single line diagram as applicable. Provide minimum 10% spare breakers.
- .6 Provide breaker type Ground Fault Interrupter(s) (GFI) as indicated.
- .7 For circuit breakers 1000A or larger for 600V systems and 2000A or larger for 208V systems, provide Ground Fault trip units.
- .8 Provide Lock-on devices as indicated and for Fire Alarm circuits, Security Equipment circuits, Exit sign circuits and Emergency Battery Equipment circuits.

2.4 PANELBOARD IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.
- .2 Nameplate for each panelboard size 5 (2 line) engraved as indicated and include panel designation and voltage/phase.
- .3 Complete updated circuit directory with typewritten card(s) located in slide-in plastic pocket(s) fixed to the back of the related door. Directory card to indicate the panel designation, mains size, voltage/phase and the location and load controlled of each circuit. Include a "letter sized" paper copy of each directory in the project maintenance manual.
- .4 Provide a plasticized typewritten information card fixed to the back of each panel door. Information card to indicate the panel designation and location, feeder type and size and locations of any controlling contactors and feeder pullboxes. Include a "letter sized" paper copy of each information card in the project maintenance manual.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb true and square, to adjoining surfaces.
- .2 Panelboards located in service rooms, mechanical rooms, and electrical rooms to be mounted on unistrut supports.
- .3 Mount panelboards to height given in Section 26 05 00 or as indicated.
- .4 Connect loads to circuits as indicated.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.
- .6 Install 4x27mm empty conduits (or equivalent) from each flush mounted panelboard single tub to ceiling space above and 2x27mm empty conduits (or equivalent) from each flush mounted panelboard single tub down to ceiling or space below where space exists.

END OF SECTION 26 24 16

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 This Section specifies standard and custom electrical cabinets and their installation.

1.2 REFERENCES

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

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section [01 78 00 - Closeout Submittals].
- .2 Operation and Maintenance Data: submit operation and maintenance data for electrical cabinets and enclosures for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoor, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect electrical cabinets and enclosures from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Enclosure constructed with [2.7] mm thick minimum steel, with weather and corrosion resistant finish to [NEMA 250] [CAN/CSA C22.2], Munsell Notation 7.5GY3.5/1.5, size as indicated.
- .2 Entire enclosure to be capable of withstanding maximum impact force of [86] MN/m² area without rupture of material.
- .3 Removable enclosure panels with formed edges, galvanized steel external fasteners removable only from inside enclosure.
- .4 Equip enclosure with hot dipped galvanized mounting rails [1] [1.3] m adjustable horizontally and vertically to enable mounting of equipment at any location within housing.
 - .1 Rails: 14 mm holes and 50 x 14 mm slots on 100 mm centres for horizontal adjustment.

- .2 Holes in side panel flanges in 60 mm increments for vertical adjustment.
- .5 Cover: tamperproof, bolt-on, domed to shed water.
- .6 Door: 3 point latching, with padlocking means.
- .7 Ventilation panel constructed to allow air circulation yet preventing entry of foreign objects, wild life, and vermin.
- .8 Door interlocks: [____].
- .9 Enclosure construction such as to allow configuration of single or ganged enclosures.
- .10 Enclosure capable of being shipped in knocked-down condition.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Assemble enclosure in accordance with manufacturer's instructions and securely mount on building structure with channels, supports and fastenings.
- .2 Mount equipment in enclosure.
- .3 Label electrical cabinets and enclosure to Section [26 05 00 - Common Work Results for Electrical]. CLEANING.
- .4 Progress Cleaning: clean in accordance with Section [01 74 11 - Cleaning].
 - .1 Leave Work area clean at end of each day.
- .5 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section [01 74 11 - Cleaning].

END OF SECTION 26 27 16

Part 1 General

1.1 SECTION INCLUDES

- .1 This Section specifies switches, receptacles, wiring devices, cover plates and their installation.

1.2 PRODUCT DATA

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

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CSA-C22.2 No.42.1, Cover Plates for Flush Mounted Wiring Devices.
 - .3 CSA-C22.2 No.55, Special Use Switches.
 - .4 CSA-C22.2 No.111, General Use Snap Switches.

Part 2 Products

2.1 COLOUR

- .1 All devices to be decora style white.
- .2 Receptacles that are switched via occupancy control or similar automatic controls shall be gray unless noted otherwise in the drawings.

2.2 SWITCHES

- .1 Heavy duty specification grade.
- .2 20 A, 120 V or 347 V, single pole, double pole, three-way, four-way switches as indicated.
- .3 Manually-operated general purpose ac switches as indicated and with following features:
 - .1 Terminal holes approved for No.10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine molding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 White toggle (red toggle for emergency power circuits).
- .4 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rating capacity of motor loads.
- .5 Switches of one manufacturer throughout project.
- .6 Standard of acceptance:
 - .1 Hubbell HBL.1221 20A series
 - .2 Leviton 1221-20A 120V series – 18221 347V
 - .3 Pass & Seymour PS20AC1 120V series – PS37201(3)0 347V

2.3 RECEPTACLES – GENERAL

- .1 Heavy duty specification grade.
- .2 Duplex receptacles, CSA type L5-15 R, 125 V, 15 A, U ground, with following features:
 - .1 White nylon molded housing (red for emergency power circuits)
 - .2 Suitable for No.10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and non riveted grounding contacts.
- .3 Receptacles of one manufacturer throughout project.
- .4 Standard of acceptance:
 - .1 Hubbell 5252 heavy duty, construction series
 - .2 Leviton 5262 series
 - .3 Pass & Seymour 5262 series

2.4 RECEPTACLES – PARTICULAR APPLICATION

- .1 Surge Suppression TVSS 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, blue face, parallel blade, U ground, impact resistant nylon face audible and LED alarm. Equal to:
 - .1 Hubbell 8262SA heavy duty series with LED.
 - .2 Leviton 8280 series
 - .3 Pass & Seymour 8200SP series (Décor)
- .2 Isolated Ground type to be 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, orange face, parallel blade, U ground, impact resistant nylon face. Equal to:
 - .1 Hubbell IG8262A series
 - .2 Leviton 8200IG series
 - .3 Pass & Seymour IG26262 series (Décor)
- .3 Ground Fault Interrupter type to be 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, white face, parallel blade, U ground, impact resistant nylon face, complete with breaker and reset button. Equal to:
 - .1 Hubbell GF8200A series
 - .2 Leviton 7599HG series
 - .3 Pass & Seymour HG1595 series (Décor)
- .4 20 Amp Receptacles (Housekeeping) Duplex receptacles – T-slot type CSA type L5-20R 125V. 20 Amp u ground with features matching 15 Amp rated Receptacles.
- .5 Safety Tamper Resistant Receptacles. Receptacles indicated with an 'S' on the drawings shall be Tamper Resistant type. Hubbell RR15xx.TR series.
- .6 All other single outlet and special purpose receptacles to be similar to the grade and series indicated above. Confirm ampacity, voltage and pin configuration prior to installation.
- .7 Range receptacle to be 250V, 50A with a 40A, 2P breaker per outlet.
- .8 Dryer receptacle to be 250V, 40A with a 30A, 2P breaker per outlet.

2.5 DIMMERS

- .1 Flush mounted - Specification grade.
- .2 Incandescent application: 600-1500 watts based on connected load plus 25% spare.
- .3 Electronic ballast application: compatible with ballasts specified.
- .4 Radio interference suppression.
- .5 Thin profile: slide to OFF feature.
- .6 Finished in white or as indicated.
- .7 Standard of acceptance:
 - .1 Lutron 'NOVA-T' NT series.
 - .2 Leviton 'Illumatech' series

2.6 INTERVAL TIMERS

- .1 Range: 0-30 minutes.
- .2 Spring wound or digital without hold feature.
- .3 Single pole 120 volt, 20 Amp contacts to open at end of timing cycle.
- .4 Flush mounting.
- .5 White finish.
- .6 Standard of acceptance:
 - .1 Wattstopper TS series
 - .2 Intermatic FF51-00
 - .3 Paragon series.....
 - .4 Leviton 6230M series

2.7 COVER PLATES

- .1 Stainless steel: Type 302 or 304, No. 4 finish, 1mm thick, accurately die cut, protective cover for shipping. Outlets in labs or as indicated in the drawings or specifications.
- .2 Nylon plates: Heavy duty, unbreakable and flush. All nylon plates to match wiring device colour.
- .3 Steel: sheet steel hot dip galvanized with rolled edges for surface mounted utility boxes.
- .4 Wall plates to be flush mounting with "positive bow" feature to ensure that all edges of plate are flush with wall or surface box when installed.
- .5 All plates to be beveled type with smooth rolled outer edge and smooth face. Exposed sharp edges are not acceptable.
- .6 Cast metal: die cast profile, ribbed for strength, flash removed, primed with grey enamel finish and complete with four mounting screws to box for special purpose wiring devices.
- .7 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for wiring devices as indicated. Double doors for standard duplex receptacles. Cover plates to fasten to box by four screws.
- .8 Gaskets: resilient rubber or close cell foam urethane.
- .9 Cover plates for all wiring devices to be from one manufacturer throughout project.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Mount wiring devices to height specified in Section 26 05 00 or as indicated.
- .2 Upper edge of plates located on separate outlets immediately alongside one another to be at exactly the same height above finished floor.
- .3 All plates to be installed parallel or perpendicular to building lines.

3.2 INSTALLATION PARTICULAR

- .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.
- .2 Receptacles:
 - .1 Install all receptacles in the vertical plane unless otherwise noted.
 - .2 Generally, install the L5-15/20R U ground pin down unless otherwise noted. Neutral up when receptacle in mounted horizontal.
 - .3 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.
 - .4 Where split receptacles has one portion switched, mount vertically and switch the upper portion.
 - .5 Surge suppression duplex receptacles to be provided for all communication and computer terminal equipment backboards and cabinets including fire alarm, telephone, public address, door security, nurse call, central dictation, RF television, security television, etc. Provide dedicated neutral conductors for each surge suppression receptacle.
 - .6 Ground fault interrupter duplex receptacles to be used, adjacent sinks or water sources.
- .3 Cover plates:
 - .1 Protect cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

END OF SECTION 26 27 26

Part 1 General

1.1 RELATED SECTIONS

- .1 Section [26 05 00 - Common Work Results - Electrical].

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2No.248.12-[94] , Low Voltage Fuses Part 12: Class R (Bi-National Standard with, UL 248-12 (1st Edition).

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section [01 33 00 - Submittal Procedures].
- .2 Submit fuse performance data characteristics for each fuse type and size above 60 A. Performance data to include: average melting time-current characteristics.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section [01 74 19 - Construction/Demolition Waste Management and Disposal], and with the Waste Reduction Workplan.
 - .1 Place materials defined as hazardous or toxic waste in designated containers.
 - .2 Ensure emptied containers are sealed and stored safely for disposal away from children.
 - .3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

1.5 DELIVERY AND STORAGE

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in [storage cabinet] [moisture free location].

1.6 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section [01 78 00 - Closeout Submittals].
- .2 [Three] spare fuses of each type and size installed above [600] A.
- .3 [Six] spare fuses of each type and size installed up to and including [600] A.

Part 2 Products

2.1 FUSES GENERAL

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer for entire project.

2.2 FUSE TYPES

- .1 Class L fuses (formerly HRC-L).

- .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- .2 Type L2, fast acting.
- .2 Class J fuses (formerly HRCI- J).
 - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .2 Type J2, fast acting.
- .3 Class R -R fuses (formerly HRCI- R). For UL Class RK1 fuses, peak let-through current and its= peak let-through values not to exceed limits of UL 198E-1982, table 10.2.
 - .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
 - .2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.
- .4 Class -C fuses (formerly HRCII- C).

2.3 FUSE STORAGE CABINET

- .1 Fuse storage cabinet, manufactured from [2.0] mm thick [aluminum] [750] mm high, [600] mm wide, [300] mm deep, hinged, lockable front access door finished in accordance with Section [26 05 00 - Common Work Results - Electrical].

Part 3 Execution

3.1 INSTALLATION

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
 - .1 Install Class R rejection clips for HRCI-R fuses.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

END OF SECTION 26 28 14

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies equipment and components for ground fault circuit interrupters (GFCIs).

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2 No.144- latest edition, Ground Fault Circuit Interrupters.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA PG 2.2-[latest edition], Application Guide for Ground Fault Protection Devices for Equipment.

1.3 PRODUCT DATA

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data and shop drawings.
- .3 Submit test report for field testing of ground fault equipment to Consultant and a certificate that system as installed meets criteria specified herein.

Part 2 Products

2.1 MATERIALS

- .1 Components comprising ground fault protective system to be of same manufacturer.

2.2 BREAKER TYPE GROUND FAULT INTERRUPTER

- .1 Single pole ground fault circuit interrupter for indicated voltage c/w test and reset facilities.

2.3 GROUND FAULT LIFE PROTECTOR

- .1 Circuit breaker to supply power to mains of phase panel and complete with:
 - .1 Automatic shunt trip breaker.
 - .2 Zero sequence current sensor.
 - .3 Facilities for testing and reset.
 - .4 CSA Enclosure Type 2, surface mounted, or as indicated.
 - .5 Ground fault trip indicator light.

2.4 GROUND FAULT PROTECTOR UNIT

- .1 Self-contained with 15 A, 120 V circuit interrupter and duplex receptacle complete with:
 - .1 Solid state ground sensing device.
 - .2 Facility for testing and reset.
 - .3 CSA Enclosure Type 2, flush mounted with face plate, or as indicated.

Part 3 Execution

3.1 INSTALLATION

- .1 Do not ground neutral on load side of ground fault relay.
- .2 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results – Electrical.
- .2 Arrange for field testing of ground fault equipment by ground fault equipment manufacturer before commissioning service.
- .3 Demonstrate simulated ground fault tests.

END OF SECTION 26 28 20

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials for moulded-case circuit breakers.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .3 Section 26 23 00 - Low Voltage Switchgear.
- .4 Section 26 24 02 - Service Entrance Board.
- .5 Section 26 28 18 - Ground Fault Equipment Protection.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include time-current characteristic curves for breakers with ampacity of 225 A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2 Collect and separate waste for disposal and for recycling in accordance with Waste Management Plan.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
 - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum symmetrical rms interrupting capacity rating as noted in drawings.

2.2 THERMAL MAGNETIC BREAKERS

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

2.3 MAGNETIC BREAKERS

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

2.4 CURRENT LIMITING AND SERIES RATED THERMAL MAGNETIC BREAKERS

- .1 Series rated breakers shall not be used on this project.

