

The Project Manual is bound in three separate volumes as follows:

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VOLUME 1

PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP

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PART 1 - GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for boilers, including accessories, and all required wiring schematics. Include boiler flue product data sheets with the submission.

1.2 CLOSEOUT SUBMITTALS

- .1 Submit with delivery of boiler(s) a copy of factory inspection and test report for each boiler, and include a copy of each report with O&M Manual project closeout data.
- .2 Submit a site inspection and boiler start-up report from boiler manufacturer's representative as specified in Part 3 of this section.
- .3 Submit signed copies of a manufacturer's non-prorated 10 year extended warranty for cast aluminium heat exchanger against corrosion, thermal stress, mechanical defects, and workmanship, and 2 year extended warranty for all other boiler components.
- .4 Training attendance records.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- .1 Supply a complete spare charge of calcium silicate chips for each acid neutralizing tank.

1.4 QUALITY ASSURANCE

- .1 Boilers and installation of boilers are to be in accordance with requirements of following:
 - .1 applicable Provincial Codes and Standards;
 - .2 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code;
 - .3 CAN/CSA B149.1, Natural Gas and Propane Installation Codes;
 - .4 ULC/ORD-C795:2021, Commercial-Industrial Gas-Fired Package Boilers.
 - .5 [ANSI Z21.13 CSA 4.9-2000 Standards.](#)
- .2 Boiler installation tradesmen are to be journeyman tradesmen licensed to install boiler equipment.

PART 2 - PRODUCTS

2.1 CONDENSING HOT WATER BOILERS

- .1 De Dietrich Products [Eutectic Cast Iron](#) Series [GT-PLUS model 430-8A-PLUS](#), fully condensing, single-stage, factory assembled, factory pressure and fire tested hot water boilers in accordance with drawing schedule and with performance requirements are as follows:
 - .1 [96.5% boiler efficiency](#)
- .2 [Boilers shall have no limit on inlet water temperatures, tempering of return water with supply water is not acceptable.](#)
- .3 Boilers complete with following construction features:
 - .1 [Boilers shall be constructed of eutectic cast iron sections manufactured in accordance with ASME requirements for low-pressure boilers and each section shall be permanently marked with the ASME symbol and the maximum allowable working pressures. The eutectic cast iron shall have a modulus of elasticity of 30% greater than other cast iron.](#)

- .2 Boilers shall be of a (3) pass scotch type wet base, wetbacks design with optimized fins and cast iron turbulators to permit greater heat transfer.
- .3 The forced draft burner shall be capable of firing the boilers pressurized combustion chamber assuring proper draft and positive ventilation. The burner shall be mounted to swing open either left or right on hinged mounting plate. Use following subparagraph for projects where seismic restraint is required.
- .4 Boiler sections shall be surface ground to ensure smooth positive mating surfaces. Boiler sections shall be assembled with precision-machined bi-spherical push nipples pressed into mating machinery nipple port in the section. Manufacturer's factory fabricated Tube Steel base frame to be used to ensure fire separation, leveling of section assembly, weight distribution, sections alignment, installation of bottom insulation, and proper section location. Boiler trim includes following:
 - .5 A gas tight seal with the use of a siliconed thermocord sandwiched between sections prevents leakage of flue gases.
 - .6 The boiler shall be complete with a drain tapping and drain valve.
 - .7 Boilers shall be complete with full-swing doors that give access to all flue ways and combustion areas for easy maintenance and cleaning without burner removal.
- .4 The complete boiler including the bottom shall be insulated with a minimum thickness of four inches of reinforced fiberglass wool insulation and shall be encased in a heavy gauge steel boiler jacket.
 - .1 This jacket shall be installed after system piping has been connected to the boiler section assembly.
 - .2 Jacket will have removable panels to allow access to the boiler as required.
- .5 Water boiler trim shall include pressure gauge, temperature gauge, flow switch (wired in series to disrupt burner operation in a reduced or no-flow condition), low water cut-off, high limit control with manual reset, operating control, high fire control, and drain valve.
 - .1 An ASME approved pressure relief valve shall be furnished sized to exceed the boiler gross output capacity and shall be factory set to relieve pressure at 30 PSI.
- .6 Boiler shall be equipped with EOM-100 Ener-O-Mizer Stainless Steel Fully Condensing Coil Tube Flue Gas Economizer.
 - .1 Economizer shall be approved as a package with boiler for dual fuel operation. Flue Gas economizer shall be 316L stainless steel for all flue gas and water contacted surfaces.
 - .2 Fins to increase area are not acceptable.
 - .3 Exterior casing shall be 16 gage galvanized steel with 2" insulation throughout.
 - .4 Economizer shall be built to section VIII of ASME boiler code and national board registration.
- .7 Not Used.
- .8 Burner controls, unless otherwise specified, are to factory installed in a dead front enclosure mounted on front head of boiler and equipped with disconnect switch, power and control wiring terminal blocks, motor starter, fuses, control circuit transformer, and control switches and relays as required. Controls include a Honeywell MCBA OEM or equal solid-state, microprocessor-based boiler and burner control which incorporates functions of temperature control, 100% shut-down combustion safeguard control, message annunciation, and fault diagnostic display, a flash card to permit replacement of control without need to re-commission boiler, and features as follows:
 - .1 3 levels of access; one for end user, one for advanced trained set-up and service technicians, and one for factory;

- .2 hardware and circuitry for building automation system control and enable/disable contacts;
- .3 ability to communicate with a PC or PDA with ReCom communication software and interface cable;
- .4 adjustable water temperature operating limit between 20°C to 90°C (70°F to 140°F) by means of an internal set-point, indoor/outdoor reset controller, or a building automation system 0-10 VDC signal, or from a lead/lag control system, and fixed safety high temperature limit;
- .5 on/off switch, and supply and return water temperature indication;
- .6 blocked heat exchanger and blocked vent indication;
- .7 operating, service, and fault diagnostic coding;
- .8 ability to be set-up with or without a computer;
- .9 hardware and circuitry for pre-operation and post-operation of burner fan;
- .10 contacts for connection to Boiler Room ventilation system to prevent boilers from operating unless ventilation system is operating (ventilation system is to "fail-open" to permit boiler operation should fan or damper motors fail or a power failure occurs).
- .9 Double wall stainless steel AL29-4C stainless steel flue gas vent for each boiler with a type 304 outer casing and AL29-4C inner flue supplied by boiler manufacturer. Each boiler is to operate under Category IV positive vent pressure conditions for room air dependent operation. Venting is to feature condensate disposal and have 50 mm (2") clearance to combustibles.
- .10 Equal to JJM Boiler Works or Condensate Neutralizer condensate acid neutralizing PVC tube sized to suit the boiler condensate discharge, supplied with boiler, filled with 12 mm (½") and 20 mm (¾") aggregate calcium carbonate and complete with floor mounting galvanized steel strut clamps, threaded PVC inlet and outlet fittings, and a spare charge of calcium silicate.
- .11 Manufacturers:
 - .1 De Dietrich Products;
 - [.2 Absolute Condensing Boiler](#)
 - [.3 SPIRE Condensing Boiler](#)

2.2 BOILER PLANT SEQUENCING CONTROL PANEL

- [.1 The boiler/burner shall be pre-wired to provide the following operation](#)
 - [.1 Local - Remote switch on burner.](#)
 - [.2 In Remote position burner shall be capable of being controlled from BEMS.](#)
 - [.3 In Local position burner shall operate from supplied controls.](#)
- [.2 The burner shall be FuelMaster Fully Modulation Power Burner \(No alternate\) with squirrel cage 3,450 rpm motor, and shall be factory tested and incorporated all necessary devices and controls to make a complete fuel burning system and bear the listing label of CSA. The burner shall be designed for natural gas and be of the forced-draft pressure-atomizing type with no CO present in the products of combustion.](#)
- [.3 The burner shall be furnished with an integral motor-driven blower, stainless steel flame retention type combustion head and observation port, and a primary control which utilizes a UV scanner.](#)
- [.4 Main gas pressure regulator, \(vented to outside atmosphere, in accordance with local codes\), approved automatically operated motorized safety gas shutoff valve, with proof of closure interlock switches, second automatically operated gas safety, manually operated gas shutoff valve located downstream of both automatic gas valves \(to permit leakage testing of valves\), test pressure](#)

tapping's upstream and downstream of each valve and regulator, air damper with high-low control linkage.

.5 Boiler controls shall be housed in a factory pre-wired control cabinet. The cabinet shall house combustion Safeguard Control to provide pre-purge, post-purge and burner sequencing, complete with flame rod. Panel shall include the following:

- All panel wiring with color-coded wire.
- Motor starters with overload protection for blower motor.
- On/off switch.
- Local/Remote Switch
- Manual/Off/Auto switch.
- Electronic safety combustion controls shall be supplied to monitor pilot and main flame. Detection will be means of a flame rod. The programming control shall be a Fireye, model MC120 and will provide pre and post purge, trial for ignition, energize main fuel circuit, interrupted tube pilot and sequence operation.
- Manual restart of each burner shall be necessary in the event of a shutdown due to flame failure.
- Permanent identification of door mounted LED's and switches;
- Operating control components as required, supplied loose for site installation.
- Fused 24 volt secondary control transformer;
- Numbered terminal strips for power and control wiring connections;

.6 Boiler plant control sequence as follows:

- .1 On first call for heat, lead boiler will come on line at low fire, and if system demand is such that output of lead boiler will not satisfy demand at low fire, boiler will modulate to high fire;
- .2 If lead boiler is unable to satisfy system demand by time it reaches 80% of its firing rate, and over a reasonable period of time, first lag boiler is to come on line at low fire and, if required, modulate to high fire;
- .3 Remaining lag boilers are brought on line as above as required to satisfy system demand;
- .4 As system demand is satisfied, boilers are to modulate back to low fire and shut-off in reverse order.
- .5 Panel suitable in all respects for interface connection into building automation system without site installation of additional hardware.

.7 PID Modulating Temp. Controller shall be supplied complete with housing for flush panel mounting. The controller shall be matched to the controlled variable and the required setpoint range by making parameter settings. The control parameters shall be set and optimized while the burner is running by all settings which are made with four buttons located on the unit front and are directly displayed.

.8 Boiler plant control sequence as follows:

- .1 on first call for heat, lead boiler will come on line at low fire, and if system demand is such that output of lead boiler will not satisfy demand at low fire, boiler will modulate to high fire;
- .2 if lead boiler is unable to satisfy system demand by time it reaches 80% of its firing rate, and over a reasonable period of time, first lag boiler is to come on line at low fire and, if required, modulate to high fire;
- .3 remaining lag boilers are brought on line as above as required to satisfy system demand;

- .4 as system demand is satisfied, boilers are to modulate back to low fire and shut-off in reverse order.
- .5 Panel suitable in all respects for interface connection into building automation system without site installation of additional hardware.

.9 Venting:

.1 All products furnished under this Section shall conform to the requirements of The National Fuel Gas Code, ANSI Z223.1 / NFPA-54 where applicable and shall comply with and be listed to UL 1738, the U.S. Standard for Venting Systems for Gas –Burning Appliances, Category II, III and IV and ULC-S636-95, the Canadian Standard for Type BH gas vent systems. Components coming in direct contact with products of combustion shall carry the appropriate UL or cUL.

.2 Positive Pressure Vent:

- .1 The vent shall be of double wall, factory built type, designed for use in conjunction with Category II, III or IV condensing or non-condensing gas fired appliances or as specified by the heating equipment manufacturer.
- .2 Maximum continuous flue gas temperature shall not exceed 550 degree F (288 degree C).
- .3 Vent shall be listed for a maximum positive pressure rating of 6" w.c. and shall have passed at 15" w.c.
- .4 The vent system shall be continuous from the appliance's flue outlet to the vent termination outside the building. All system components shall be UL / cUL listed and supplied from the same manufacturer.
- .5 The vent shall be constructed from AL29-4C® or UNS S44735 stainless steel, with a minimum wall thickness of .016" for 3" through 7" diameter vents, .019" for 8" through 12" diameter vents and .024" for 14" and 16" diameter vents.
- .6 All system components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings require to install the vent system shall be UL listed and provided by the vent manufacturer.
- .7 All system components shall include a factory – installed gasket in their female – end to render the vent air and water tight when the male / female ends are pushed together as per manufacturers instructions. Vent systems requiring field installed sealants or compounds shall not be acceptable.
- .8 All system components shall include a factory – installed internal mechanical locking band for fastening and securing all vent components against each other.
- .9 Vent layout shall be designed and installed in compliance with manufacturers installation instructions and all applicable local codes.

.3 Vent System Layout

- .1 The vent system shall be routed to maintain minimum clearance to combustibles as specified by the manufacturer.
- .2 Vent installation shall conform to the manufacturer's installation instructions, its UL listing and state / local codes.
- .3 The vent system and breechings shall be inspected and cleaned before the final connection to the appliances.

.4 Mechanical Equipment

- .1 If dampers or fans are installed in conjunction of the vent system, such equipment shall be supported independently from the vent system. Protect the vent system from twisting or movement due to fan torque or vibration.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Provide condensing hot water boilers.
- .2 Move boilers into position, remove casters, and secure each boiler in place, level, and plumb, on neoprene-steel-neoprene vibration isolation pads on a concrete housekeeping pad.
- .3 Anchor each boiler and concrete base in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical Systems. Provide flexible connections in piping connections to each boiler.
- .4 Connect each boiler with piping and flue.
- .5 Arrange piping as to provide adequate clearance for service and operation. Pipe safety relief valves and drain valves to floor drain.
- .6 Install thermometers and pressure gauges on supply and return piping no higher than 1800 mm above floor.
- .7 Install relief valve sized to suit boiler input and located upstream of any shut-off valve. Conform to manufacturer's installation instructions and piping schematic on drawings. Extend each gas pressure relief (full size) through roof and terminate with gooseneck and screen. Pipe Vent drain through inline neutralizing cartridge, then to floor drain.
- .8 Install condensate acid neutralizers adjacent to boilers and connect with piping from boilers to neutralizers and from neutralizers to drain in accordance with manufacturer's directions and drawing requirements.
- .9 Install control components shipped loose for each boiler, including low water cut-offs, relief valve, and flow switch. Unless otherwise instructed, follow manufacturer's installation instructions. Provide pressure gauges and thermometers in boiler water supply and return piping connections.
- .10 Wall mount lead/lag control panel where shown but confirm exact location prior to installation.
- .11 Perform required control wiring in conduit to connect control components. Follow boiler manufacturer's control wiring schematics and conduit and conductor installation requirements specified as part of electrical work.
- .12 When boiler plant installation is substantially complete, but prior to start-up, and prior to flushing and cleaning heating piping system as specified in Section 23 25 00 - HVAC Water Treatment, inspect each boiler and remove visible dirt, oil and debris, then cooperate with the boiler boil-out chemical supplier to ensure proper boil-out procedures are followed.

3.2 SYSTEM STARTUP

- .1 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .2 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .3 Upon notification of completion of the installation, boiler manufacturer shall furnish the services of a field technician, to start the boiler and provide combustion tests over the operating range and issue report to the Consultant indicating system acceptance as installed.

3.3 CLOSEOUT ACTIVITIES

- .1 Include for a one day on-site boiler plant operation demonstration and training session. Training is to be a full review of all components including but not limited to a full boiler internal inspection, construction details, burner operation, maintenance, flame characteristics, and adjustments, gas train maintenance, boiler normal operation, abnormal events, normal shut-down, emergency shut-down, and setting up controls.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Provide positive seismic restraints on electrical systems and components required by the building code and by the local authority having jurisdiction.
- .2 This section covers design, supply, installation, and inspection of complete SFRS (Seismic Force Resisting System) for electrical systems.