2.5 SOLID STATE TRIP BREAKERS

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

2.6 OPTIONAL FEATURES

- .1 Include:
 - .1 On-off locking device.
 - .2 Handle mechanism.

Part 3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.

END OF SECTION 26 28 21

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for fused and non-fused disconnect switches.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA-C22.2 No.4-04(R2014), Enclosed Switches.
 - .2 C22.2 No.39-M1987 (R2013), Fuseholder Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers Steel, Metal, and Plastic waste in accordance with Waste Management Plan.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Fusible and non-fusible disconnect switch in CSA Enclosure and size as indicated.
- .2 Provision for padlocking in on-off switch position by locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated.
- .5 Fuseholders: to CSA C22.2 No.39 relocatable and suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

Part 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches and complete with fuses where applicable.

END OF SECTION 26 28 23

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 This section specifies contactors for control and protective devices

1.2 REFERENCES

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for [contactors] and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for [contactors] for incorporation into manual.
- .3 Include operating information required for start-up, synchronizing and shut-down of generating units.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in indoor dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect contactors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 CONTACTORS

- .1 Contactors: to [CSA C22.2 No.14].
- .2 [Electrically held] [Permanent magnet latch type] [Mechanically held] controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.
- .3 [Breaker] [Fused switch] combination contactor as indicated.
- .4 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.
- .5 Mount in CSA Enclosure type 2 unless otherwise indicated.
- .6 Include following options in cover:
 - .1 [Red] [Green] indicating lamp.

- .2 [Stop-Start] pushbutton.
- .3 [Hand-Off-Auto] selector switch.
- .4 [On-Off] selector switch.
- .7 Control transformer: in accordance with Section [26 29 03 - Control Devices], factory wired and installed in contactor enclosure.

2.2 EQUIPMENT IDENTIFICATION

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Size 4 nameplate indicating name of load controlled.

Part 3 Execution

3.1 INSTALLATION

- .1 Install contactors and connect power wires and auxiliary control devices.
- .2 Identify contactors with nameplates or labels indicating panel and circuit number.
- .3 Test contactors in accordance with 26 05 00 - Common Work Results for Electrical.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.3 PROTECTION

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

END OF SECTION 26 29 01

Part 1 General

1.1 SECTION INCLUDES

- .1 This Section describes manual and magnetic motor starters for motors up to 600 volts

1.2 REFERENCES

- .1 International Electrotechnical Commission (IEC)
 - .1 IEC 947-4-1-[latest edition], Part 4: Contactors and motor-starters.
 - .2 CAN/CSA – C22.2 No.14-[latest edition], Industrial Control Equipment.

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 26 05 00 – Common Work Results - Electrical.
- .2 Include operation and maintenance data for each type and style of starter.

1.5 EXTRA MATERIALS

- .1 Provide listed spare parts for each different size and type of starter:
 - .1 [3] contacts, stationary.
 - .2 [3] contacts, movable.
 - .3 [1] contacts, auxiliary.
 - .4 [1] control transformer.
 - .5 [1] operating coil.
 - .6 [2] fuses.
 - .7 [10]% indicating lamp bulbs used.

Part 2 Products

2.1 MANUAL MOTOR STARTERS

- .1 Single and Three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 Overload heater [s], manual reset, trip indicating handle.

- .2 Accessories:
 - .1 Pushbutton: heavy duty, oil tight, labelled as indicated.
 - .2 Indicating light: standard heavy duty, oil tight, type and colour as indicated.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.2 FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include [fused disconnect switch] [motor circuit interrupter] [circuit breaker] with operating lever on outside of enclosure to control [disconnect] [motor circuit interrupter] [circuit breaker], and provision for:
 - .1 Locking in "OFF" position with up to 3 padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
 - .1 Selector switches: heavy duty, oil tight, labelled as indicated.
 - .2 Indicating lights: heavy duty, oil tight, type and color as indicated.
 - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.3 FULL VOLTAGE REVERSING MAGNETIC STARTERS

- .1 Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Two - 3 pole magnetic contactors mounted on common base.
 - .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
 - .3 Three overload relays with heater elements, manual reset.
- .2 Accessories:
 - .1 Selector switches: heavy duty, oil tight, labelled as indicated.
 - .2 Indicating lights: heavy duty, oil tight, type and color as indicated.
 - .3 Auxiliary control devices as indicated.

2.4 MAGNETIC STARTER, REDUCED VOLTAGE, AUTO-TRANSFORMER

- .1 Auto-transformer starter closed circuit transition type, of size, type, rating and enclosure type as indicated and with following components:
 - .1 Three-3 pole contactors.
 - .2 Auto-transformer with 50%, 65% and 80% taps.
 - .3 One adjustable pneumatic timing relay.

- .4 One-3 pole manual reset overload device.
- .5 Thermal overload protection of auto-transformers.
- .2 Accessories:
 - .1 Selector switches: heavy duty, oil tight, labelled as indicated.
 - .2 Indicating lights: heavy duty, oil tight, type and color as indicated.
 - .3 Auxiliary control devices as indicated.

2.5 MAGNETIC STARTER REDUCED VOLTAGE STAR-DELTA

- .1 Reduced voltage star-delta open transition starter, of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two-3 pole delta contactors with auxiliary relays and interlocks.
 - .2 One-3 pole star contactor with auxiliary relays and interlocks.
 - .3 Mechanical interlock to interlock one delta contactor and the star contactor.
 - .4 One timing relay.
 - .5 Three pole manual, reset overload relays.
- .2 Reduced voltage star-delta closed transition starter, of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two-3 pole delta contactors with auxiliary relays and interlocks.
 - .2 One-3 pole star contactor with auxiliary relay and interlocks.
 - .3 One-3 pole transition contactor.
 - .4 One set of transition resistors.
 - .5 Mechanical interlock, to interlock one delta contactor and the star contactor.
 - .6 One timing relay.
 - .7 Three pole manual reset overload relays.
- .3 Accessories:
 - .1 Selector switches: heavy duty, oil tight, labelled as indicated.
 - .2 Indicating lights: heavy duty, oil tight, type and color as indicated.
 - .3 Auxiliary control devices as indicated.

2.6 MAGNETIC STARTER REDUCED VOLTAGE PART WINDING

- .1 Two-step reduced voltage, part winding starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two-3 pole contactors.
 - .2 Adjustable pneumatic timer.
 - .3 Six manual reset overload relays.
- .2 Three step reduced voltage part winding starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Three-3 pole contactors.
 - .2 One set starting resistors.
 - .3 Six manual reset overload relays.

- .3 Accessories:
 - .1 Selector switches: heavy duty, oil tight, labelled as indicated.
 - .2 Indicating lights: heavy duty, oil tight, type and color as indicated.
 - .3 Auxiliary control devices as indicated.

2.7 THREE PHASE MANUAL REVERSING STARTER

- .1 Three phase manual reversing starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two-3 pole manual motor starters, quick make and break.
 - .2 Six overload relays and manual reset.
 - .3 Mechanical interlock to prevent both switches from closing at same time.
- .2 Accessories
 - .1 Selector switches: heavy duty, oil tight, labelled as indicated.
 - .2 Indicating lights: heavy duty, oil tight, type and colour as indicated.

2.8 THREE PHASE MANUAL TWO SPEED SEPARATE WINDING STARTERS

- .1 Three phase manual two speed separate winding starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Two-3 pole manual motor starters, quick make and break.
 - .2 Six overload relays and manual reset.
 - .3 Mechanical interlock to prevent both switches from closing at same time.
- .2 Accessories:
 - .1 Selector switches: heavy duty, oil tight, labelled as indicated.
 - .2 Indicating lights: heavy duty, oil tight, type and colour as indicated.

2.9 CONTROL TRANSFORMER

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

2.10 FINISHES

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

2.11 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

Part 3 Execution

3.1 INSTALLATION

- .1 Install starters, connect power and control as indicated.
- .2 Ensure correct fuses and overload devices elements installed.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 26 29 10

Part 1 General

1.1 SECTION INCLUDES

- .1 Diesel engine driven generator sets above 30kW rating, normally 3 phase, 120/208V to 250kV.A, 600V from 250 to 750kV.A. and 2400V delta or 2400/4160V star above 750kV.A.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Petroleum Institute (API)
 - .1 ANSI/API 650-[1988(A2000)], Welded Steel Tanks for Oil Storage Tenth Edition; Addendum 1.
- .2 American National Standards Institute (ANSI)/National Electrical Manufacturers' Association (NEMA)
 - .1 ANSI/NEMA MG1-[1998], Motors and Generators.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-3.6-[2000], Regular Sulphur Diesel Fuel.
- .4 International Organization for Standardization (ISO)
 - .1 ISO 3046-1-[2002], Reciprocating Internal Combustion Engines - Performance - Part 1: Declarations Of Power, Fuel And Lubricating Oil Consumptions, And Test Methods.
- .5 National Electrical Manufacturers Association (NEMA)
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 ULC-S601-[00], Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids.
 - .2 CAN/ULC-S603-[92], Standard for Steel Underground Tanks for Flammable and Combustible Liquids.

1.3 SYSTEM DESCRIPTION

- .1 Generating system consists of:
 - .1 Diesel engine.
 - .2 Alternator.
 - .3 Alternator control panel.
 - .4 Battery charger and battery.
 - .5 Automatic engine enclosure ventilation system.
 - .6 Fuel supply system.
 - .7 Exhaust system.
 - .8 Steel mounting base.
 - .9 Sub-base fuel tank
 - .10 Synchronizing panel.
 - .11 Manual by-pass switch.
- .2 System designed to operate as an unattended emergency standby unit.

1.4 ACCEPTABLE MANUFACTURER

- .1 Acceptable manufacturers: Cummins, Cullen-MTU, Caterpillar, Kohler

1.5 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 00 Common Work Results - Electrical.
- .2 Include:
 - .1 Engine: make and model, with performance curves.
 - .2 Alternator: make and model.
 - .3 Voltage regulator: make, model and type.
 - .4 Manual bypass switch: make and model.
 - .5 Battery: make, type and capacity.
 - .6 Battery charger: make, type and model.
 - .7 Alternator control panel: make and type of meters and controls.
 - .8 Governor type and model.
 - .9 Automatic engine enclosure ventilation system.
 - .10 Cooling air requirements in m³/s.
 - .11 British standard or DIN rating of engine.
 - .12 Flow diagrams for:
 - .1 Diesel fuel.
 - .2 Cooling air.
 - .13 Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, sub-hose fuel tank and total weight.
 - .14 Continuous full load output of set at 0.8PF lagging.
 - .15 Description of set operation including:
 - .1 Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
 - .2 Manual starting.
 - .3 Automatic shut down and alarm on:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator overvoltage.
 - .7 Lube oil high temperature.
 - .8 Over temperature on alternator.
 - .4 Manual remote emergency stop.

1.6 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for diesel generator for incorporation into manual specified in Section 26 05 00 – Common Work Results - Electrical.
- .2 Include in Operation and Maintenance Manual instructions for particular unit supplied and not general description of units manufactured by supplier and:
 - .1 Operation and maintenance instructions for engine, alternator, control panel, automatic transfer switch, manual bypass switch, battery charger, battery, fuel system, engine room ventilation system, exhaust system and accessories, to permit effective operation, maintenance and repair.
 - .2 Technical data:
 - .1 Illustrated parts lists with parts catalogue numbers.
 - .2 Schematic diagram of electrical controls.
 - .3 Flow diagrams for:
 - .1 Fuel system.
 - .2 Lubricating oil.
 - .3 Cooling system.
 - .4 Certified copy of factory test results.
 - .5 Maintenance and overhaul instructions and schedules.
 - .6 Precise details for adjustment and setting of time delay relays or sensing controls which require on site adjustment.

1.7 WARRANTY

- .1 For Work of this Section 12 month warranty period prescribed in Section 26 05 00 – Common Work Results – Electrical is extended to 60 months or 1500 operating hours, whichever occurs first.

1.8 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with the manufacturer's recommendations.
- .2 Include, at a minimum:
 - .1 [2] fuel filter replacement elements.
 - .2 [2] lube oil filter replacement elements.
 - .3 [2] air cleaner filter elements.
 - .4 [2] sets of fuses for control panel.
 - .5 Special tools for unit servicing.

Part 2 Products

2.1 DIESEL ENGINE

- .1 Diesel engine: to ISO 3046-1.
 - .1 Engine: standard product of current manufacture, from company regularly engaged in production of such equipment.
- .2 Naturally aspirated, synchronous speed 1800 r/min.
- .3 Capacity:

- .1 Rated continuous power in kW at rated speed, after adjustment for system losses in auxiliary equipment necessary for engine operation; to be calculated as follows: Rated continuous output = Generator kW divided by Generator efficiency at full load.
 - .1 Under following site conditions:
 - .1 Altitude: [____] m.
 - .2 Ambient temperature: [____] degrees C.
 - .3 Relative humidity: [____] %.
 - .2 Engine overload capability 110% of continuous output for 1 hour within 12 hours period of continuous operation.
- .4 Cooling System:
 - .1 Liquid cooled: heavy duty industrial radiator mounted [on generating set base with engine driven pusher type fan to direct air through radiator from engine side] [remotely with electrically driven fan], with ethylene glycol anti-freeze non-sludging above minus 46 degrees C.
 - .2 Air cooled: air cooling duct enveloping cylinder walls with pressure cooling by engine driven blower.
 - .3 To maintain manufacturer's recommended engine temperature range at 10% continuous overload in ambient temperature of 40 degrees C.
 - .4 Block heater: thermostatically controlled lube oil or liquid coolant heater connected to line side of automatic transfer switch to allow engine to start in room ambient minus 10 degrees C.
 - .1 Switch and fuse in heater circuit, mounted in engine-alternator control cubicle and fed from line side of automatic transfer switch.
- .5 Fuel:
 - .1 Type A fuel oil: to CAN/CGSB-3.6.
 - .2 Arctic Grade [1] [2] : to CAN/CGSB-3.6.
- .6 Fuel system: solid injection, mechanical fuel transfer pump with hand primer, fuel filters and air cleaner, fuel rack solenoid energized when engine running.
- .7 Governor:
 - .1 Mechanical hydraulic with:
 - .1 Steady state speed band of plus or minus 0.5%.
 - .2 Speed regulation no load to full load 5% maximum.
 - .3 Electronic load sharing type, electric actuator, speed droop externally adjustable from isochronous to 5%, temperature compensated with steady state speed maintenance capability of plus or minus 0.25%.
- .8 Lubrication system:
 - .1 Pressure lubricated by engine driven pump.
 - .2 Lube oil filter: replaceable, full flow type, removable without disconnecting piping.
 - .3 Lube oil cooler.
 - .4 Engine sump drain valve.
 - .5 Oil level dip-stick.
- .9 Starting system:
 - .1 Positive shift, gear engaging starter 12 or 24V dc.

- .2 Cranking limiter to provide 3 cranking periods of 10s duration, each separated by 5 s rest.
- .3 [Lead acid], 12 or 24V storage battery with sufficient capacity to crank engine for 1min at 0 degrees C without using more than 25% of ampere hour capacity.
- .4 Battery charger: constant voltage, solid state, two stage from trickle charge at standby to boost charge after use. Regulation: plus or minus 1% output for plus or minus 10% input variation. Automatic boost for 6h every 30 days. Equipped with dc voltmeter, dc ammeter and on-off switch. Minimum charger capacity: 7 A.
- .10 Vibration isolated engine instrument panel with:
 - .1 Lube oil pressure gauge.
 - .2 Lube oil temperature gauge.
 - .3 Lube oil level gauge.
 - .4 Coolant temperature gauge.
 - .5 Coolant level gauge.
 - .6 Running time meter: non-tamper type.
- .11 Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.
- .12 Drip tray.

2.2 ALTERNATOR

- .1 Alternator: to ANSI/NEMA MG1.
- .2 Rating: 600 V, 3 phase 4 wire, 60Hz, at 0.8PF.
- .3 Output at 40 degrees C ambient:
 - .1 100% full load continuously.
 - .2 110% full load for 1h.
 - .3 150% full load for 1 min.
- .4 Revolving field, brushless, single bearing.
- .5 Drip proof.
- .6 Amortisseur windings.
- .7 Synchronous type.
- .8 Dynamically balanced rotor permanently aligned to engine by flexible disc coupling.
- .9 Exciter: [rotating brushless] [permanent magnet].
- .10 [EEMAC] [NEMA] class [F] [H] insulation on windings.
- .11 [Thermistors] [Platinum resistance temperature transducers] embedded in stator winding and connected to alternator control circuitry.
- .12 Voltage regulator: thyristor controlled rectifiers with phase controlled sensing circuit:
 - .1 Stability: [____]% maximum voltage variation at any constant load from no load to full load.
 - .2 Regulation: 1.5% maximum voltage deviation between no-load steady state and full-load steady state.
 - .3 Transient: 1.5% maximum voltage dip on one-step application of 0.8PF full load.
 - .4 Transient: 25% maximum voltage rise on one-step removal of 0.8PF full load.

- .5 Transient: 12 s maximum voltage recovery time with application or removal of 0.8PF full load.
- .13 Alternator: capable of sustaining 300% rated current for period not less than 10s permitting selective tripping of down line protective devices when short circuit occurs.

2.3 CONTROL PANEL

- .1 Weatherproof totally enclosed, [free standing] [wall mounted] [mounting base isolated from diesel generator].
- .2 Instruments:
 - .1 Digital indicating type 2% accuracy, rectangular face, flush panel mounting:
 - .1 Voltmeter: ac, scale 0 to 750 V.
 - .2 Ammeter: ac, scale 0 to 2200 A.
 - .3 Wattmeter scale 0 to 2200 kW.
 - .4 Frequency meter: scale 55 to 65Hz.
 - .5 kW.h meter.
 - .2 Voltmeter selector switch, rotary, panel mounting, round notched handle, four position, labelled "Off-Phase A-Phase B-Phase C".
 - .3 Ammeter selector switch, rotary, maintained contacts, panel mounting, designed to prevent opening of current circuits, round notched handle, four position labelled "OFF- Phase A-Phase B-Phase C".
 - .4 Instrument Transformers
 - .1 Potential-dry type for indoor use:
 - .1 Ratio: 600 to 120.
 - .2 Rating: 600 V, 60Hz, BIL 25 kV.
 - .2 Current-dry type for indoor use:
 - .1 Ratio: 600 to 5.
 - .2 Rating: 600 V, 60Hz, BIL 25 kV.
 - .3 Positive action automatic short-circuiting device in secondary terminals.
- .3 Controls:
 - .1 Engine start button.
 - .2 Selector switch: Off-Auto-Manual - Test full load test no load.
 - .3 Engine emergency stop button and provision for remote emergency stop button.
 - .1 Alternator output breaker:
 - .1 Circuit breaker: bolt-on, moulded case, temperature compensated for 40 degrees C ambient, dual thermal-magnetic trip.
 - .2 Voltage control rheostat: mounted on inside of control panel.
 - .3 Operating lights, panel mounted:
 - .1 "Normal power" pilot light.
 - .2 "Emergency power" pilot light.
 - .3 Green pilot lights for breaker on and red pilot lights for breaker off.

- .4 Solid state indicator lights for alarm with [1set] manually reset NO/NC contacts wired to terminal block for remote annunciation on:
 - .1 Low fuel level.
 - .2 Low battery voltage.
 - .3 Ventilation failure.
 - .4 Low coolant temperature.
 - .5 Low DC voltage.
 - .6 High DC voltage.
 - .7 Ground fault.
 - .8 Fuel leak.
- .5 Solid state controller for automatic shutdown and alarms with 1set manually reset NO/NC contacts wired to terminal block for remote annunciation on:
 - .1 Engine overcrank.
 - .2 Engine overspeed.
 - .3 Engine high temperature.
 - .4 Engine low lube oil pressure.
 - .5 Short circuit.
 - .6 AC over voltage.
 - .7 Fail to crank.
 - .8 Emergency stop.
- .6 Lamp test button.
- .7 Synchronization and load sharing.
- .8 Provision for remote monitoring.
- .9 The alarms and conditions for shut down indicated in items .4 and .5 shall be available on digital display panel on the control panel.
- .10 The control system shall include time delay start and time delay stop functions. The time delay start shall be adjustable 0-300 seconds, factory set at 3 seconds. The time delay stop shall be adjustable 0-600 seconds, factory set at the manufacturer's recommended setting.
- .11 The control system shall include sender failure monitoring logic for speed sensing, oil pressure and engine temperature and be capable of discriminating between failed sender or wiring components and an actual failure conditions.
- .12 The control system shall include an idle mode control which allows the engine to run in the idle mode in the Manual position only. In this mode, the alternator excitation system shall be disabled.
- .13 The control system to have data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set as well as the total time of operation at various loads as a percent of the standby rating of the generator set.
- .14 Three sets of NO/NC relays to be provided, one for common alarm one for the running condition one for low fuel condition.

- .15 The controls shall include a load shed control, to operate a set of dry contacts when the generator is overload.
- .16 Provide Modbus and other interface required in order to connect the generator control panel to the BMS in the Building. The BMS must be able to read all the monitoring and operation signals from genset. This contractor is responsible for all the conduit and wires to the BMS panel and coordinate with Division 15 for final connection.

2.4 MANUAL BYPASS SWITCH

- .1 Load break bypass and isolation switch: manually operated, double throw, to provide bypass around transfer switch to facilitate maintenance on diesel generator control panel and transfer switch. Switch lockable in bypass position.

2.5 STEEL MOUNTING BASE

- .1 Complete generating set mounted on [structural] steel base of sufficient strength and rigidity to protect assembly from stress or strain during transportation, installation and under operating conditions on suitable level surface.
- .2 Assembly fitted with vibration isolators and control console resiliently mounted.
 - .1 Spring type isolators with adjustable side snubbers and adjustable for levelling.
- .3 Sound insulation pads for installation between isolators and concrete base.
- .4 The generator set shall be provided with an outdoor weatherproof waterproof enclosure. The package shall comply with the requirements of the Canadian Electrical Code for all wiring materials and component spacing. The total assembly of generator set and enclosure shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 40 degrees C. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable, and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.
- .5 Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation of service work.
- .6 Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.
- .7 A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.
- .8 The enclosure shall include the following maintenance provisions:
 - .1 Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves.
 - .2 External radiator fill provision.
- .9 The fueling tank and generator enclosure manufactured and assembled by the same manufacturer and must be available for inspection before delivery to the site.

2.6 EXHAUST SYSTEM

- .1 Heavy duty [residential type] [industrial] [critical] [horizontally] mounted exhaust silencer with condensate drain, plug and [flanged] [welded] couplings.
- .2 Heavy duty flexible exhaust pipe with flanged couplings as required.
- .3 Fittings and accessories as required.
- .4 Expansion joints: stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion.

2.7 FUEL SYSTEM

- .1 Fuel storage tanks: to ANSI/API 650, ULC labelled.
 - .1 Above ground tank: to ULC-S601.
 - .2 Day tank integral to generator and capable of supplying generator for 24 hours minimum. The tank to be dual wall sub-base constructed with corrosion resistant steel. The tank shall be completed with drain tap and dip stick (mark in letters and inches) for manually checking the fuel level. The tank shall be completed with a locking (padlock) fuel fill cap and spiral type mechanical fuel gauge next to the fuel cap. The tank also complete with a float type leak detector between the inner and outer wall for detecting any inner wall rupture. The integrated sub base fuel tank to be on painted steel structural steel support base frame complete with flexible supply and return hoses with connection fittings, fuel filter, vent line connection fittings and 110% containment capacity and accessories specified. Submit the size of tank based on calculated recommendation from manufacturer to consultant for approval. The fuel tank and all accessories to be waterproof.
 - .3 Factory installed leak detection of day tank and leak alarm kit.
 - .4 Four level float switch kit for connecting to fuel filling station and controls.
 - .5 Low level alarm kit.
 - .6 Integral transfer pump.

2.8 COOLING AIR SYSTEM

- .1 Engine ventilating system:
 - .1 Recirculating damper assembly with modulating motor.
 - .2 Cold air inlet damper assembly with modulating motor.
 - .3 Air discharge and intake gooseneck weatherhoods.
 - .4 Modulating thermostat.
 - .5 Replaceable air intake filters.

2.9 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Control panel:
 - .1 Size [4] [5] nameplates for controls including alternator breakers and program selector switch.
 - .2 Size [2] [3] nameplates for meters, alarms, indicating lights and minor controls.

2.10 FABRICATION

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

2.11 FINISHES

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Alternator control cubicle: paint inside, exterior to match engine and alternator.
- .3 Exhaust and inlet air hoods [international orange].
- .4 Other ducts and racks grey.
- .5 Supply 0.25L of touch-up enamel (appropriate colour).

2.12 SOURCE QUALITY CONTROL

- .1 Factory test generator set including engine, alternator, control panels and accessories in presence of [Engineer] [Consultant].
- .2 Test procedure:
 - .1 Prepare blank forms and check sheet with spaces to record data. At top of first sheet record:
 - .1 Date.
 - .2 Generator set serial no.
 - .3 Engine, make, model, serial no.
 - .4 Alternator, make, model, serial no.
 - .5 Voltage regulator, make and model.
 - .6 Rating of generator set, kW, kV.A, V, A, r/min, Hz.
 - .2 Mark check sheet and record data on forms in duplicate as test proceeds.
 - .3 [Engineer's] [Consultant's] signature on completed forms to indicate concurrence in results of test.
- .3 Tests:
 - .1 With 100% rated load, operate set for 24 h, taking readings at 30 min intervals, and record following:
 - .1 Time of reading.
 - .2 Running time.
 - .3 Ambient temp in degrees C.
 - .4 Lube oil pressure in kPa.
 - .5 Lube oil temp in degrees C.
 - .6 Engine coolant temp in degrees C.
 - .7 Exhaust stack temp in degrees C.
 - .8 Alternator voltage: phase 1, 2, 3.

- .9 Alternator current: phase 1, 2, 3.
- .10 Power in kW.
- .11 Frequency in Hz.
- .12 Power Factor.
- .13 Battery charger current in A.
- .14 Battery voltage.
- .15 Alternator cooling air outlet temp.
- .2 At end of 23 hours run increase load to 110% rated value, and take readings every 15 min for 1 hour.
- .3 After completion of 24 hours run, demonstrate following shut down devices and alarms:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator overvoltage.
 - .7 Low battery voltage, or no battery charge.
 - .8 Manual remote emergency stop.
 - .9 High alternator temperature.
- .4 Next install continuous strip chart recorders to record frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments to include:
 - .1 No load to full load to no load.
 - .2 No load to 70% load to no load.
 - .3 No load to 20% load to no load.
 - .4 20% load to 40% load to no load.
 - .5 40% load to 60% load to no load.
 - .6 60% load to 80% load to no load.
- .4 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate generating unit and install as indicated.
- .2 Install fuel supply system as indicated.
- .3 Complete wiring and interconnections as indicated.
- .4 Start generating set, provide load bank and fuel and test to ensure correct performance of components.
- .5 Provide power for charger from an emergency power panel.
- .6 Provide remote generator annunciator in the main electrical room.
- .7 Provide connection and monitoring to Fire Alarm Panel and annunciator.

- .8 Provide connection and monitoring to BMS.

3.2 FIELD QUALITY CONTROL

- .1 Notify Engineer 10 working days in advance of test date.
- .2 Provide fuel for testing and leave full tanks on acceptance.
- .3 Demonstrate:
 - .1 Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.
 - .2 Unit start and shut down on "Manual" control
 - .3 Unit start and transfer on "Test" control.
 - .4 Unit start on "Engine start" control.
 - .5 Operation of manual bypass switch.
 - .6 Operation of automatic alarms and shut down devices.
- .4 Perform 6 hours load testing of unit on full load to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling. Record following at 30 minute intervals during the entire test:
 - .1 Kilowatts
 - .2 Amperes
 - .3 Voltage
 - .4 Frequency
 - .5 Oil Pressure
 - .6 Coolant Temperature
 - .7 Room Temperature
 - .8 Noise level at 3m from unit
- .5 Record noise level measurements in dB at various locations around the unit and area surrounding the exhaust port.
- .6 At end of test run, check battery voltage to demonstrate battery charger has returned battery to full charged state.
- .7 After the demonstration, refill fuel tank.

END OF SECTION 26 32 13

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for automatic load transfer equipment which can monitor voltage on all phases of normal power supply, initiate cranking of standby generator unit, transfer loads and shut down standby unit when normal power is re-established.
- .2 The Contractor shall furnish and install the low voltage automatic transfer switch having the ratings, features/accessories and enclosures as specified herein and as shown on the contract drawings.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C282-15 – Emergency Electrical power Supply for Buildings
 - .2 CSA C22.2 No.178- latest edition, Automatic Transfer Switches.
 - .3 CSA C22.2 No. 5.1 Moulded Case Circuit Breakers

1.3 SCOPE OF WORK

- .1 Provide and install a breaker type, open transition automatic transfer switches with bypass isolation, and having the ratings, features/accessories and enclosures as shown on the drawings and as specified herein:
 - .1 Bus rating: 1200 A 208V 3-phase 4-wire c/w maintenance bypass.