1.2 REFERENCES

- .1 Seismic restraints are to be provided for all electrical and non-structural components of building services in accordance with the current: NBCC; OBC, and good engineering practice (references listed below):
 - .1 CSA S832-14 (R2019), Seismic risk reduction of operation and functional components (OFCs) of buildings.
 - .2 SMACNA (Sheet Metal and Air-conditioning Contractors' National Association's) Seismic Restraint Manual Guidelines for Mechanical Systems (3rd ed.).
 - .3 ASHRAE (American Society for Heating, Refrigerating and Air-conditioning Engineers) A Practical Guide to Seismic Restraint; ASHRAE Applications Handbook, Seismic and Wind Restraint Design Chapter; ASHRAE Standard 171-2008: Methods of Test for Seismic restraints.
 - .4 VISCMA (The Vibration Isolation and Seismic Control Manufacturers Association) has developed Testing and Rating Standards for Seismic Restraint Components that comply with Code and ASHRAE based requirements.
- .2 The following guides may be used for supplemental information on typical seismic installation practices. Where a conflict exists between the guides and these construction documents, the construction documents will preside.
 - .1 Federal Emergency Management Agency (FEMA) manual 413, Installing Seismic Restraints for Electrical Equipment, January 2014.

1.3 COORDINATION

- .1 Trades shall supply necessary information to the Vibration Isolation Manufacturer regarding equipment to be isolated.
- .2 Provide shop drawings to other trades for setting anchor bolts and other appurtenances necessary for the proper installation of this equipment.

1.4 SUBMITTALS

- .1 Shop Drawings:
 - .1 Include placement drawings for electrical equipment and equipment assemblies including runs of cable trays and conduit/cable racks showing methods of attachment to particular structure for each piece of equipment and assembly and provide anchorage/attachment details. Submit samples of materials required to complete seismic restraint work for review if and when required.
- .2 Product Data:
 - .1 Include Seismic Rating Data for each seismically rated isolator or restraint component.

- .2 Submit copies of documents requested herein, testing reports, certificate of approvals, and commissioning sheets.
- .3 Delegated Design Submittals:
 - .1 Submit for Consultant's review, seismic design drawings and product shop drawings with calculations approved and sealed by a Professional Engineer licensed and registered in Place of Work and experienced in such Work. Be responsible for costs for services of this Professional Engineer. Shop drawings to identify equipment type, manufacturer's name, model number and weight of equipment to be restrained.
 - .2 Include for manufacturer of vibration control products, to develop/design a seismic restraint system and perform seismic calculations in accordance with latest requirements of local governing building code, requirements of local governing authority having jurisdiction, and additional requirements specified in this article. Design of seismic restraints to include requirements to withstand forces of area rating as per local governing building code requirements.
 - .3 Provide calculations to determine restraint loadings for all restrained systems and equipment resulting from seismic forces.

1.5 CLOSEOUT SUBMITTALS

- .1 Include for Professional Engineer to inspect same on site (note that multiple inspections to be required as work progresses) and to provide typewritten Inspection Reports to the Consultant throughout construction and to provide "Letters of Assurance and Conformance" with specified Codes, Standards and Bylaws. Additionally, include copies of documents in Operating and Maintenance Manuals.
- .2 At the completion of the project, upon request by the Consultant, attend a review of the installation on site.
- .3 Provide a sealed written report, certifying that the installations have been completed in accordance with the specified design(s) and shop drawing(s) can be furnished, by others, upon this request.
- .4 The installing contractor shall submit a report to the Consultant, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the Contractor to properly complete the seismic restraint work as per the specifications.
- .5 Record documents: documented torques.

1.6 QUALITY ASSURANCE

- .1 The contractor shall utilize a supplier familiar/experienced with the design of seismic systems to provide a comprehensive package of isolation and seismic restraint for the project. Provide detailed shop drawings showing the proposed restraint system for all required equipment, piping, and ductwork on the project. The shop drawings shall include calculations certified by a Profession Engineer (Structural), licensed in the jurisdiction where the project occurs.
- .2 Certification documents to be signed and sealed by a Professional Engineer (Structural) with at least 5 years experience in the design of seismic restraints.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Manufacturer List:
 - .1 Eaton TOLCO.
 - .2 Mason Industries.
 - .3 Kinetics Noise Control.
 - .4 nVent (Caddy).
 - .5 Vibro-Acoustics.
- .2 Substitutions: Other manufacturers acceptable to the Authority Having Jurisdiction.

2.2 DESIGN CRITERIA

- .1 Review architectural and structural drawings to confirm the seismic criteria for the project.

2.3 GENERAL

- .1 Electrical equipment installation is to meet local governing authority having jurisdiction and code seismic requirements and additional requirements for vibration isolation.
- .2 Provide labour, materials, and equipment required and necessary to seismically restrain electrical equipment and equipment bases including concrete pads, and guarantee function of materials and equipment supplied.
- .3 Provide additional seismic requirements for suspended electrical raceways, luminaires, and other equipment as per governing local authority requirements and requirements of current codes and by-laws.
- .4 Provide seismic restraining devices to restrain mechanical, electrical, and related equipment, and equipment bases including concrete pads, as per governing local authority requirements and requirements of current codes and by-laws.
- .5 In event that inadequate isolation is provided by isolation product manufacturer's isolation package, be responsible for improving isolation to an acceptable standard at no additional cost to contract. Isolation product manufacturer's seismic restraint engineer to verify that seismic restraints and combination isolator/restraints intended for use on project are fit for intended purpose. Be responsible for ensuring that manufacturer's seismic restraints are in compliance with applicable local building code requirements for Place of Work.

2.4 VIBRATION CONTROLS AND SEISMIC RESTRAINTS

- .1 Electrical equipment installation is to meet local governing authority having jurisdiction and code seismic requirements and additional requirements outlined herein.
- .2 Provide labour, materials, and equipment required and necessary to seismically restrain electrical equipment and equipment bases including concrete pads, and guarantee function of materials and equipment supplied.
- .3 Make electrical connections to vibration-isolated equipment with flexible conduit or other flexible means acceptable to the Consultant and local governing authority having jurisdiction so as not to restrict maximum anticipated movement of equipment under seismic excitation movement.

- .4 In event that inadequate isolation is provided by isolation product manufacturer's isolation package, be responsible for improving isolation to an acceptable standard at no additional cost to contract. Isolation product manufacturer's seismic restraint engineer to verify that seismic restraints and combination isolator/restraints intended for use on project are fit for intended purpose. Be responsible for ensuring that manufacturer's seismic restraints are in compliance with applicable local building code requirements for Place of Work.
- .5 Provide additional seismic requirements for suspended electrical raceways, luminaires, and other equipment as per governing local authority requirements and requirements of current codes and by-laws.
- .6 Include for manufacturer of vibration control products to develop/design a seismic restraint system and perform seismic calculations in accordance with latest requirements of local governing building code, requirements of local governing authority having jurisdiction, and additional requirements specified in this article. Design of seismic restraints to include provisions to withstand forces of area rating as per governing building code requirements.
- .7 Provide vibration isolation for equipment or parts connected rigidly to isolated equipment.
- .8 Provide vibration isolation for transformers by means of bridge bearing neoprene isolators or open steel spring isolators. Static deflection of vibration isolators for electrical transformers is indicated below. Isolators requiring a static deflection greater than 13 mm (1/2") to be open spring isolators unless otherwise specified.

Transformer Rating	On Grade (Isolated Slab)	Location on Grade (Continuous Slab)	Upper Floor (Suspended Slab)
Less than 10 kVA	6 mm	6 mm	18 mm
10 – 100 kVA	6 mm	12 mm	25 mm
Greater than 100 kVA	6 mm	25 mm	38 mm

- .9 Standard vibration isolation requirements of equipment such as gensets, power transformers and distribution equipment, to comply with following:
 - .1 Choose equipment isolation mounts on basis of achieving 98% vibration isolation efficiency at lowest operating speed. Natural frequency of each vibration isolation system to be at least 1/10 of lowest excitation frequency of rotating machinery, whenever practicable, but in no case less than 1/7. Where structural floor deflection exceeds 1/10 of determined static deflection of isolator, increase isolator static deflection to maintain this minimum ratio of floor to isolator deflection. Where static deflections are shown on drawings, Specifications, or schedules, they are to be used as a guide only. Actual isolators are to achieve required static deflection under load, with at least 50% reserve deflection;
 - .2 Submit shop drawings identifying equipment, lowest operating speed, weight, brand, type and location of isolators prior to ordering or fabrication.
- .10 Neoprene Isolators:
 - .1 Neoprene isolators to be bridge bearing rated type manufactured from bridge bearing quality neoprene, CAN/CSA-S6-88 Section 11.5.8.
 - .2 Where a ribbed pad is used, height of ribs is not to exceed 0.7 times width of rib. A steel layer to be used to distribute load in a multi-layered unit.
 - .3 Select neoprene pads or elements at supplier's optimum recommended loading and do not load beyond limit specified in neoprene manufacturer's literature.

- .4 Test neoprene isolators to ASTM specifications. Submit to Consultant, following test data to verify performance of neoprene isolators:
 - .1 A data sheet listing all of ASTM test results.
 - .2 Load deflection curves for isolator indicating deflection to full compression for both laterally restrained and unrestrained isolators.
- .11 Open Steel Spring Isolators:
 - .1 Springs to be "Iso-Stiff" (spring coefficient 1.0 to 1.5) with a working deflection between 0.3 and 0.6 of solid deflection.
 - .2 Spring mounts to be complete with levelling devices, minimum 6 mm (1/4") thick neoprene sound pads, and zinc chromate plated hardware.
 - .3 Sound pads to be sized for a minimum deflection of 1.2 mm (0.0472") and meet requirements for neoprene isolators.
- .12 Seismic restraints to restrain equipment in all directions and to be sized to meet appropriate Sp factor defined in Table 4.1.9.D of current National Building Code and Commentary J of Supplement to current Code. Calculations bearing seal of a qualified Professional Engineer to be submitted with shop drawings to justify stated seismic restraint requirements.
- .13 Attachment points and fasteners to be capable of withstanding a load of 3 times sized capacity of restraint. Equipment suppliers to provide proof of conformance with this clause by means of shop drawings certified by a qualified Professional Engineer.
- .14 Submit test data to the Consultant, showing load deflection curves up to 1.5 times rated capacity of restraint, and certifying that neither neoprene elements nor restraint body sustained any deformation after release of load.
- .15 Adjust restraints to have clearances between 3 mm (1/8") and 6 mm (1/4") under normal operating conditions of equipment.

2.5 SEISMIC RESTRAINTS FOR CONTAINERIZED GENSETS SKIN TIGHT

- .1 Electrical equipment installed inside containerized genset enclosure specified in Section 26 32 13.16 to comply with local governing authority and code seismic requirements and additional requirements outlined herein.
- .2 Supply labour, materials, and equipment required and necessary to seismically restrain electrical equipment and guarantee function of materials and equipment supplied.
- .3 Neoprene Isolators:
 - .1 Neoprene isolators to be bridge bearing rated type manufactured from bridge bearing quality neoprene, CAN/CSA-S6-88 Section 11.5.8.
 - .2 Where a ribbed pad is used, height of ribs is not to exceed 0.7 times width of rib. A steel layer to be used to distribute load in a multi-layered unit.
 - .3 Select neoprene pads or elements at supplier's optimum recommended loading and do not load beyond limit specified in neoprene manufacturer's literature.
 - .4 Test neoprene isolators to ASTM specifications. Submit to the Consultant, following test data to verify performance of neoprene isolators:
 - .1 a data sheet listing ASTM test results;
 - .2 load deflection curves for isolator indicating deflection to full compression for both laterally restrained and unrestrained isolators.

- .4 Open Steel Spring Isolators:
 - .1 Springs to be "Iso-Stiff" type with spring coefficient from 1.0 to 1.5.
 - .2 Spring mounts to be complete with levelling devices, minimum 6 mm (1/4") thick neoprene sound pads.
- .5 Seismic restraints to restrain equipment in all directions and to be sized to meet appropriate Sp factor defined in Table 4.1.9.D of current National Building Code and Commentary J of Supplement to current Code. Calculations bearing seal of a qualified Professional Engineer to be submitted with shop drawings to justify stated seismic restraint requirements.
- .6 Attachment points and fasteners to be capable of withstanding a load of 3 times sized capacity of restraint. Equipment suppliers to provide proof of conformance with this clause by means of shop drawings certified by a qualified Professional Engineer.
- .7 Submit test data to the Consultant, showing load deflection curves up to 1.5 times rated capacity of restraint, and certifying that neither neoprene elements nor restraint body sustained any deformation after release of load.
- .8 Adjust restraints to have clearances between 3 mm and 6 mm (1/8" and 1/4") under normal operating conditions of equipment.

PART 3 - EXECUTION

3.1 GENERAL

- .1 The following typical electrical equipment requires seismic protection (as applicable to Project):
 - .1 Transformers;
 - .2 Switchboards/switchgear;
 - .3 Panelboards;
 - .4 Engine/generator and generator control panel;
 - .5 Automatic transfer switches;
 - .6 Fire alarm system, cabinets and devices;
 - .7 Luminaires;
 - .8 Mobile generator connection box;
 - .9 Conduit and duct banks;
 - .10 Genset PLC system and cabinet;
 - .11 Other electrical equipment, as required.

3.2 PREPARATION

- .1 The Contractor shall notify the local representative of the seismic restraint materials manufacturer prior to installing any seismic restraint devices. The Contractor shall seek the representative's guidance in any installation procedures with which he/she is unfamiliar.
- .2 Obtain required training from manufacturer's representative on any special installation procedures. Install components in accordance with manufacturer's instructions to suit specific installation requirements.
- .3 Coordinate size, shape, reinforcement, and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of

20 kPa (3,000 psi) or as specified by the Consultant. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled into structural slab.

- .4 Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer seismic restraint manufacturer's written instructions.
- .5 Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g., roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.

3.3 INSTALLATION

- .1 Isolated and restrained equipment, conduit located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure are not acceptable.
- .2 Attach conduit to the trapeze per seismic restraint manufacturer's design. Install cables so they do not bend across sharp edges of adjacent equipment or building structures.
- .3 Do not brace or support equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a transverse restraint to a wall, and then a longitudinal restraint to either a floor/ceiling/roof at the same braced location.
- .4 Install vertical braces to stiffen hanger rods and prevent buckling per seismic restraint manufacturer's design. Clamp vertical brace to hanger rods. Requirements apply equally to hanging equipment. Do not weld vertical braces to hanger rods.
- .5 General Seismic Controls for Electrical Systems:
 - .1 Seismically restrain per specific code requirements all Electrical components listed below (unless otherwise indicated on the drawings), using seismic cable restraints:
 - .1 Seismically restrain all conduit 78 mm (3") in nominal diameter and larger. Single supported conduit is restrained in the same fashion as single clevis supported pipe.
 - .2 Seismically restrain all conduit, bus ducts, or cable trays that are supported on trapeze bars, that have been assigned a Component Importance Factor equal to 1.5, and that have a total weight greater than 146 N/m (10 lb/ft). This total weight includes not only the conduit, bus duct, or cable trays, but also includes the trapeze bars as well.
 - .2 The Contractor is to provide the weight per unit length for cable trays and bus duct.
 - .3 Single supported conduit and trapeze supported conduit, bus duct, and cable trays to be seismically restrained in a manner similar to mechanical pipes and HVAC ducts.
 - .4 Provide seismic restraint components intended to be used with suspended single supported conduit and trapeze supported conduit, cable trays, and bus ducts. Components intended to both support and restrain distribution systems such as wall mounted conduit, cable trays, and bus ducts will need to be designed and evaluated for both the dead weight load and the design horizontal seismic load.
 - .5 To ensure that the seismic forces are transferred properly to the restraint points, cables should be strapped either individually or in bundles to the cable tray at regular intervals. It is necessary for the conduit, bus ducts, and cable trays to be attached to the trapeze bars