1.4 SYSTEM DESCRIPTION

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

1.5 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Include:
 - .1 Make, model and type.
 - .2 Dimensioned drawings of the unit and enclosure.
 - .3 Load classification.
 - .4 Single line diagram showing controls and relays.
 - .5 Description of equipment operation including:

- .1 Automatic starting and transfer to standby unit and back to normal power.
- .2 Test control.
- .3 Manual control.
- .4 Automatic shutdown.

1.6 CLOSEOUT SUBMITTALS

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

Part 2 Products

2.1 MATERIALS

- .1 Instrument transformers: to CAN3-C13.
- .2 Contactors: to ANSI/NEMA ICS2.

2.2 CIRCUIT BREAKER TYPE TRANSFER EQUIPMENT

- .1 Circuit Breaker Type Transfer Equipment: to CSA C22.2No.5.
- .2 Rated: as indicated on plans.
 - .1 Fault withstand rating: 24 kA symmetrical for 3 cycles.
 - .2 One normal three phase molded-case circuit breaker with thermal magnetic trip mounted on common base, designed for double throw action, motor operated, mechanically held and interlocked, wall mounted CSA enclosure.
 - .3 One emergency three phase moulded-case circuit breaker with thermal magnetic trip, motor operated, and interlocked.
 - .4 Circuit breakers:
 - .1 Trip free in closed position.
 - .2 Interrupting rating: 1200A symmetrical.
 - .5 Dead front construction with access to relays and controls for inspection and maintenance, and manual operating lever for transfer switch.
 - .6 Main contacts - silver plated, protected by arc disruption means.
 - .7 Auxiliary contact: silver plated to initiate emergency generator start-up on failure of normal power.
 - .8 Solid neutral bar, fully rated.
 - .9 Overlapping neutral contacts on contractor type transfer equipment.
 - .10 Switchable neutral pole on circuit breaker type equipment.
 - .11 Fault withstand rating: 24kA symmetrical for 3 cycles.

2.3 CONTROLS

- .1 Selector switch - four position "Test", "Auto", "Manual", "Engine start".

- .1 Test position - Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.
- .2 Auto position - Normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.
- .3 Manual position - Transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.
- .4 Engine start position - Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.
- .2 Control transformers: dry type with 120V secondary to isolate control circuits from:
 - .1 Normal power supply.
 - .2 Emergency power supply.
- .3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:
 - .1 Voltage sensing: 3 phase for normal power and on one phase only for emergency, solid state type, adjustable drop out and pick up, close differential, 2V minimum undervoltage protection.
 - .2 Time delay: normal power to standby, adjustable solid state, 0 to 60s.
 - .3 Time delay on engine starting to override momentary power outages or dips, adjustable solid state, 0 to 60s delay.
 - .4 Time delay on retransfer from standby to normal power, adjustable 0 to 60s.
 - .5 Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable solid state, 20s intervals to 10 min.
 - .6 Time delay during transfer to stop transfer action in neutral position to prevent fast transfer, adjustable, 5s intervals to 180s.
 - .7 Frequency sensing, to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.
- .4 Solid state electronic in-phase monitor.

2.4 ACCESSORIES

- .1 Pilot lights to indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel.
- .2 Plant exerciser: 168h timer to start standby unit once each week for selected interval but does not transfer load from normal supply. Timer adjustable 0-168h in 15 min intervals.
- .3 Auxiliary relay to provide 2 N.O. and 2 N.C. contacts for remote alarms.
- .4 Instruments:
 - .1 Digital true rms, indicating type 2] accuracy, flush panel mounting:
 - .1 Voltmeter: ac, scale 0 to 750V.
 - .2 Ammeter: ac, scale 0 to 5 A.
 - .3 Frequency meter: scale 55 to 65 Hz.
- .5 Voltmeter selector switch: rotary, maintained contacts, panel mounting type, round notched handle, four position, labelled "OFF – Phase A – Phase B – Phase C".
- .6 Potential transformers - dry type for indoor use:
 - .1 Ratio: 600 to 120.
 - .2 Rating: 600V, 60Hz.

- .3 Accuracy rating: 5%.
- .7 Ammeter selector switch: rotary, maintained contacts, panel mounting type, designed to prevent opening of current circuits, round notched handle, four position labelled "OFF - Phase A - Phase B - Phase C".
- .8 Current transformers - dry type for indoor use:
 - .1 Ratio: 1000 to 5.
 - .2 Rating: 600 V, 60Hz.
 - .3 Accuracy rating: 5%.
 - .4 Positive action automatic short- circuiting device in secondary terminals.
- .9 Manual bypass: YES.

2.5 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Control panel:
 - .1 For selector switch and manual switch: size4 nameplates.
 - .2 For meters, indicating lights, minor controls: size2 nameplates.

2.6 OPERATIONS

- .1 The automatic transfer switches are to be continuous rated as per drawings for – 3 phase – 4 wire -208 V operation, and are to be compatible with new emergency generator.
- .2 The automatic transfer switches shall include standard components and provide control to:
 - .1 Select through a switch “with load” or “without load” to test as follows:
 - .1 “Without load” the generator set runs unloaded.
 - .2 “With load” the automatic transfer switch transfers load to the generator set as if normal source interruption occurred.
 - .2 Monitor each ungrounded line with a calibrated dial adjustable voltage solid state sensors and sense a decrease of voltage below a set point or loss of voltage on any phase of the normal power supply. Voltage sensors shall be temperature compensated.
 - .3 Signal the engine generator set to start in the event of power interruption. A solid state time delay shall delay this signal three seconds to avoid nuisance start-ups on momentary voltage dips or power outages. The
 - .4 shall include the three second start delay.
 - .5 Retransfer the load to the line after normal power restoration. A time delay shall delay this retransfer to avoid short term normal power restoration (variable one to five minutes, set at one minute).
 - .6 Provide an automatic retransfer of the load from generating set to normal source if the generating set output interrupts after normal source restores voltage.
 - .7 Signal the engine generator to stop after load retransfer to normal source. A solid state time delay on stop shall permit the engine to run unloaded to cool down before shutdown.

- .8 Provide a device to electrically disconnect the control sections from the transfer switch for maintenance service during normal operation.
- .3 Selected automatic transfer switch shall be included in a factory assembly with bypass-isolation switch equipment. The bypass-isolation switch shall provide a safe means for manually bypassing the transfer switch from either source (Normal or Emergency) to the load [, while under load if necessary,] and to isolate the transfer switch from both sources for maintenance or repair [Designs that bypass to only one source are not acceptable under this specification.]
 - .1 Ratings:
 - .1 Bypass-isolation switch equipment shall be ULC Listed and CSA approved, manually operated with continuous current rating, voltage and frequency ratings, and withstand and closing ratings equal to the transfer switch ratings at the specified conditions of ambient temperature, humidity and altitude.
 - .2 Construction:
 - .1 The bypass-isolation and transfer switch shall be mechanically held in each position. Switching mechanisms shall be break before make on all poles. The switch mechanism shall be an over centre toggle device which provides stored energy contact operation during both opening and closing. The speed of contact operation shall be independent of the force applied to the operating handles, which permits manual operation under load.
 - .3 Bypass Switch:
 - .1 Equipment shall provide for manual bypass operation to the source opposite that to which the transfer switch is connected. This shall cause the transfer switch to go automatically to a position disconnected from both sources.
 - .4 Interlocks:
 - .1 Positive mechanical interlocks shall prevent all possible source to source interconnections. Designs which depend on electrical interlocks to prevent source to source interconnections, or which intentionally interconnect the sources, are not acceptable.
 - .2 The interlock system shall assure a properly sequenced, mechanically guided bypass and isolation action.
 - .3 The equipment shall utilize automatic mechanical stops.
- .4 Emergency generator supplier is to install automatic transfer switch, and make all necessary connections to facilitate a complete operational system, in conjunction with new emergency generator installation. Generator equipment supplier is to provide Consultant with written Verification Report complete with test results.

2.7 SOURCE QUALITY CONTROL

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Consultant.
- .2 Notify Consultant 10 days in advance of date of factory test.
- .3 Tests:
 - .1 Operate equipment both mechanically and electrically to ensure proper performance.

- .2 Check selector switch, in modes of operation [Test, Auto, Manual, Engine Start] and record results.
- .3 Check voltage sensing and time delay relay settings.
- .4 Check:
 - .1 Automatic starting and transfer of load on failure of normal power.
 - .2 Retransfer of load when normal power supply resumed.
 - .3 Automatic shutdown.
 - .4 In-phase monitor operation.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate, install and connect transfer equipment.
- .2 Check relays, solid state monitors and adjust as required.
- .3 Install and connect remote alarms.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance as follows:
 - .1 Energize transfer equipment from normal power supply.
 - .2 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
 - .3 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
 - .4 Repeat, at 1h intervals, 3 times, complete test with selector switch in each position, for each test.

END OF SECTION 26 36 23

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies the materials and installation for luminaires for the entire project including exterior lighting fixtures.
- .2 Refer to the Luminaire Schedule on the electrical drawings.

1.2 REFERENCES

- .1 CAN/CSA C22.1-18, Canadian Electrical Code, Part I.
- .2 CAN/CSA C22.2 No.9.0, General Requirements for Luminaires.

1.3 GREEN INITIATIVES

- .1 There shall be no light trespass from the building and site. Luminaries to improve night sky access and reduce impact on nocturnal environments.
 - .1 All exterior luminaries with more than 1000 initial Lamp Lumens are shielded and all luminaries with more than 3500 initial Lamp Lumens meet the full cut-off IESNA classification.
 - .2 The maximum candela value of all interior lighting shall fall within the building (not out through windows) and the maximum candela value of all exterior lighting shall fall within the property.
 - .3 Any luminaire within a distance of 2.5 times its mounting height from the property boundary shall have shielding such that no light from that luminaire crosses the property boundary.

1.4 ADDITION OF ACCEPTABLE MANUFACTURERS

- .1 Material/products considered to satisfy the specification, but of a manufacturer other than those named may be submitted to the Consultant for consideration not later than five (5) working days prior to closing of tender or of bid depository subtrade tender whichever is earlier.
- .2 Alternate approvals will be given by written addendum only. No other substitution will be permitted after closing of tenders.
- .3 Alternate approvals granted before the closing of tenders will be limited to a manufacturer's system and/or series only. This limited approval will not preclude substitute equipment/material from complying with specific features included with equipment/material specified. Determine that the alternate product meets the specification intent before basing a tender on the product.

1.5 PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit complete photometric and heat dissipation data prepared by independent testing laboratory for proposed luminaires.

1.6 SAMPLE LUMINAIRES

- .1 Submit sample luminaires for review prior to manufacturing when requested by the Consultant.

- .2 Sample luminaires to be operable and complete with lamps, accessories and a plug-in power cord if requested by the Consultant.
- .3 Deliver samples to the Consultants office or to another location as directed. Collect the sample(s) at the conclusion of the review.

1.7 INTENT

- .1 Provide lighting fixtures and accessories for all outlets as listed in the Luminaire Schedule and as shown on drawings.
- .2 Lighting fixtures shall be structurally well designed and constructed, using new parts and materials of the highest commercial grade available.
- .3 Ground all lighting equipment to grounding system.
- .4 Verify all ceiling types and finishes before ordering fixtures and provide fixtures suitable for mounting in or on ceilings being installed in each area, as specified. Where fixture types specified are not suitable for ceiling being installed, obtain written instructions from the Consultant before ordering fixtures.
- .5 Fixtures of the same or similar type shall be supplied by the same manufacturer.

Part 2 Products

2.1 BALLASTS

- .1 All ballasts shall be supplied with a rated voltage matching the supply voltage indicated on the drawings. Ballast output current and voltage shall match the current and voltage ratings of the lamp or lamps they are designed to operate. All ballasts to be built to CSA Standard C22.2 No.74.
- .2 Ballasts shall comply with FCC and NEMA limits covering EMI and RFI and shall not interfere with operation of other normal electrical equipment.
- .3 Minimum requirements for electronic ballasts:
 - .1 Sound rating of 'A'.
 - .2 High frequency operation (25 KHz or higher).
 - .3 Total harmonic distortion to be less than 10%.
 - .4 Current crest factor to be less than 1.7.
 - .5 Rated lamp life shall be maintained.
 - .6 High power factor of 90% or higher.
 - .7 High efficiency ballasts for linear fluorescent lamps.
 - .8 Input voltage as indicated on drawings.
 - .9 Ballasts used in exterior luminaires to have minimum starting temperature of - 18°C.
- .4 Minimum requirements for electromagnetic ballasts:
 - .1 Pulse start type for metal halide.
 - .2 Current crest factor to be less than 1.7.
 - .3 Epoxy encased "super quiet" ballast assemblies for all interior fixtures ballast.
 - .4 Ballasts used in exterior luminaires to have minimum starting temperature of - 30°C.

2.2 LAMPS

- .1 Provide and install lamps in all fixtures in the project.
- .2 Install fluorescent lamps with the same Watt rating as indicated. Refer to schedule for lamp colour and colour rendering index.
- .3 High Pressure Sodium lamps to be coated. Metal Halide lamps to be coated unless otherwise noted.
- .4 Compact fluorescent lamps shall be 2700K colour temperature or as indicated.

2.3 SOLID STATE LIGHTING

- .1 Solid state lighting rated correlated colour temperature (CCT) shall be with four (4) MacAdam ellipses of the specified CCT in the luminaire schedule. Colour consistency between lamps in the same fixture type shall be within four (4) MacAdam ellipses of the rated CCT.
- .2 Solid state lighting shall have a CRI greater or equal to the value listed in the luminaire schedule. In addition the lamps shall have an R9 value greater than 50 measured under the same conditions as the CRI.
- .3 Solid state lighting systems (including required drivers) shall have a power factor greater than 90 at full rated output.
- .4 Solid state lighting lumen maintenance data shall be provided for L70 testing.

2.4 SOCKETS

- .1 Sockets for incandescent fixtures shall be standard medium base.
- .2 Sockets for fluorescent fixtures shall be standard medium bi-pin unless otherwise noted.

2.5 FIXTURES

- .1 Accessories and components shall comply with relevant CSA Standards.
- .2 Recessed downlight fixtures shall be of the approved prewired type with junction box forming an integral part of the fixture assembly and so located in relation to the fixture that the junction box is CSA approved for 75 degree C wire. The electrical trade shall supply and install all necessary plaster rings, supports, etc., required for complete and proper installation.
- .3 Except where otherwise noted in the Luminaire Schedule, depth of recessed fluorescent fixtures shall not exceed 150 mm, including mounting yokes, or bridges. Design of reflector and lamp position shall be to provide high efficiency, even brightness and lack of lamp lines.
- .4 All metal parts shall be thoroughly cleaned and finished in high reflectance baked enamel over corrosion-resistant primer. Finish as indicated in luminaire schedule.
- .5 All internal fixture diffusers, lens panels, lens frames, etc., shall be securely and adequately supported and shall be removable without the use of tools for cleaning.
- .6 Fixtures shall incorporate adequate gasketing, stops and barriers to form light traps and prevent light leaks.
- .7 Fixtures shall be designed for adequate dissipation of ballast and lamp heat to avoid short ballast life, nuisance thermal tripping and decreased lamp output. Heat test reports by independent laboratories shall be provided where required by the Consultant.

- .8 Construction of all fixtures shall be such as to provide a rigid well aligned fixture. Formed or ribbed backplates, end plates, reinforcing channel, heavy gauge sockets, straps, etc., shall be used where required to accomplish this.
- .9 The construction and performance of all fluorescent fixtures shall be subject to the acceptance of the Consultant.

Part 3 Execution

3.1 INSTALLATION AND SUPPORTS

- .1 Provide complete and proper support for all fixtures, fixture hangers, etc., including headers in ceiling space, where required, for proper support of outlet boxes and fixture hanger assemblies.
- .2 Support fixtures as shown on the drawings, level, plumb and true with the structure and other equipment in a horizontal or vertical position as intended. Wall or side bracket mounted fixture housings shall be rigidly installed and adjusted to give a neat flush fit to the surface on which it is mounted.
- .3 All hangers, supports, fastenings or accessory fittings shall be protected against corrosion. Care shall be taken during the installation to assure that insulation and corrosion protection is not damaged.
- .4 Self aligning seismically rated ball joint hangers shall be used for rod suspended fixtures. Ceiling canopies or hood assemblies intended to cover the suspension attachments shall be installed to fit tightly to the ceiling without restricting the alignment of the hanger. Support fixtures by hangers and mounting arrangements which will not cause the fixture frame, housing, sides or lens frame to be distorted; or prevent complete alignment of several fixtures in a row.
- .5 The suspension length of all ceiling mounted suspended types of lighting fixtures as listed in the Fixture Schedule shall be the overall length from the ceiling to the lowest point of the fixture body, reflector or glassware in its hanging position.
- .6 Metal inserts, expansion bolts or toggle bolts in concrete slabs for stems which do not carry wiring must be accurately located in relation to the outlet boxes, to allow perfect alignment and spacing of suspension stems.
- .7 Where fixtures are surface mounted on the underside of an inverted tee bar ceiling, the fixture shall be supported either directly from the building structure by means of rod hangers and inserts or by means of metal angle headers, supported from the tee bar framing structure above the tile. Fixtures shall be supported from the quarter points.
- .8 Wiring from outlet boxes to fluorescent fixtures and wiring through fluorescent fixture channels shall be rated for 90 degrees C.
- .9 Connection to incandescent fixtures shall be by means of approved fixture type wiring.
- .10 All recessed fixtures to be installed so that they are removable from below to gain access to outlet box or prewired fixture box. Connect all recessed fixtures to boxes with flexible conduit and approved fixture wire. Provide approved drywall enclosures in insulated ceilings. Volume of enclosure to comply with Electrical Code.
- .11 Install fixture lenses as late as possible to protect from dirt and dust. Remove and clean or replace lenses to the satisfaction of the Consultant.

END OF SECTION 26 50 00

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for emergency lighting systems.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.141-15, Unit Equipment for Emergency Lighting.

1.3 PRODUCT DATA

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

Part 2 Products

2.1 EQUIPMENT

- .1 Emergency lighting equipment: to CSA C22.2 No.141.
- .2 Supply voltage: 120, 347 V, ac.
- .3 Output voltage: 24 V dc.
- .4 Operating time: 2 hour.
- .5 Battery: sealed, maintenance free.
- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations.
- .7 Solid state transfer circuit.
- .8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
- .10 Lamp heads: integral on unit or remote as indicated, 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: LED, 6 W.
- .11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 Finish: white.
- .13 Auxiliary equipment:
 - .1 Ammeter.
 - .2 Voltmeter.
 - .3 Test switch.
 - .4 Time delay relay.
 - .5 Battery disconnect device.
 - .6 AC input and DC output terminal blocks inside cabinet.
 - .7 Bracket.
 - .8 Hardwire connection for AC.
 - .9 RFI suppressors.

2.2 WIRING OF REMOTE HEADS

- .1 Conduit: in accordance with Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Conductors: in accordance with Section 26 05 21 – Wires and Cables 0-1000 V, sized as indicated [in accordance with manufacturer's recommendations].

Part 3 Execution

3.1 INSTALLATION

- .1 Install unit equipment.
- .2 Direct heads.

END OF SECTION 26 52 01

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for exit signs complete with directional arrows.

1.2 TYPE OF EXIT SIGN

- .1 Install specification grade LED type exit signs in general public areas where indicated on drawings.
- .2 Install specification grade weatherproof LED type exit signs located outdoor or designated 'WP' where indicated on drawings.

1.3 PRODUCT DATA

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: submit manufacturer's product data sheets indicating dimensions, materials, and finishes, including classifications and certifications.

Part 2 Products

2.1 EXIT SIGN TYPES

- .1 **General Areas:**
 - .1 Thin line, LED, edge lit, slim-profile with extruded aluminum. Ready Lite RAE/LDE Series or approved equivalent
- .2 **Weatherproof Type:**
 - .1 White polycarbonate housing with gasketed polycarbonate clear faceplate, LED type. ReadyLite RN series or approved equivalent.
- .3 All exit signs shall comply with CAN/CSA C860 (R2016).
- .4 Exit signs shall be complete with 10 year warranty.

2.2 MOUNTING TYPE

- .1 Allow for exit signs to be mounted as to best suit ceiling/wall type and architectural features:
 - .1 Surface wall mounted
 - .2 End wall mounted double face
 - .3 Recessed wall mounted
 - .4 Ceiling mounted single face
 - .5 Ceiling mounted double face
- .2 Exit signs to have direction arrows where indicated.
- .3 Provide steel rod pendant supports for exit signs to mount to +3.5m A.F.F. in high ceiling areas as required.

Part 3 Execution

3.1 INSTALLATION

- .1 Install exit signs as shown on plans complete with double face units where indicated.
- .2 Exit signs must be clear of all visual obstruction.

- .3 Contractor to confirm locations before final installation.

3.2 LOCATION

- .1 Review locations of exit signs with engineer and architect to ensure effectiveness and compatibility with decor before rough in.
- .2 Failure to do so may result in relocation at no extra charge to the project.

3.3 MOUNTING HEIGHT

- .1 Wall mounted signs shall be clear above doors and, if space allows, 2.4 metres to centre, but with 25mm clearance of ceiling.
- .2 Ceiling mounted signs shall be mounted directly on ceiling, unless it is obstructed from view. Stem mount using two fixture rods (9.5mm white smooth type).
- .3 Mount as indicated on architectural and/or electrical drawings.

3.4 SPARE

- .1 Provide quantity of eight (8) spare exit signs – four (4) in general areas and four (4) in apparatus bay area and allow for installation to within 5-metre radius of nearest exit sign shown on plans to suit final fit-up requirements.
- .2 Turn over unused exit signs to the Owner at project completion.

END OF SECTION 26 53 00

Part 1 General

1.1 SECTION INCLUDES

- .1 This Bid Specification is for “commercial grade” Level 2 Electric Vehicles Equipment (EV) charging stations suitable for installations at parking facilities and/or garages.

1.2 REFERENCES

- .1 UL Subject 2594 Electric Vehicle Supply Equipment
- .2 UL 2231 Standards for Personnel Protection Systems in EV Charging
- .3 UL 62 Flexible Cords and Cable (Including EV Cable)
- .4 UL 50E Electrical Enclosures, Environmental Considerations
- .5 UL991 Safety Controls Employing Solid State Devices (If Used)
- .6 UL 1998 Software in Programmable Components (If Used)
- .7 NFPA 70 National Electrical Code Article 625, EV Charging Systems
- .8 SAE J1772 Recommended Practice Electrical Vehicle & Plug-In-Hybrid Electric Vehicle Conductive Coupler
- .9 EMI Compliance FCC Part 15 Class A or B
- .10 ISO Standards 14443, 18092

Part 2 Products

2.1 SCOPE

- .1 Manufacturer standard of acceptance:
 - .1 ELMEC EVC-30 Smart Pro (EVduty ONE) pedestal-mounted unit complete with cable management system.
- .2 Provide EV charging stations to surface parking stalls as indicated on plan.
- .3 EV charging stations shall have the capability of load-sharing and billing users on pay-per-use basis, and are to include web application user interface(s) as well as display and status indicators. The stations will include all hardware, software and mounting hardware required to install a fully functional charging system.
- .4 EV charging stations and pedestal mounting hardware shall be supplied from one manufacturer.

2.2 EV CHARGING STATION CONFIGURATIONS

- .1 The EV charging stations shall be “commercial” grade, smart Level 2 type and available in the following configurations: Single Output, pedestal mount

2.3 GENERAL REQUIREMENTS

- .1 At a minimum, the EV stations shall include the following:
 - .1 EV unit and all mounting hardware
 - .2 Software/hardware to control, operate, communicate, diagnose, and capture data
 - .3 Cable – minimum 25 ft. in length measured coming out of the unit (UL 62 compliant)
 - .4 Cable management system - self-retracting cable or hanger to keep the cable off the ground when not in use

- .5 Connector - SAE J1772-2009 compliant
- .6 Wall or stanchion mountable signage with owner approved wording and graphics (public garage area only).
- .7 NEMA 4X rated aluminium enclosure.
- .8 Output current adjustable from 6A to 30A with energy management functionality including power-sharing and power-limiting.
- .9 Communication interface – ZigBee (IEEE 803.15.4 meshed network) to enable multiple charging stations to share the same network service.
- .10 Networking - 3G or 4G via separate communications gateway or Local Area Network through wireless access point connection
- .11 Network management – connectivity with the manufacturers network for payment and driver services.

2.4 FUNCTIONS AND FEATURES

- .1 At a minimum, the EV stations shall meet the following:
 - .1 User interface - start/stop mechanism, status indicators, and a display readable in sunlight and low ambient lighting conditions
 - .2 Meter/display of energy consumption – 3% accuracy or better
 - .3 Diagnostic capability
 - .4 Americans with Disabilities Act (ADA) compliant
 - .5 Smartphone connectivity including the ability to meter and pay for usage.
 - .6 RFID capability to limit access and complete payments for usage.

2.5 SAFETY FEATURES

- .1 The EV stations shall meet the following:
 - .1 Auto short circuit and ground fault shutoff
 - .2 Auto restarts - in event of power outage and/or ground fault
 - .3 Protect against “live power” (de-energizes connector if uncoupled from vehicle)
 - .4 Power surge protection
 - .5 Outdoor-rated enclosure - NEMA 3R, 3S, 3X, 3RX, 3SX, 4, 4X, 6, or 6P (UL50E)
 - .6 UL listed and/or ETL (UL 2594, UL 2231, UL 1998, UL 991) and NEC Article 625

2.6 OPERATING ENVIRONMENT

- .1 The EV stations shall meet the following:
 - .1 Input Voltage 208 Volt AC (VAC) single-phase
 - .2 Voltage Frequency 60Hz
 - .3 Power Output 7.2 kW at 208V.
 - .4 Temperature-Operating Condition -22°F to +122°F (-30°C to +50°C) min.
 - .5 Humidity Up to 90% RH, non-condensing
 - .6 Regulatory compliance FCC part 15 Class A or Class B

2.7 SIGNAGE

- .1 Signage shall be mounted on marine grade aluminium, suitable for exterior usage with photo reflective background. No smaller than 300mm x 480mm.

- .2 Green writing/pictograms over white background.
- .3 Wording, symbols and pictures to be submitted for review/approval during shop drawings process.

2.8 LOAD MANGAEMENT

- .1 Not used.

2.9 NETWORK CONNECTIVITY

- .1 The EV stations shall be:
 - .1 Network-ready – include hardware/software to communicate with a network management system (NMS)
 - .2 Connect to a local area network

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Provide and install EV charging stations as described in this specification and as shown on the drawings.
- .2 Provide EV charging distribution panelboards and infrastructure as described in this specification and as shown on the drawings.
- .3 Connect to circuit as noted.
- .4 Provide circuit labelling at EV charging connection.
- .5 Ensure the feeder conductors are sized such that voltage drop is less than 3% between service entrance and EV charging connection.
- .6 Test correct operation of all chargers using subject vehicle. Ensure correct charging rates and suitable voltages are attained.
- .7 Mount signage as noted in drawings or directed by architect.
- .8 Coordinate with owner for smartphone application setup and metering billing requirements for users.
- .9 Include all commissioning and startup activities to provide the owner with a complete and operational system.
- .10 Allow for two (2) 4-hour sessions with the owner and/or owners forces for training and demonstration of the system.

END OF SECTION 00 00 00

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies the materials and installation for communication cables inside buildings.

1.2 SCOPE

- .1 Supply and installation of a data/communication cabling system, complete with complete with provision of cables, connectors, and patch panels as indicated on the drawings and as required for a complete and fully functioning system.
- .2 All materials and installation shall meet the requirements of these specifications.
- .3 Fibre Optic System to be in accordance with Section 27 05 15.
- .4 The complete data/communications system installation is to be in accordance with EIA/TIA-568 Standards.
- .5 All cables made redundant by new installation are to be removed. All existing abandoned cables are also to be removed back to the source.

1.3 REFERENCES

- .1 Canadian Standards Association, (CSA International)
 - .1 CSA-T529-latest edition, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/EIA TIA 568a with modifications).
 - .2 CSA-C22.2 No. 214-latest edition, Communications Cables (Bi-national Standard, with UL 444).
 - .3 CAN/CSA-C22.2 No. 182.4-latest edition, Plugs, Receptacles, and Connectors for Communication Systems.
- .2 Telecommunications Industry Association (TIA)
 - .1 TIA/EIA-568-latest edition, Commercial Building Telecommunications Cabling Standards Set.

1.4 SYSTEM DESCRIPTION

- .1 Structured system of telecommunications cables (copper) installed within buildings for distributing voice and data, including video signals.
- .2 Installed in physical star configuration with separate horizontal and backbone sub-systems. Horizontal cables link work areas to telecommunications closet located on same floor. Telecommunications rooms linked to central equipment room by backbone cables.