- sufficiently to resist the design horizontal seismic forces, both transverse (T) and longitudinal (L).
- .6 Brace a change of direction longer than 3.7 m (12 ft).
 - .7 This specification does not allow the use of the "12 inch rule" where the piping and electrical may be exempted from seismic restraint based on the length of the support rods provided that the rods are not subjected to bending moments.
 - .8 Install restraint cables so they do not bend across edges of adjacent equipment or building structure. Tie back to structure at 45 degrees to the structure.
 - .9 Longitudinal restraints for single pipe supports shall be attached rigidly to the pipe, not to the pipe hanger.
 - .10 For supports with multiple pipes (trapezes), secure pipes to trapeze member with clamps approved for application.
 - .11 Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.
 - .12 Install flexible piping connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.
 - .13 Roof mounted duct is to be installed on sleepers or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading factors shall be determined by the registered design professional.
 - .14 Longitudinal restraints for single conduit supports shall be attached rigidly to the pipe, not to the pipe/conduit hanger.
 - .15 For supports with multiple conduits (trapezes), secure conduit to trapeze member with clamps approved for application.
 - .16 Rod Stiffener Clamps are required where the hanger rod exceeds the maximum length shown in the seismic calculation sheets. They are only required at restraint locations.
 - .17 Seismically Rated Beam Clamps are required where welding to or penetrations to steel beams are not approved.
 - .18 Adjust restraint cables so that they are not visibly slack. Cable not to support weight during normal operation.
 - .19 Seismic systems are to be compatible with requirements for anchoring and guiding of systems.
 - .20 Drilled or power-driven anchors or fasteners shall not be permitted for use with seismic control measures.
 - .21 Friction due to gravity does not constitute a seismic attachment.
 - .22 Seismic restraint connections are not to be connected to the bottom chord of steel joists or the bottom flange of steel beams.
 - .23 Standard beam clamps can be used to support restrained components; they cannot be used to connect the seismic restraint to the structure – only for the hanger rods.
 - .24 Make electrical connections to vibration-isolated equipment with flexible conduit or other flexible means acceptable to the Consultant and local governing authority having jurisdiction

so as not to restrict maximum anticipated movement of equipment under seismic excitation movement.

- .6 Panelboards, Lighting, Emergency Lighting Battery Units, and Emergency Remote Heads
 - .1 Wall mounted panelboards, lighting, emergency lighting battery units, and emergency remote heads can be directly mounted to the building structure with approved fasteners to suit. Minimum two or more anchors shall be provided on each side of all wall mounted equipment.
 - .2 For emergency battery units, pre-installed brackets must be used.

3.4 FIELD TESTS AND INSPECTIONS

- .1 Test, adjust, and certify installation. Submit copies of test report to the Consultant.
- .2 Inspect for removal of break away hardware to ensure proper torques of installed systems.
- .3 For non-visually verifiable product, manufacturers to verify proper torque for a minimum 10% of application. Document torques for applications per manufacturer's instructions.
- .4 The contractor shall notify the local representative of the seismic restraint materials manufacturer mid-way through the listed project if they require an inspection of any and all vibration and seismic restraint devices already installed. A typewritten report of any installation errors, improperly selected devices, or other fault in the system which could affect the performance of the system shall be documented and the contractor shall perform all steps that are required from this written report to properly complete the vibration and seismic restraint work as per the specifications. Report to include clear sketches as required.
- .5 The installing contractor shall submit a report to the Consultant, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Provide a short circuit and coordination study for the electrical distribution system. The basic analysis shall include a protective device evaluation, and a protective device coordination study.
- .2 The project shall begin at the point of utility service for the facility and continue down through the system to all downstream distribution and branch panelboards, motor control centres and significant motor locations.
- .3 The project shall include any new generators and any associated emergency power distribution equipment, including automatic transfer switches and generator ground fault protection.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 73.19 – Arc-Flash Hazard Analysis.
- .2 Single Line Diagram.

1.3 REFERENCE STANDARDS

- .1 Perform all studies in accordance with the latest applicable IEEE and ANSI standards.
 - .1 ANSI C38.010-1999.
 - .2 ANSI C37.5-1979.
 - .3 ANSI C37.13-1990.

1.4 SUBMITTALS

- .1 In accordance with Section 01 33 00:
- .2 Submit the following:
 - .1 Submit for review the protection coordination study.
 - .2 Shop drawings for equipment affected by the coordination study will not be reviewed until the coordination study has been submitted and reviewed.
 - .3 Include a one-line diagram of the system.
- .3 Projection System Coordination:
 - .1 Prepare a graph or coordination curves, prior to manufacture of service entrance and distribution equipment on K & E No. 336E Time-Current characteristic graph paper. Time-current characteristics shall be plotted of the following:
 - .1 [Existing protection device upstream of this project](#)
 - .2 Main and feeder protective devices at every voltage level used in distribution system.
 - .3 Protective devices associated with largest motor and/or refrigeration compressor.
 - .2 Preliminary submission of [TCC curves](#) for comment will be accepted.
 - .3 Each time-current characteristic curve sheet shall include:
 - .1 A single line diagram for the portion of the system involved.
 - .2 Transformer damage curves (where applicable).

- .3 Cable damage curves (where applicable).
- .4 Available fault levels for the portion of the system involved.
- .4 Consult manufacturer of the refrigeration compressors and obtain recommendations for settings on starters. Incorporate information in co-ordination curves and submit the associated curves to Compressor Manufacturer and obtain approval from the manufacturer.
- .5 Compressor manufacturer and mechanical trade contractor will determine and calibrate proper protection on motor starters and will ensure that it coordinates with protective devices on switchboard.
- .6 Co-ordination curves, mentioned above, shall be prepared by distribution equipment manufacturers as soon as possible after award of contract.
- .7 At the option of this contractor under this section, these co-ordination curves may also be prepared by an independent testing organization. In this case, the independent testing organization shall determine the proper settings of all protective relays and devices and pass them on to the switchboard manufacturer for incorporation into the switchboards. Include all associated costs in the tender.
- .8 Distribution Equipment manufacturers shall examine drawings and specifications prior to award of contract to ensure that relays and devices being supplied by them will co-ordinate satisfactorily to Supply Authority requirements. Payment will not be allowed, after award of contract, for extra charges due to device changes to comply with recommended practices, due to oversight or negligence by distribution equipment manufacturers.

1.5 CLOSEOUT SUBMITTALS

- .1 The Engineer who prepared the report shall visit the site and confirm that the feeder sizes as installed are consistent with the report as submitted.
- .2 Submit final version of the report with as-constructed feeder lengths and feeder sizes.

1.6 QUALITY ASSURANCE

- .1 Preparer Qualifications: Firm experienced in the analysis, evaluation, and coordination of electrical distribution systems and similar to the system for this project.
- .2 The study shall be prepared in accordance with the latest edition of NETA ATS, the Canadian Electrical Code, as well as manufacturer's recommendations.
- .3 Short-Circuit Analysis and Coordination Study shall be performed by a registered Professional Engineer. Study shall be signed and sealed by the Engineer. The Engineer shall have a minimum of eight years experience in the analysis, evaluation, and coordination of electrical distribution systems.
- .4 The firm conducting the study shall have one million worth of Professional Liability Insurance in addition to standard general insurance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Independent Testing Organizations
 - .1 AC Tesla.
 - .2 Brosz and Associates.

- .3 C-INTECH.
- .4 Eastenghouse.
- .5 Enkompass.
- .6 G.T. Wood.
- .7 Haronitis and Associates Ltd.
- .2 Electrical distribution manufacturers:
 - .1 Eaton.
 - .2 Schneider Electric.