Part 2 Products

2.1 RACEWAYS

- .1 Raceways and wireways shall be as specified in Section 26 05 34.
- .2 All cables to be installed in conduit and cable support system as per Sections 26 05 34 and 26 05 36.

2.2 CONNECTORS

- .1 All data/communications UTP cables shall be terminated on 8 pin, 8 position, Category 6 modular RJ45 jacks. Commscope Systimax : GigaSpeed XL MGS400 series 700206758 (Blue).

- .2 Data/communications outlets shall be connected to the cable in EIA/TIA standard pin configuration 568A, using the following ISDN standard for telephone and data outlets:

Pair		Pin No.	Pin Colour	Colour Code
1	T	5	Green	Wh-Blue
	R	4	Red	Blue
2	T	3	Black	Wh-Orange
	R	6	Yellow	Orange
3	T	1	Blue	Wh-Green
	R	2	Orange	Green
4	T	7	Brown	Wh-Brown
	R	8	Slate(Grey)	Brown

2.3 PATCH PANELS

- .1 Provide AMP "110 Connect Series" Category 6, modular RJ45, 48-port patch panels for data/ communications system to be located in main communications room for termination of data/communications cabling. Commscope Systimax: 760151498.
- .2 All patch panels shall have loose jacks, and shall be loaded as required. Ensure that there is 20% space available in the patch panels at the completion of the project.
- .3 Provide cable support for all rack mounted patch panels.
- .4 All patch panels shall be clearly labelled.

2.4 COMMUNICATION OUTLETS AND TERMINAL CONNECTIONS

- .1 Data/communications outlets are to consist of 100 x 100 box c/w single gang plaster ring and flush mounted into walls unless indicated otherwise. Outlets to be complete with quantity of modular RJ45 jacks as indicated on plans.
- .2 Cable runs will have 300mm length of cable left coiled up inside outlet box for termination of RJ45 jacks.
- .3 All cables shall have all pares connected using the EIA.TIA standard pin configuration 568A. Telephone jacks are to mount in the top position of outlets, and data jacks in the lower position.

2.5 COVERPLATES

- .1 Coverplates are to be brushed stainless steel in accordance with Section 26 27 26 complete with provision for data/communication jacks as indicated on plans.
- .2 Cover plates to have 2, 4 or 6 cutouts for jacks.
- .3 Provide blank filler plugs for all unused ports.
- .4 The wall plates shall be clearly and permanently marked with icon identification for both service types as well as with clear identification of cable/termination numbers.

2.6 PATCH PANELS AND PATCH CORDS

- .1 Provide Commscope Category 6 (as per drawings), modular RJ45, patch panels for data/communications system to be located in Main IT Room or as indicated on plans for termination of data/communications cabling.
- .2 Provide cable management rings for wall mounted patch panels AMP #558265-1 (48 port), Amp #556561-1 (96 port).
- .3 Label patch panel ports, indicating room locations of all outlets.
- .4 Cross-connect ports shall be labelled to correspond to work station address and riser cable number.
- .5 Provide cable support bars for wall mounted patch panels.
- .6 Based on the functionality, the patch panels will be clearly labeled

2.7 BIX MOUNTING BLOCKS

- .1 Voice horizontal cables shall be terminated onto Category 6 BIX mounting blocks complete with BIX distribution connectors in telecommunications room.
- .2 Provide BIX mounting blocks complete with BIX distribution connectors for termination of telephone inter-building cable, each end, for cross-connect to telephone horizontal field equipment.
- .3 Label BIX connectors, indicating room locations of all outlets.
- .4 Label riser cables.

2.8 GROUND BAR

- .1 Label bus bar connections.
- .2 All patch panels, racks, and cable trays must be bonded to ground with #6 Cu. green insulated ground wire.

2.1 LABELLING

- .1 Labels on wall plates and patch panels to be Brother P-Type or equivalent, black lettering on white tape. Labelling identification numbering to be as follows:
- .2 Patch Panel Labels
 - .1 Patch panels should be labelled consecutively with "0+", "100+" etc. with all labels affixed directly to the patch panel.
 - .2 The callout area for each jack of the "Data-In" patch panels should be labelled with the room number of the location where the corresponding circuit will be found. Labels like "231", "253a" etc should appear on the patch panels, there is no need to repeat the data jack numbers as the information should be readily apparent from the manufacturer's silk-screening (1 to 96) in conjunction with the "100+" panel label assignment.
- .3 Wall Plate Labels
 - .3 The patch panel designations are key to the following wall port labelling scheme:
 - .1 Data jacks at the remote wall plate derive their numbering based on the position to which they are wired on the corresponding patch panel.
 - .2 Data circuits wired to the first "Data-In" panel (0+) will receive labels "D1" to "D96", data circuits wired to the 2nd "Data-In" panel (100+) will receive labels "D101" to "D196" (by adding 100 to the patch panel location where the circuit is terminated) etc.

- .3 Separate telephone identification is not required; all new outlets are considered to be data outlets.
 - .4 The data ("D107" etc.) labels are the only labels required to be on the remote wall plates.
- .4 Raceway Labels
 - .4 All empty raceways shall be clearly and permanently marked at both ends to indicate destination and function. The markings shall be clearly visible after construction is completed.
- .2 Each cable shall be clearly marked with a permanent sequential identifier at each end of the cable. All horizontal cable terminations will be labelled at patch panels and at data/comm. outlets. Labelling of wiring to be the same identifier as the termination point label.
- .5 Raceway Labels
 - .1 All empty raceways shall be clearly and permanently marked at both ends to indicate destination and function. The markings shall be clearly visible after construction is completed.
- .6 Each cable shall be clearly marked with a permanent sequential identifier at each end of the cable. All horizontal cable terminations will be labeled at patch panels and at data/communications outlets. Labeling of wiring to be the same identifier as the termination point label.

2.2 RACKS AND WIRE MANAGEMENT

- .1 Provide complete and operational two post rack to be located in the main IT/communications room.
- .2 Racking shall be fully welded (not bolted together on site).
- .3 Rack system shall be complete with horizontal and vertical wire management.
- .4 Standard of acceptance (All part numbers are Panduit):
 - .1 Two Post Rack: R2P
 - .2 Two Post Rack Shelf: RSHLF
 - .3 Vertical Wire Management: PRVF8 c/w PRD8 hinged doors.
 - .4 Horizontal Wire Management 1RU: CMPHHF1 c/w CMPH1C covers.
 - .5 Horizontal Wire Management 2RU: CMPHF2 c/w CMPH2C covers.
 - .6 Vertical Power Bar(2): CMRPSVD20.

2.3 PERFORMANCE REQUIREMENTS

- .1 The complete end-to-end installation, including jacks, cables, patch panels, and patch cords shall meet the industry standard performance parameters for enhanced Category 6 as recommended by CAN/CSA-T529, latest revision. Test parameters shall include:

Attenuation, Return Loss, NEXT, Power Sum NEXT, ELNEXT, Power Sum NEXT, ELFEXT, ACR, Power Sum ACR, Propagation Delay, and Delay Skew.

Part 3 Execution

3.1 INSTALLATION OF HORIZONTAL DISTRIBUTION CABLES

- .1 Communications raceway shall be minimum 20mm EMT conduit stubbed into accessible ceiling space. All cables in ceiling space shall be installed in conduit and cable support system and cable tray and as indicated on the drawings.
- .2 Wires and cable shall be as short as practical except that sufficient slack shall be provided to:
- .3 Prevent undue stress on cable forms, wires, and connections.
- .4 Enable network components to be removed and replaced during servicing without disconnecting other parts.
- .5 Facilitate movement of equipment for maintenance purposes.
- .6 Wires and cables shall be placed and protected to avoid contact with rough surfaces or sharp edges. Where wires or cables run through holes in metal, they shall be protected by suitable grommets or bushings.
- .7 Clearance between cables and heat emitting or interference generating devices shall be such as to avoid deterioration of these wires and cables due to heat dissipation from these devices, and to comply with industry standards. In particular cables shall have a minimum separation of 150mm from unshielded power lines and 600mm from fluorescent lighting.
- .8 The horizontal wiring shall be continuous with no splice points. Bridged taps are not permitted and there will be no cross-connects between the outlet and the patch panel.
- .9 The maximum cable length for each run is 90 metres and will allow for 3 extra metres at the work station end and 7 extra metres for the patch cord/cross-connect end.
- .10 Each cable shall be clearly marked with a permanent sequential identifier at each end of the cable. All horizontal cable terminations will be labelled at cross-connects and at telecommunications outlets. Labelling will include room number or patch panel as per labelling requirements reference.
- .11 Horizontal conduit fill must comply with the Canadian Electrical Code requirements.
- .12 Provide a data communications outlets at all DDC control panels, whether indicated on electrical plans or not. Confirm final locations and quantities with Mechanical Contractor and Mechanical Drawings.**

3.2 INSTALLATION OF BACKBONE CABLES

- .1 Install wiring and devices as indicated on plans
- .2 Provide 20mm G.1.S. painted plywood for equipment mounting.
- .3 The cabling components installed in the structured cabling system shall be warranted for a minimum of 25 years from the date of installation against defects in materials and workmanship.
- .4 Leave a pullstring in each data/communications outlet conduit.
- .5 Provide bushings on all conduit ends.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Test intra-building telephone cable for continuity.
- .3 All data/communications cables shall be tested using testing equipment approved for Category 6/6a installations.
- .4 Testing shall be conducted by authorized representative of cable and hardware manufacturer.
- .5 Tests shall be performed from termination block to wall outlet jack on horizontal cables.
- .6 Testing set-up shall be for a channel test, maximum length of 95m.
- .7 Testing shall include verification of labelling integrity.
- .8 Test results shall be documented and shall include the following information in addition to the cable parameters:
 - .1 Cable ID
 - .2 Transmit and Receive locations
 - .3 Test Equipment used to complete the test
 - .4 Contractor's name
 - .5 Technician's name and signature
 - .6 Date test was performed
 - .7 Relevant additional comments
- .9 The complete end-to-end installation, including jacks, cables and patch panels shall meet or exceed industry standard performance requirements for Category 6. Cable test parameters are to include: Attenuation, Return Loss, NEXT, Power Sum NEXT, ELFEXT, Power Sum ELFEXT, ACR, Power Sum ACR, Propagation Delay, and Delay Skew. Permanent Link Test is required.
- .10 Provide verification of the pin outs to CSA T529, ISDN (T568A) configuration.
- .11 Test results must include the Telecommunication Room number from which the cables terminate and indicate the following information:
 - .1 Telecommunication Room
 - .2 Room number of outlet box location
 - .3 Communication jack number.

END OF SECTION 27 05 14

Part 1 General

1.1 RELATED SECTIONS

- .1 27 05 14 - Communication Cables Inside Buildings.

1.2 REFERENCES

- .1 American National Standards Institute
 - .1 ANSI J-STD-607-A-[2002], Joint Standard - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- .2 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 TIA/EIA-606-[2002], Administration Standard for the Commercial Telecommunications Infrastructure.
- .3 U.S. Department of Labor/Occupational Safety and Health Administration (OSHA)
 - .1 Nationally Recognized Testing Laboratory (NRTL).

1.3 SYSTEM DESCRIPTION

- .1 Telecommunications grounding and bonding system consist of grounding busbars, bonding backbones, and other bonding conductors.
- .2 Provides ground reference for telecommunications systems within building and bonding to it of telecommunications rooms.
- .3 Metallic pathways, cable shields, conductors, and hardware within telecommunications spaces are bonded to telecommunications grounding and bonding system.

1.4 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
- .2 Separate waste materials for recycling in accordance with Section [01 74 21 - Construction/Demolition Waste Management and Disposal

Part 2 Products

2.1 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- .1 Predrilled copper busbar, listed and approved by NRTL, electrotin plated with holes 8 mm diameter for use with standard-sized lugs to: ANSI J-STD-607-A.
- .2 Dimensions 6 mm thick, 100 mm wide, 300 mm long to: ANSI J-STD-607-A.

2.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

- .1 Predrilled copper busbar, listed and approved by NRTL, electrotin plated with holes 8 mm diameter for use with standard-sized lugs to: ANSI J-STD-607-A.
- .2 Dimensions 6 mm thick, 100 mm wide, 300 mm long to: ANSI J-STD-607-A.

2.3 BONDING CONDUCTOR FOR TELECOMMUNICATIONS

- .1 #6 AWG copper conductor, green insulated marked to: ANSI J-STD-607-A.

2.4 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- .1 3/0 AWG copper conductor, green insulated marked to: ANSI J-STD-607-A.

2.5 GROUNDING EQUALIZER (GE)

- .1 3/0 AWG copper conductor, green insulated marked to: ANSI J-STD-607-A.

2.6 WARNING LABELS

- .1 Non-metallic warning labels in English and French to: ANSI J-STD-607-A.
- .2 Identify labels with wording "If this connector is loose or must be removed, please call the building telecommunications manager".

Part 3 Execution

3.1 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- .1 Install TMGB in shared electrical/communications entrance facility on insulated supports 50 mm high at location close to the network cabinet.

3.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

- .1 Install TGB in main IT room.

3.3 BONDING CONDUCTORS GENERAL

- .1 When placed in ferrous metallic conduit or EMT longer than 1 m, bond to each end of conduit or EMT using 6 AWG copper conductor.

3.4 BONDING CONDUCTOR FOR TELECOMMUNICATIONS

- .1 Install bonding conductor for telecommunications from TMGB to service equipment (power) ground.
- .2 Use exothermic welding, 1 hole non-twisting lugs for connection to TMGB.

3.5 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- .1 Install TBB[s] from TMGB to each TGB as indicated.
- .2 Use exothermic welding, 1 hole non-twisting lugs for connection to TMGB and TGBs.

3.6 BONDING TO TMGB

- .1 Bond metallic raceways in Elec/Communications Entrance Facility to TMGB using 6 AWG [green insulated] copper conductor.
- .2 For cables within Communications Entrance Facility having shield or metallic member, bond shield or metallic member to TMGB using 6 AWG [green insulated] copper conductor.
- .3 Bond equipment [cabinet] located in Elec/Communications Entrance Facility to TMGB using 6 AWG [green insulated] copper conductor.

3.7 BONDING TO TGB

- .1 Bond metallic raceways in IT Room to TGB using 6 AWG [green insulated] copper conductor.
- .2 For cables within IT Room having shield or metallic member, bond shield or metallic member to TGB using 6 AWG [green insulated] copper conductor.
- .3 Bond equipment [cabinet] located in IT Room to TGB using 6 AWG [green insulated] copper conductor.