2.2 PROTECTIVE DEVICE COORDINATION STUDY

- .1 Prepare coordination time-current characteristic curves to determine the required settings/sizes of the protective devices to maximize selectivity. The utility upstream protective device feeding the facility shall be maintained as the upper limit for coordination. These settings shall be obtained by the preparer, along with any other protective device setting requirements. The coordination curves shall be prepared on log-log paper and illustrate adequate clearing times between series devices. The curves shall be created through the use of the study software package, but must reflect actual protective devices to be installed. Adequate time-current curves shall be generated to depict coordination. In addition, protective device characteristics shall be suitably determined to reflect calculated short-circuit levels at the location.
- .2 A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection in explicit detail. All curve sheets shall be multi-colour for improved clarity. Areas lacking complete coordination shall be highlighted and reasons provided for allowing condition to remain or provide solution to resolve situation. System coordination, recommended ratings, and setting of protective devices shall be accomplished by a registered professional electrical engineer with a minimum of eight years of current experience in the coordination of electrical power systems.
- .3 The following information shall be provided on all curve sheets:
 - .1 Device identification and associated settings/size.
 - .2 Voltage at which curves are plotted.
 - .3 Current multiplier.
 - .4 ANSI frequent fault damage curve.
 - .5 Cable insulation damage curves.
 - .6 Transformer inrush point.
 - .7 Single-line for the portion of the system.
 - .8 Motor starting profiles (where applicable).

2.3 SINGLE LINE DIAGRAM

- .1 The final report shall include a multi-colour single line diagram of the electrical distribution system within the scope of the project. The single line diagram shall include:
 - .1 Transformer rating, voltage ratio, impedance, and winding connection.
 - .2 Feeder cable phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type.

- .3 Switchgear, switchboards, panelboards, MCC's, fuses, circuit breakers, ATS's and switches continuous current ratings.
- .4 Protective relays with appropriate device numbers and CT's and PT's with associated ratios.
- .5 Detailed legend indicating device type identification and other significant details.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Obtain fault level and X/R ratio information from the utility.

3.2 SUMMARY

- .1 The results of the system studies shall be summarized in a final report.
- .2 Where required, copies of the final report shall be submitted to the Supply Authority for their review and approval. Submit approved copies of the report to the Consultant.

3.3 ADJUSTING

- .1 The contractor shall engage the manufacturer's service group or alternately a qualified independent testing firm to perform field adjustments of the protective devices as required for placing the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study and protective device evaluation / coordination study.
- .2 Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved protective device coordination study, shall be carried out by manufacturer's service group.
- .3 Submit a final service report confirming that settings have been completed.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Provide an Arc Flash Hazard Analysis Study per the requirements described in CSA Z462 Standard for Electrical Safety in the Workplace.
- .2 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are obtained in CSA Z462-08, Annex D, or more recent version of the standard as cited by this Section.
- .3 The scope of the studies shall include all existing distribution equipment and all new distribution equipment supplied by the equipment manufacturer under this contract.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 73.16 – Coordination Studies.
- .2 Single Line Diagram.

1.3 REFERENCES

- .1 Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - .1 IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
 - .2 IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - .3 IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
 - .4 IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
 - .5 IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
 - .6 IEEE 1584-2018 - Guide for Performing Arc-Flash Hazard Calculations.
- .2 American National Standards Institute (ANSI):
 - .1 ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
 - .2 ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
 - .3 ANSI C37.010-2016 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
 - .4 ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
- .3 CSA Group:
 - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (28th edition/2021).
 - .3 CSA Z462:21, Workplace electrical safety.

1.4 SUBMITTALS

- .1 Submit the protective device coordination study to the Consultant prior to receiving final review of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 CLOSEOUT SUBMITTALS

- .1 The results of the protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. The complete report with input and output data shall be provided in PDF format.
- .2 The report shall include the following sections:
 - .1 Executive Summary.
 - .2 Descriptions, purpose, basis, and scope of the study.
 - .3 Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties.
 - .4 Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
 - .5 Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
 - .6 Details of the incident energy and flash protection boundary calculations.
 - .7 Recommendations for system improvements, where needed.
 - .8 Single Line Diagram.
- .3 Arc flash labels (refer to CSA Z462 Annex Q) shall be provided in hard copy only.

1.6 QUALIFICATIONS

- .1 Arc flash hazard analysis studies shall be conducted under the supervision and approval of a licensed Professional Electrical Engineer skilled in performing and interpreting the power system studies.
- .2 The licensed Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.
- .3 The licensed Professional Electrical Engineer shall have a minimum of eight (8) years of experience in performing power system studies.
- .4 The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.7 COMPUTER ANALYSIS SOFTWARE

- .1 The studies shall be performed using the latest revision of the SKM or equivalent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Independent Testing Organizations:
 - .1 AC Tesla.
 - .2 Brosz and Associates.
 - .3 C-INTECH.
 - .4 Eastenghouse.
 - .5 Enkompass.
 - .6 G.T. Wood.
 - .7 Haronitis and Associates Ltd.
- .2 Electrical distribution manufacturers:
 - .1 Eaton.
 - .2 Schneider Electric.

2.2 STUDIES

- .1 The contractor shall furnish an Arc Flash Hazard Analysis Study per CSA Z462, reference Section 4.1.8.2.2, 4.3.3.

2.3 DATA COLLECTION

- .1 Contractor shall furnish all data as required by the power system studies. The Engineer performing arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- .2 Source combination may include present and future motors and generators.

2.4 ARC FLASH HAZARD ANALYSIS

- .1 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in CSA Z462 Annex D.
- .2 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, panelboards, and splitters) where work could be performed on energized parts.
- .3 [Deleted](#)
- .4 Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 calories per square centimetre.
- .5 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- .6 The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely

reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

- .7 The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
 - .1 Fault contribution from induction motors should not be considered beyond 3-5 cycles.
- .8 Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- .9 For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- .10 When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- .11 Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- .12 Arc Flash calculations shall be based on actual overcurrent protective device clearing time.
- .13 Maximum clearing time will be capped at 2 seconds based on IEEE 1584.
- .14 Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.5 REPORT SECTIONS

- .1 Incident energy and flash protection boundary calculations:
 - .1 Arcing fault magnitude.
 - .2 Protective device clearing time.
 - .3 Duration of arc.
 - .4 Arc flash boundary.
 - .5 Working distance.
 - .6 Incident energy.
 - .7 Hazard Risk Category.
 - .8 Recommendations for arc flash energy reduction.

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

- .1 Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- .2 Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- .3 Notify Owner in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

- .1 The contractor of the Arc Flash Hazard Analysis shall provide a 90 mm (3.5 in) by 125 mm (5 in) thermal transfer type label of high adhesion polyester for each work location analyzed.
- .2 All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- .3 The label shall include the following information, at a minimum:
 - .1 Location designation.
 - .2 Nominal voltage.
 - .3 Flash protection boundary.
 - .4 Hazard risk category.
 - .5 Incident energy.
 - .6 Working distance.
 - .7 Engineering firm and issue date.
 - .8 Labels shall be machine printed, with no field markings.
- .4 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - .1 For each 600 volt, and applicable 208 volt panelboard, one arc flash label shall be provided.
 - .2 For each motor control centre, one arc flash label shall be provided.
 - .3 For each low voltage switchboard, one arc flash label shall be provided.
 - .4 For each switchgear, one flash label shall be provided.
 - .5 For medium voltage switches one arc flash label shall be provided.
- .5 Arc Flash Warning Label General Instructions:
 - .1 Only qualified electricians who recognize and avoid the electrical and Arc Flash hazards are allowed to place the arc flash warning labels.
 - .2 Electricians should wear suitable PPE, such as electrical safety boots, Safety Glasses, etc. while performing labeling.
 - .3 Generally, arc flash label shall be put on a prominent pre-cleaned place on the front of the electrical equipment (such as switchgear, panel, disconnect switch, generator output

- breaker). Label should be visible and readable, displayed horizontally, attached flatly and securely, and not allowed to cover other signs or labels on the equipment.
- .4 Under the special request of the client, labels could be put on the back of the panel door when the panel is located in clean and finished spaces such as an office area.
 - .5 When putting a label on small equipment with no space labeling on the wall just beside the equipment is allowed.
 - .6 Special request may be attached to this General Instruction. For examples, more than one identical label is applied for large equipment; different labels could be applied for different sections of one equipment; for a splitter with several disconnect switches only one label is placed on the splitter for this group.
 - .7 Take the pictures for each label to indicate both names of the label and equipment and labeling area of the equipment. Email these pictures to the Consultant for quality control and record.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Occupancy and Vacancy sensors.
- .2 Power packs, and auxiliary relays, momentary switches.
- .3 Manual controls devices, including dimming switches and low voltage momentary switches.
- .4 Timer switches.
- .5 Daylight harvesting photo sensors.
- .6 Emergency lighting control units.