3.8 LABELLING

- .1 Apply warning labels to telecommunications bonding and grounding conductors.
- .2 Apply additional administrative labels to: [TIA/EIA-606].

END OF SECTION 27 05 26

Part 1 General

1.1 RELATED SECTIONS

1. Division 1 - Construction/Demolition Waste Management and Disposal.
2. Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.
3. Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
4. Section 26 05 36 - Cable Trays for Electrical Systems.
5. Section 27 05 14 – Communications Structured Cabling Inside Buildings

1.2 SYSTEM DESCRIPTION

1. Telecommunications (data, telephone, radio, etc) raceways system consists of outlet boxes, cover plates, conduits, cabletroughs, pull boxes, sleeves and caps, fish wires, service poles, service fittings, concrete encased ducts.

1.3 WASTE MANAGEMENT AND DISPOSAL

1. Separate and recycle waste materials in accordance with Division 1 - Construction/Demolition Waste Management and Disposal.
2. Remove from site and dispose of all packaging materials at appropriate recycling facilities.
3. Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material for recycling in accordance with Waste Management Plan.
4. Divert unused metal conduit and wiring materials from landfill to metal recycling facility.
5. Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 MATERIAL

1. Conduits: EMT type, in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
2. Cabletroughs: in accordance with Section 26 05 36 - Cable Trays and Support Systems.
3. Junction boxes, cabinets type: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.
4. Outlet boxes, conduit boxes, and fittings: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.
5. Fish wire: polypropylene.
6. Minimum conduit size: 25 mm.

Part 3 Execution

3.1 INSTALLATION

1. Install raceway system, including distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cabletroughs, service poles, miscellaneous and positioning material to constitute complete system.

END OF SECTION 27 05 28

Part 1 General

1.1 SECTION INCLUDES

1. Supply and installation of raceway only for communications, security, access control, public-address, and audio/visual system.

1.2 RELATED SECTIONS

1. Section 28 13 00 - Access Control System
2. Section 28 23 00 – Video Surveillance

1.3 SUBMITTALS

1. Not required.

1.4 WASTE MANAGEMENT AND DISPOSAL

1. Deposit packaging materials in appropriate container on site for recycling or reuse.
2. Avoid using landfill waste disposal procedures when recycling facilities are available.
3. Collect and separate plastic, paper packaging and corrugated cardboard.
4. Dispose of corrugated cardboard, polystyrene and plastic packaging material in appropriate on-site bin.

1.5 WARRANTY

1. Project Warranty: Refer to contract for project warranty provisions.
2. Manufacturer's Warranty: Submit, for Engineer's acceptance, manufacturer's standard warranty document executed by authorized company official.

Part 2 Products

2.1 MATERIALS

1. Wiring methods as noted in Section 26 05 01 and Section 26 05 34.

Part 3 Execution

3.1 INSTALLATION

1. Install raceways per drawings and details, including conduits to door strikes contacts and homeruns to electrical room.
2. Provide pull strings in all conduits and mark both ends of conduit with respective termination locations.

END OF SECTION 27 53 50

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for fire detection and fire alarm systems.

1.2 REFERENCES

- .1 NBC-latest edition, National Building Code of Canada.
- .2 British Columbia Building Code 2018
- .3 Government of Canada
 - .1 TB OSH Chapter 3-03, latest edition, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-03, Standard for Fire Protection Electronic Data Processing Equipment.
 - .2 TB OSH Chapter 3-04, latest edition, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-04, Standard for Fire Alarm Systems.
- .4 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524-latest edition, Installation of Fire Alarm Systems.
 - .2 ULC-S525- latest edition, Audible Signal Appliances.
 - .3 CAN/ULC-S526- latest edition, Visual Signal Appliances, Fire Alarm.
 - .4 CAN/ULC-S527- latest edition, Control Units.
 - .5 CAN/ULC-S528- latest edition, Manual Pull Stations.
 - .6 CAN/ULC-S529- latest edition, Smoke Detectors.
 - .7 CAN/ULC-S530- latest edition, Heat Actuated Fire Detectors.
 - .8 CAN/ULC-S531- latest edition, Smoke Alarms.
 - .9 CAN/ULC-S536- latest edition, Inspection and Testing of Fire Alarm Systems.
 - .10 CAN/ULC-S537- latest edition, Verification of Fire Alarm Systems.

1.3 DESCRIPTION OF SYSTEM

- .1 System shall be fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital and multiplexing techniques for data transmission.
- .2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to fire department.
- .3 The system shall be fully addressable, zoned, non-coded single stage.
- .4 System to be modular in design to allow for future expansion.
- .5 Operation of system shall not require personnel with special computer skills.
- .6 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 Power supplies.
 - .3 Initiating/input circuits.

- .4 Output circuits.
- .5 Auxiliary circuits.
- .6 Wiring.
- .7 Manual and automatic initiating devices.
- .8 Audible and visual signalling devices.
- .9 End-of-line resistors (class B wiring only).
- .10 Local and Remote annunciators and displays.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

- .1 System:
 - .1 To TB OSH Chapter 3-04.
 - .2 Subject to Fire Commissioner of Canada (FC) approval.
 - .3 Subject to FC inspection for final acceptance.
 - .4 To Canadian Forces Fire Marshal approval.

1.5 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include:
 - .1 Layout of equipment.
 - .2 Zoning.
 - .3 Complete wiring diagram, including schematics of modules.

1.6 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual.
- .2 Include:
 - .1 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.
 - .2 Copy of sound pressure levels for each space.
 - .3 Technical data - illustrated parts lists with parts catalogue numbers.
 - .4 Copy of approved shop drawings.
 - .5 List of recommended spare parts for system.

1.7 EXTRA MATERIALS

- .1 Provide maintenance materials as recommended by the system manufacturer. Submit recommended spare parts list to Consultant for review in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include four (4) spare glass rods for manual pull box stations if applicable.
- .3 **Include for six (6) additional spare audible devices, wired and installed within 30m of the nearest audible device.** Devices will be utilised where sound level readings during verification are below Building Code requirements. Unused devices are to be turned over to the owner or credited to the contract.

- .4 Include for two (2) spare manual pull stations and allow for installation within 10m radius of fire alarm system devices.
- .5 Include for two (2) spare heat detectors and allow for installation within 10m radius of fire alarm system devices.
- .6 Include for two (2) spare smoke detectors and allow for installation within 10m radius of fire alarm system devices

1.8 MAINTENANCE

- .1 Provide one year's free maintenance with two inspections by manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to Consultant.

Part 2 Products

2.1 MATERIALS

- .1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- .2 In accordance with applicable CAN/ULC standards.

2.2 SYSTEM OPERATION

- .1 Single stage operation. Operation of any alarm initiating device to:
 - .1 Cause audible signal devices to sound throughout building.
 - .2 Transmit signal to fire department via fire alarm transmitter.
 - .3 Cause zone of alarm device to be indicated on control panel and remote annunciator.
 - .4 Cause air conditioning and ventilating fans to shut down or to function so as to provide required control of smoke movement.
 - .5 Cause fire doors and smoke control doors if normally held open, to close automatically.
- .2 Capability to program smoke detector status change confirmation on any or all zones in accordance with CAN/ULC-S527, Appendix C.

2.3 CONTROL PANEL

- .1 Single stage operation.
- .2 Zoned.
- .3 Non-coded.
- .4 Enclosure: CSA Enclosure 1, c/w lockable concealed hinged door, full viewing window, flush lock and 2 keys.
- .5 Provide 120 volt circuit and ceramic heater for all exterior mounted annunciator panels, whether indicated or not.
- .6 Supervised, modular design with plug-in modules:
 - .1 Alarm receiver with [trouble and alarm indications] [provision for remote supervised annunciation], for class A and B initiating circuits.
 - .2 Spare zones: compatible with smoke detectors and open circuit devices.
 - .3 Space for future modules.

- .4 Latching type supervisory receiver circuits. Discrete indication for both off-normal and trouble.
- .7 Components:
 - .1 Coded alarm receiver panel with trouble and alarm indications for class A and B initiating circuits.
 - .2 Single stage alarm pulse rate panels:
 - .1 Single stroke control type for output to signal control panel continuously.
 - .3 Common control and power units:
 - .1 Control panel containing following indications and controls:
 - .1 "Power on" LED (green) to monitor primary source of power to system.
 - .2 "Power trouble" indication.
 - .3 "Ground trouble" indication.
 - .4 "Remote annunciator trouble" indication.
 - .5 "System trouble" indication.
 - .6 "System trouble" buzzer and silence switch c/w trouble resound feature.
 - .7 System reset switch.
 - .8 "LED test" switch if applicable.
 - .9 "Alarm silence" switch to silence signals manually. If new alarm occurs after signals have been silenced, signals to resound.
 - .10 "Signals silenced" indication.
 - .2 Master power supply panel to provide 24Vdc to system from 120Vac, 60Hz input.
 - .3 Fire department connections:
 - .1 Plug-in module for shunt type municipal box.
 - .2 Fire department bypass switch c/w indicator for trouble at panel.
 - .4 Auxiliary relays: plug-in type, dust cover, supervised against unauthorized removal by common trouble circuit.
 - .1 Contacts: 2.0A, 120Vac, for functions such as release of door holders or initiation of fan shut down.
 - .2 Contact terminal size: capable of accepting 22-12AWG wire.
 - .5 Manufacturer: Simplex Grinnell, Edwards, MIRCOM and Notifier.

2.4 POWER SUPPLY

- .1 120V, ac, 60Hz input, 24Vdc output from rectifier to operate alarm and signal circuits, with standby power of gel cell batteries minimum expected life of 4 years, sized in accordance with BC Building Code.

2.5 MANUAL ALARM STATIONS

- .1 Manual alarm pull stations: addressable, pull lever, wall mounted surface type, non-coded single pole normally open contact for single stage English signage.
- .2 Manufacturer - Addressable manual pull station: Edwards SIGA-278, Simplex 4099-9001, or Mircom, Notifier equivalent

- .3 Provide steel protective guards for pull stations installed where required by Architect.
- .4 Provide weatherproof covers for pull stations as indicated on plan.

2.6 AUTOMATIC ALARM INITIATING DEVICES

- .1 Heat detectors, fixed temperature, non-restorable, rated 57°C.
 - .1 Weatherproof heat detector where indicated
 - .2 Simplex 4098-9733 c/w 4098-9792 (standard base), Edwards, or equivalent. White finish.
- .2 Thermal detectors, addressable, fixed temperature: 57°C.
- .3 Smoke detector: addressable ionization/photoelectric type.
 - .1 Dual chamber, ionization, twistlock, plug-in type with fixed wire-in base assembly with integral red alarm LED. Detector to be addressable type c/w electronics to communicate detector's status and field adjustable address setting.
 - .2 **For general use:** Simplex 4098-9714 c/w 4098-9792 (standard base), SIGA-PS with SIGA-SB base, or equivalent. White finish.
 - .3 **For door hold open device:** Simplex 4098-9714 c/w 4098-9791 (relay base), as indicated on plan
- .4 Duct Smoke Detector
 - .1 Dual chamber, multisensor, twistlock, plug-in type with fixed wire-in base assembly with integral red alarm LED. Detector to be addressable type c/w electronics to communicate detector's status and field adjustable address setting. If shaft mounted or obstructed, provide remote indicating LED and access hatch in accordance with Section 26 05 00.
- .5 Remote LED alarm indicator for concealed thermal and smoke detectors.

2.7 AUDIBLE SIGNAL DEVICES

- .1 Signal chimes: heavy duty, single stroke, 24Vdc, with solid striking plunger and resonating chamber, 95dB.
- .2 Bells: vibrating type, gongs of special alloy steel, 24Vdc, 150mm, 95dB.
- .3 Horns: 95dB, weatherproof mounting, 24Vdc.
- .4 Mini-horns: 95dB, surface mounting, red colour, 24Vdc.
- .5 All audible devices must be programmed to a temporal pattern 3, as required by the BC Building Code.
- .6 White finish.
- .7 Simplex 4901-9820, Edwards 2447TH-R, or equivalent (No strobe)
- .8 Simplex 4906-9127, Edwards 2452THS-15/75-R or equivalent (horn with 15/75 cd strobe)
- .9 Simplex 4906-9127, Edwards 2452THS-110-R, or equivalent (horn with 60-120 cd strobe)

2.8 REMOTE ANNUNCIATOR PANELS

- .1 LED type with designation cards to indicate zone.
- .2 LED's to annunciate alarm and trouble.
- .3 Wired in multiple with main control panel.
- .4 Supervised, including trouble signal for open circuit.

- .5 LED test button.

2.9 GRAPHIC DISPLAY

- .1 Provide and install flush mounted LED back-lit remote graphic annunciator complete with driver, LCD display, scroll, acknowledge button, system re-set system trouble, power on, and signal silence, where indicated on plans.
- .2 Ensure all annunciator locations are approved by local fire department.
- .3 Display:
 - .1 Alarms and troubles for alarm initiating circuits.
 - .2 Supervisory alarms and troubles common supervisory alarm for supervisory initiating circuits.
 - .3 Common system trouble.
 - .4 Alarms for standby emergency generator.
 - .5 Trouble buzzer
 - .1 Acknowledging trouble at main panel to silence trouble buzzers in system.
 - .6 Supervised, with LED test button and alarm trouble acknowledge button.
 - .7 Minimum wiring configuration with main panel and other remote annunciators.
 - .8 Annunciator to be complete with brushed aluminum trim and hinged lockable cover.
 - .9 Provide 100 watt, 120 volt ceramic strip heater inside annunciator enclosure for exterior weatherproof mounted annunciator panels. Monitor strip heater via the fire alarm system and provide trouble indicator. Provide 120 volt power to heater, whether shown on plans or not.

2.10 VISUAL ALARM SIGNAL DEVICES

- .1 Strobe type: flashing, red, 24Vdc.
- .2 Designed for surface mounting on ceiling or walls as indicated.
- .3 Adjustable candela output, 15, 30, 75 or 110/120 candela.
- .4 Edwards CS405, Simplex 4906-9101 or equivalent.

2.11 SPRINKLER SYSTEM CONNECTION

- .1 Provide waterflow/tamper modules for connection to sprinkler system for monitoring of flow switches and valves.
- .2 Provide input modules for connection of pressure switches for monitoring.
- .3 Provide alarm/trouble indication of heat tracing system at the control panel and remote annunciator panel.