1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

- .1 Line voltage manual control devices, as described in Section 26 27 26 – Wiring Devices.
- .2 Multi-zone scene controllers, as described in Section 26 09 36 – Modular Dimming Controls.

1.3 RELATED REQUIREMENTS

- .1 Section 26 08 50 – Commissioning of Lighting.
- .2 Section 26 27 26 – Wiring Devices.
- .3 Section 26 51 19 – LED Interior Lighting.
- .4 Section 26 56 19 – LED Exterior Lighting.

1.4 REFERENCES

- .1 CSA Group:
 - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (28th edition/2021).
 - .3 CSA C22.2 No. 14-13 – Industrial Control Equipment.
 - .4 CSA C22.2 No. 42 - General Use Receptacles.
 - .5 CSA C22.2 No. 42.1 - Cover Plates for Flush Mounted Wiring Devices.
 - .6 CSA C22.2 No. 184 - Solid-State Lighting Controls.
 - .7 CSA C22.2 No. 184.1 - Solid State Dimming Controls.
 - .8 CSA C22.2 No. 156 - Solid-State Speed Controls.
- .2 National Electrical Manufacturers Association (NEMA):
 - .1 WD1 (R2005) — General Color Requirements for Wiring Devices.
 - .2 WD6 – Dimensional Specifications.
- .3 Ontario Building Code.
- .4 UL 924 - Standard for Safety of Emergency Lighting and Power Equipment.

1.5 SUBMITTALS

- .1 In accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Submit manufacturer's descriptive literature and product specifications for each product.
 - .2 Manufacturer's product drawings.
 - .3 Manufacturer's installation instructions.
- .3 Where the lighting controls include the option for custom engraving, or custom touchscreen user interfaces on control devices, switches, or scene controllers, the Contractor is to submit proposed engraving/labelling/graphics as part of the shop drawing submittal, for review by the Owner.

1.6 CLOSEOUT SUBMITTALS

- .1 Documentation of all lighting control system setpoints, sensor sensitivities, occupancy sensor timeouts, and as-programmed sequences of operation to aid in future troubleshooting.
- .2 Lighting controls functional test report.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Products free of defects in material and workmanship.

1.8 WARRANTY

- .1 Product is warranted free of defects in material and workmanship.
- .2 Product is warranted to perform the intended function within design limits.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Wattstopper DLM.
- .2 Acuity Brands Lighting (nLight, Sensorswitch).
- .3 Cooper Lighting Solutions.
- .4 Current Lighting (formerly Hubbell/GE).
- .5 Lutron Vive.

2.2 GENERAL REQUIREMENTS OF ALL SENSORS AND POWER PACKS

- .1 Manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1 per cent.
- .2 Five year warranty and CUL listed.
- .3 In the event of failure, provide a bypass manual "override on" feature on each sensor.
- .4 When bypass utilized, lighting to remain on constantly, or control is to be diverted to a wall switch until sensor is replaced. The override feature is to be designed for use by building maintenance personnel and not be readily achieved by building occupants.

2.3 OCCUPANCY AND VACANCY SENSORS

- .1 General:
 - .1 Sensors using passive infrared, ultrasonic, microphonic, and multi-technology adaptive technology.
 - .2 Sensor timeouts configurable by system software.
 - .3 Electrical: Rating: 24 VDC input voltage, up to 40 mA current draw.
 - .4 Mechanical: Mounting: Sensors for mounting on ceilings and walls, including corners, must be available.
 - .5 Environmental:
 - .1 Operating Temperature Range: 0 degrees C to 40 degrees C
 - .2 Relative Humidity: 0 per cent to 95 per cent non-condensing.
- .2 Dual Technology Wall Switch Sensor, 24V
 - .1 Wattstopper DW-100-24-W series (Basis of Design).
 - .2 Sensor capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.
 - .3 Utilize a dual sensing verification principle for coordination between ultrasonic and Passive Infrared (PIR) Technologies to reduce likelihood of false triggering.
 - .4 For best results, sensor shall feature a trigger mode where the end-user can choose which technology will activate the sensor from Off mode (initial), the type of detection that will reset the time delay (maintain), and the type of detection that will cause the sensor to be turned back on immediately after the lights are turned off due to lack of motion (re-trigger). Selection of technologies for initial, maintain, and re-trigger shall be done with DIP switches.
 - .5 Sensor shall have its trigger mode factory preset to allow for quick installation in most applications. In this default setting, both technologies must occur in order to initially activate lighting systems. Detection by either technology shall maintain the lighting on, and detection by either technology shall turn lights back on after lights were turned off for 5 seconds or less in automatic mode, and 30 seconds or less in manual mode.
 - .6 Robotic test method, as referred in the NEMA WD 7 Guide, shall be utilized for minor motion coverage verification.
 - .7 Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 kHz. It shall utilize Advanced Signal Processing which automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
 - .8 The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall filter short wavelength IR, such as those emitted by the sun and other visible light sources. Face lens grooves in to avoid dust and residue build up which affects IR reception.
 - .9 Utilize zero crossing circuitry to reduce stress on relay, and therefore increase sensor life.
 - .10 Operate at 24 VDC and halfwave rectified and utilize a power pack or lighting control system input module to supply power.
 - .11 To blend in aesthetically, sensor protrusion not more than 3/8" from the wall and utilize colour-matched lens.

- .12 To assure detection at desktop level uniformly across the space, sensor shall have a 28 segment, 2 level, Fresnel injection molded lens.
 - .13 Sensor shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by DIP switch.
 - .14 To avoid false ON activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
 - .15 Coverage up to 1,000 sq. ft. for walking motion, with a field view of 180 degrees.
 - .16 Automatic-ON or manual-ON operation, adjustable with a DIP switch.
 - .17 Sensor shall have an adjustable time delay.
 - .18 Each sensing technology shall have an LED indicator that remains active at all times, in order to verify detection within the area to be controlled.
 - .19 Sensor shall have a service switch to allow end-users to operate the sensor in the unlikely event of a failure; set by a trim pot.
 - .20 Sensor shall have a built-in light level that features simple, one-step daylighting setup that works from 8 fc to 180 fc.
 - .21 The Dual Technology wall switch sensor shall be a completely self-contained control system that replaces a standard toggle switch
- .3 Dual Technology Ceiling Mounted Sensor, 24V
- .1 Wattstopper DT-300 series (Basis of Design).
 - .2 The Dual Technology sensor shall be capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes.
 - .3 Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic or microphonic and Passive Infrared (PIR) Technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either technology shall keep the lighting on.
 - .4 Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.
 - .5 Sensors shall be ceiling mounted with a flat, unobtrusive appearance, and provide 360 degree coverage.
 - .6 Ultrasonic sensing shall be volumetric in coverage, with a frequency of 40 kHz. It shall utilize Advanced Signal Processing that automatically adjusts the detection threshold dynamically to compensate for changing levels of activity and airflow throughout a controlled space.
 - .7 To avoid false ON activations, and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, in order to respond only to those signals caused by human motion.
 - .8 The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.
 - .9 Sensors shall operate at 24 VDC, and halfwave rectified, and utilize a 24 V power pack.

- .10 Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
- .11 The sensor shall have a built-in light level sensor that works from 10 fc to 300 fc.
- .12 The sensors shall feature terminal style wiring.
- .13 Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.

2.4 SPECIAL PURPOSE OCCUPANCY SENSORS

- .1 Occupancy Sensors for High bay applications:
 - .1 For use in warehouses, distribution centres, and gymnasiums.
 - .2 Maximum 14 m (45 feet) mounting height.
 - .3 Surface-mount or end-mount model to suit application.
 - .4 180 degree and 360 degree coverage lenses available.
 - .5 Low-voltage, passive infrared (PIR) sensor.
 - .6 End-mount model to attach directly to industrial T5HO and T8 fixtures through an extended 13 mm (0.5 inch) chase nipple or junction box.
 - .7 Adjustable timeout for maximum energy savings.
 - .8 Basis of design: Lutron LUT-WSPSM24V-360-CPN6111 and similar.