2.12 ISOLATION MODULES

- .1 Addressable zone isolation modules.
- .2 Edwards SIGA-IM, Simplex 4090-9116 or equivalent

2.13 MAGNETIC DOOR HOLD OPEN DEVICES

- .1 Magnetic two-piece device. One piece flush mounted on wall and the other piece on door, 120V AC.

- .2 Wire through Low Voltage Relay, to de-energize door holder, upon signal from fire alarm system.

2.14 ANCILLARY DEVICES

- .1 Remote relay unit to initiate fan shutdown.
- .2 Provide relay interlocks to fire alarm control panel to shut down fans as indicated on mechanical equipment schedule.
- .3 Provide relay interlocks and control switches in main control panel and annunciator panels to enable smoke removal fans operation as described in the Mechanical Specifications.
- .4 Provide relay contact to DDC system to signal the status of the fire alarm system.
- .5 Provide relay contacts to DDC system to signal the status of the smoke removal switches
- .6 Controls relays: Edwards SIGA-CR, Simplex 4090-9002 or equivalent
- .7 Input modules: Edwards SIGA-CT2, Simplex 4090-9001 IAM, or equivalent

2.15 WIRE AND CABLE

- .1 Conductor Insulation: Minimum rating 300 volts. Single conductor RW90XLPE (X-link).
- .2 Multi-conductor cables 105°C with outer PVC jacket, colour coded, FAS rated.
- .3 Conductor sizes as follows:
 - .1 To initiating circuits: #18 AWG minimum, and in accordance with manufacturer's requirements.
 - .2 To signal circuits: #16 AWG minimum, and in accordance with manufacturer's requirements.
 - .3 To control circuits: #12 AWG minimum, and in accordance with manufacturer's requirements.
 - .4 Size all fire alarm wiring for maximum 3% voltage drop at maximum load at last device in run.
- .4 All wiring to be copper.
- .5 All wiring to be tag identified at the points of connection.
- .6 Provide a ground conductor with all system wiring and bond all metal parts including device boxes.
- .7 All fire alarm system wiring to be in conduit except short drops from ceiling junction box to detectors mounted in T-Bar ceiling may be rated fire alarm system cable.

Part 3 Execution

3.1 INSTALLATION

- .1 Install systems in accordance with CAN/ULC-S524 and TB OSH Chapter 3-04.
- .2 Install main control panel and connect to ac power supply.
- .3 Locate and install manual alarm stations and connect to alarm circuit wiring.
- .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.
- .5 Connect alarm circuits to main control panel.

- .6 Locate and install signal devices, bells, chimes, horns and visual signal devices and connect to signalling circuits.
- .7 Connect signalling circuits to main control panel.
- .8 **Both initiating circuit and notification circuit are to be CLASS A wiring.**
- .9 Install remote annunciator panels and connect to annunciator circuit wiring.
- .10 Locate and install door releasing devices.
- .11 Locate and install remote relay units to control fan shut down.
- .12 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- .13 Install spare devices per Consultant's direction.
- .14 Turn over unused devices in unopen condition or credit to the Contract.

3.2 FIRE ALARM ZONES

- .1 Provide zoning for fire alarm detection devices as indicated on the drawings.
- .2 Provide all required connections to all mechanical sprinkler system alarm and supervisory devices. Coordinate with Mechanical drawings and specifications.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests as described herein and in accordance CAN/ULC-S537.
- .2 Fire alarm system:
 - .1 Test each device and alarm circuit to ensure manual stations, thermal and smoke detectors, and sprinkler system transmit alarm to control panel and actuate general alarm ancillary devices.
 - .2 Check annunciator panels to ensure zones are shown correctly.
 - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.
 - .4 Manufacturer's technician to verify all new devices and reconnected existing fire alarm system equipment and components in accordance with ULC Standard S537.
 - .5 Provide a Certification of Verification.
 - .6 After verification, demonstrate and spot test system as required by Consultant and Fire Commissioner.
 - .7 Provide Engineer with written verification report for review and include copies in maintenance manuals
 - .8 Class A circuits.
 - .1 Test each conductor on all circuits for capability of providing alarm signal on each side of single open-circuit fault condition imposed near midmost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
 - .2 Test each conductor on all circuits for capability of providing alarm signal during ground-fault condition imposed near midmost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

- .9 Class B circuits.
 - .1 Test each conductor on all circuits for capability of providing alarm signal on line side of single open-circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
 - .2 Test each conductor on all circuits for capability of providing alarm signal during ground-fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
- .10 The contractor is responsible for verifying adequate audible coverage of the fire alarm system in all spaces of the project. Audibility test results are to be included in the fire alarm verification report. Should the levels fail with respect to the requirements of the Code, the contractor is to bring this matter to the attention of the Engineer/Consultant immediately for action.

3.4 TRAINING

- .1 Arrange and pay for two (2) 4-hour on-site lectures and demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

END OF SECTION 28 31 00

Part 1 General

1.1 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM D1056-[00], [latest edition], Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
- .2 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A3000 - latest edition, Cementitious Materials Compendium. Includes:
 - .1 CAN/CSA-A5- latest edition, Portland Cement
 - .2 CSA A23.1/A23.2- latest edition, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.
 - .3 CSA G30.3- latest edition, Cold-Drawn Steel Wire for Concrete Reinforcement.
 - .4 CSA G30.5- latest edition, Welded Steel Wire Fabric for Concrete Reinforcement.
 - .5 CAN/CSA-G30.18- latest edition, Billet-Steel Bars for Concrete Reinforcement.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings for precast manholes in accordance with Section [01330] [01 33 00] - Submittal Procedures.

Part 2 Products

2.1 PVC DUCTS

- .1 PVC ducts, type EB1, encased in [reinforced] concrete.

2.2 PVC DUCT FITTINGS

- .1 Rigid PVC [opaque solvent welded] [translucent pushfit] type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.
- .2 Expansion joints.
- .3 Rigid PVC 5 degree angle couplings.

2.3 PRECAST CONCRETE MANHOLES

- .1 Precast concrete manholes and auxiliary sections fabricated in steel forms.
- .2 Aggregates: to CSA A23.1/A23.2.
- .3 Portland cement [with [40]% Fly ash replacement]: to CAN/CSA-A3000-A5, Type [10] [30] [50].

- .4 Steel welded wire fabric mesh reinforcing: to [CSA G30.3], [CSA G30.5], [CAN/CSA-G30.18].
- .5 Pulling inserts and bolts for racks integrally cast in concrete.
- .6 Neoprene gasket seals between manhole sections: to ASTM D1056.
- .7 Size: [762] [____] mm clear diameter.

2.4 DRAINAGE

- .1 Floor drain fittings in each manhole consisting of floor drain, back water valve, trap and pipe connection to [drainage system]. [Dry sump].
- .2 Storm sewer connection: cast iron service saddle consisting of oil resistant gasket, stainless steel clamp and oil resistant O ring.
- .3 Sump pit: [300 x 300 x 125] mm.

2.5 MANHOLE NECKS

- .1 Concrete brick and mortar.

2.6 MANHOLE FRAMES AND COVERS

- .1 Cast iron manhole frames and covers.
- .2 Bolted on covers to prevent unauthorized entry.
- .3 Size: [762] [____] mm clear diameter.

2.7 GROUNDING

- .1 Ground rods: in accordance with Section [16061] [26 05 27] - Grounding - Primary] for cable rack grounding.

2.8 CABLE RACKS

- .1 Hot dipped galvanized cable racks and supports.
- .2 [12 x 100] mm preset inserts for rack mounting.

2.9 CABLE PULLING EQUIPMENT

- .1 Pulling iron: galvanized steel rods, size and shape as indicated.
- .2 Pull rope: [6] mm stranded [nylon] [polypropylene], tensile strength [5] kN, continuous throughout each duct run with [3] m spare rope at each end.

2.10 MARKERS

- .1 Concrete type cable markers: [600 x 600 x 100] mm, with words: "Cable", "Joint", "Conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.
- .2 Cedar post type markers: [89 x 89] mm square, [1.5] m long, pressure treated with clear, or copper naphthenate or 5% pentachlorophenol solution, water repellent preservative, with nameplate fastened near post top, on side facing duct.
 - .1 Nameplate: aluminum anodized [89 x 125] mm, [1.5] mm thick mounted on cedar post with mylar label 0.125 mm thick with words "Cable", "Joint", "Conduit" with arrows to indicate change in direction.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Install underground [duct banks] [and manholes] including formwork.
- .2 Build [duct bank] [and manholes] on undisturbed soil [or on well compacted granular fill not less than [150] mm thick, compacted to 95% of maximum proctor dry density].
- .3 Open trench completely between manholes to be connected before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.
- .4 Prior to laying ducts, construct "mud slab" not less than [75] mm thick.
- .5 Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400.
- .6 Install base spacers at maximum intervals of [1.5] m levelled to grades indicated for bottom layer of ducts.
- .7 Lay PVC ducts with configuration and reinforcing as indicated with [preformed interlocking, rigid plastic] intermediate spacers to maintain spacing between ducts at not less than [40] [75] mm horizontally and vertically. Stagger joints in adjacent layers at least [150] mm and make joints watertight. Encase duct bank with [75] mm thick concrete cover. [Use galvanized steel conduit for sections extending above finished grade level].
- .8 Make transpositions, offsets and changes in direction using 5 degree bend sections, do not exceed a total of 20 degree with duct offset.
- .9 Use bell ends at duct terminations in manholes or buildings.
- .10 Use conduit to duct adapters when connecting to conduits.
- .11 Terminate duct runs with duct coupling set flush with end of concrete envelope when dead ending duct bank for future extension.
- .12 Cut, ream and taper end of ducts in field in accordance with manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.

- .13 Allow concrete to attain 50% of its specified strength before backfilling.
- .14 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete. Tie ducts to spacers with twine or other non-metallic material. Remove weights or wood braces before concrete has set and fill voids.
- .15 Clean ducts before laying. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.
- .16 Immediately after placing of concrete, pull through each duct [steel] [wooden] mandrel not less than [300] mm long and of diameter [6] mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .17 Install four [3] m lengths of [15M] [10M] reinforcing rods, one in each corner of duct bank when connecting duct to manholes or buildings. Wire rods to [15M] [10M] dowels at manhole or building and support from duct spacers. Protect existing cables and equipment when breaking into existing manholes. Place concrete down sides of duct bank filling space under and around ducts. Rod concrete with flat bar between vertical rows filling voids.
- .18 In each duct install pull rope continuous throughout each duct run with [3] m spare rope at each end.

3.2 MANHOLES

- .1 Build cast-in-place manholes.
- .2 Install precast manholes.
- .3 Place concrete in two lifts with slab and sump in first, walls, roof and neck in second lift. Provide key in walls to slab. Place [100 x 6] mm PVC water bar vertically in key. Install ground rod before placing slab and place reinforcing steel, inserts for cable rack, pulling irons, drain, duct outlets, duct run dowels before casting walls. Make manhole to duct connection as indicated.
- .4 Provide [115] mm deep window to facilitate cable bends in wall at each duct connection. Terminate ducts in bell-end fitting flush with window face. Provide four [10M] steel dowels at each duct run connection to anchor duct run. [On runs of 16 ducts and over, support concrete duct encasement on a [700] mm wide by [75] mm thick concrete pier poured against manhole wall between slab and bottom of duct run, provide dowels for anchoring].
- .5 Alternately connect large duct runs by leaving square opening in wall, later pouring duct run and wall opening in one pour, and install [10M x 3m] reinforcing rods in duct run at manhole connection.
- .6 Build up concrete manhole neck to bring cover flush with finished grade in paved areas and [40] mm above grade in unpaved areas.

- .7 Install manhole frames and covers for each manhole. Set frames in concrete grout onto manhole neck.
- .8 Drain floor towards sump with 1 to 48 slope minimum and install drainage fittings as indicated.
- .9 Install cable racks, anchor bolts and pulling irons as indicated.
- .10 Grout frames of manholes. Cement grout to consist of two parts sand and one part cement and sufficient water to form a plastic slurry.
- .11 Ensure filling of voids in joint being sealed. Plaster with cement grout, walls, ceiling and neck.
- .12 Spray paint "X" on ceiling of manhole above floor drain or sump pit.

3.3 MARKERS

- .1 Mark location of duct runs under hard surfaced areas not terminating in manhole with [railway spike] driven flush in edge of pavement, directly over run. Place concrete duct marker at ends of such duct runs. Construct markers and install flush with grade.
- .2 Mark ducts every [150] m along straight runs and changes in direction.
- .3 Where markers are removed to permit installation of additional duct, reinstall existing markers.
- .4 Lay concrete markers flat and centered over duct with top 25 mm above earth surface.
- .5 Provide drawings showing locations of markers.

3.4 INSPECTIONS

- .1 Inspection of duct will be carried out by [Department Representative] [Consultant] prior to placing. Placement of concrete and duct cleanout to be done when [Department Representative] [Consultant] present.

END OF SECTION 33 65 73

Part 1 General

1.1 SECTION INCLUDES

- .1 Provision of rigid conduit - encased underground service ducts.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA A23.1/A23.2-[00(June 2001)] [latest edition], Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.

1.3 REGULATORY REQUIREMENTS

- .1 Co-ordinate and meet requirements of power supply authority. Ensure availability of power when required.

Part 2 Products

2.1 MATERIALS

- .1 Underground ducts: to Section [02582] [33 65 76] - Direct Buried Underground Cable Ducts, rigid type [DB2], size [as indicated].
- .2 Rigid steel galvanized conduit and fittings: to Section [16133] [26 05 34] - Conduits, Conduit Fastenings and Conduit Fittings.
- .3 Conductors: [copper] [aluminum], type [RWU-90], size and number of conductors [as indicated].
- .4 Meter socket: [weatherproof], to Section [16053] [26 09 02] - Metering and Switchboard Instruments.
- .5 Concrete: to CSA A23.1/A23.2 latest edition.

Part 3 Execution

3.1 INSTALLATION

- .1 Install cables in trenches and in [ducts] [conduit] in accordance with Section [16133] [26 05 44] - Installation of Cables in Trenches and in Ducts.
- .2 Allow adequate conductor length for connection to supply by power supply authority.
- .3 Install meter socket and conduit.
- .4 Allow adequate conductor length for connection to service equipment.

- .5 Make grounding connections in accordance with Section [16062] [26 05 28] - Grounding - Secondary.
- .6 Provide concrete encasement in accordance with CSA A23.1, [where indicated on drawings].

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section [16010 - Electrical General Requirements] [26 05 00 - Common Work Results - Electrical].
- .2 Perform additional tests if required by authority having jurisdiction.

END OF SECTION 33 71 75