2.5 POWER PACKS

- .1 General:
 - .1 Self-contained transformer and relay module.
 - .2 Internal relay controlling up to 20A for 120, 230, 277VAC or 347VAC ballast loads and 120VAC incandescent loads.
 - .3 Provide a 24 VDC, 150 mA output.
 - .4 Capable of parallel wiring without regard to AC phases on primary.
 - .5 Power pack can be used as a standalone, low voltage switch, or can be wired to sensor for auto control.
 - .6 Construction: high impact, UL rated plastic case
 - .7 Power pack shall be UL/CUL Listed, FCC Certified, UL 2043 plenum rated and meets ASHRAE 90.1 requirements
 - .8 Shall at minimum meet the following environmental specifications:
 - .1 Operating Temperature Range: 0 degrees C to 40 degrees C
 - .2 Relative Humidity: 0 per cent to 95 per cent non-condensing
- .2 Power Pack and Auxiliary Relay, 347 V
 - .1 Power Pack: Wattstopper B347D-P Series (Basis of Design)
 - .2 Auxiliary Relay: Wattstopper S347-E-P Series (Basis of Design)

- .3 Power pack shall be a self-contained transformer and relay module measuring 45 mm by 70 mm by 38 mm (1.75 inch by 2.75 inch by 1.5 inch).
- .4 For ease and speed of installation, power pack shall have 12 mm (1/2") snap-in nipple for 12 mm (1/2") knockouts and mounting on outside of enclosure.
- .5 Power pack shall have dry contacts capable of switching 15 amp ballast @ 347 VAC, 60Hz.
- .6 Power pack shall have primary voltage input of 347 VAC.
- .7 Power pack shall provide a 24 VDC, 114 mA output, with the relay connected.
- .8 Power pack shall be capable of parallel wiring without regard to AC phases on primary.
- .9 Power pack can be used as a standalone, low voltage switch, or can be wired to sensor for auto control.
- .10 Power pack shall have hold-ON and hold-OFF inputs for integration with lighting control panels, BMS and other building systems.
- .11 Power pack shall have overcurrent protection if the low voltage current drawn exceeds 150 mA. In the event of an overcurrent, the low voltage output current shuts down and the LED will blink to indicate a fault condition.
- .12 Power pack shall have an LED to indicate status of relay.
- .13 Power pack shall utilize Zero Crossing Circuitry to protect from the effects of inrush current and increase product longevity.

2.6 DECORATOR LOW VOLTAGE MOMENTARY SWITCHES

- .1 Wattstopper DCC2 series (Basis of Design).
- .2 Switch intended for use with power packs and sensors requiring a momentary contact switch that provides on/off signals.
- .3 12 VAC/VDC, 24 V Rectified, 24 VAC/VDC
- .4 50 mA Max. Internal Contact rating
- .5 500 mΩ resistance when closed
- .6 Single pole, double throw with centre position rest.

2.7 DIMMING SWITCHES

- .1 Direct control of dimming luminaires up to the luminaire manufacturer's specified rating.
- .2 Coordinate dimming signal configuration (2-wire phase cut, 3-wire, 4-wire 0-10V, or 4-wire DALI) with the fixture ballast or driver per Section 26 51 19, lighting fixture schedule, and related sections.
- .3 Compatible with related lighting control devices i.e. occupancy sensors.
- .4 Submit luminaire manufacturer's dimmer compatibility documentation to demonstrate compatibility and limits of dimming level.
- .5 Manufacturers:
 - .1 Lutron NovaT* style dimmers.
 - .2 Cooper
 - .3 Leviton.
 - .4 Approved Equal.

2.8 TIMER SWITCHES

- .1 Digital time switch programmable to turn loads off after a preset time.
- .2 Capable of operating as an ON/OFF switch.
- .3 Five terminal, completely self-contained control system that replaces a standard toggle switch. Switching mechanism 30 V @ 1 A air gap relay.
- .4 24 VAC when used in conjunction with power packs. For small rooms, or small localized loads, line voltage is permitted.
- .5 No minimum load requirement.
- .6 Time scroll feature permitting manual overriding of the preset time-out period. Selecting time scroll UP shall allow time-out period to scroll up throughout the timer possibilities to the maximum. Time scroll DN (down) shall allow time-out period to scroll down to minimum.
- .7 Options available for user to enable:
 - .1 One second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).
 - .2 Beep warning sounding every five seconds once the time switch countdown reaches one minute.
- .8 Manual timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.
- .9 Liquid crystal display (LCD) that shows the timer's countdown.
- .10 Incorporates two pulsed, open collector NPN transistor outputs for external latching relay coil drives or lighting control panel inputs.
- .11 Fit behind a decorator style faceplate. Concealed calibration switch for setting time-out, time scroll, one second light flash, and beep warning to prevent tampering of adjustments and hardware.
- .12 Time-out period adjustable in increments of 5 minutes from 5 minutes to 1 hour, and in increments of 15 minutes from 1 hour to 12 hours.
- .13 Operate with power packs in order to control additional loads.
- .14 Utilize terminal style wiring.
- .15 For safety, in the event there is an open circuit in the low voltage line, automatically switch to OFF mode.
- .16 Warranty: 5 year warranty.
- .17 CUL listed.
- .18 Wattstopper TS-400 and TS-400-24 series (Basis of Design).

2.9 EMERGENCY LIGHTING CONTROL UNIT FOR 120 VOLT CIRCUITS

- .1 Description:
 - .1 Sequence of Operation: activate emergency lighting in the event of loss of normal utility power, regardless of control status of the luminaire.
 - .2 Provide all required functionality to allow any standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building.
- .2 Device shall be listed to UL 924 to meet the intent of Ontario Building Code for "fail-safe operation", and be approved for use in Canada.

- .3 Example Manufacturers
 - .1 Functional Devices Inc. ESR01P series.
 - .2 Douglas Lighting Controls WR-RIB2401B-EL.
 - .3 Philips Bodine BLCD-20B.
 - .4 Schneider Electric SLSERC1277.
 - .5 Wattstopper ELCU-200 series.
 - .6 Approved Equal.
- .4 Mounting: Able to fit in a standard junction box knockout.
- .5 Features:
 - .1 Senses local single circuit power failure.
 - .2 LED indication for emergency and normal power.
 - .3 Provides absolute fail-to-on emergency lighting.
 - .4 Emergency lights are controlled with normal lighting.
 - .5 Sequence of Operation: automatically switch emergency lighting on and off as normal lighting is switched. When normal power is not available, force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.
- .6 Specifications:
 - .1 120 VAC; 60 Hz.
 - .2 Maximum Ballast Load: 10A @ 120 VAC.
 - .3 Housing: Fire rated V-0, 80 degrees C.
 - .4 Zero crossing circuitry to protect relay contacts from damaging effects of inrush current generated by switching electronic ballast loads.
 - .5 UL94 V-O plenum rated with compression wire terminals.
 - .6 UL, cUL listed Emergency Lighting and Equipment; five year warranty.

2.10 DAYLIGHT HARVESTING PHOTO SENSORS

- .1 General:
 - .1 Class 2, low voltage.
 - .2 Ambient light sensor designed to interface directly with the analog input of the Lighting Control System.
 - .3 Supply an analog signal to the Lighting Control System proportional to the light measured.
 - .4 Sensor output shall provide for zero or offset based signal.
 - .5 Capable of a fully adjustable response in the range between 0 and 10,000 foot candles with a +/- 1 per cent accuracy at 21 degrees C.
 - .6 Input: 10 VDC.
 - .7 Output: 0 VDC to 10 VDC.
 - .8 Flame retardant housing and meet UL 94 HB standards.
 - .9 Operating temperature: -10 degrees C to 60 degrees C.

- .2 Interior sensors: Fresnel lens, with a 60 degree cone of response. Range between 0 fc and 750 fc.
- .3 Exterior sensors: Complete with hood over the aperture to shield the sensor from direct sunlight. Outdoor sensor circuitry completely encased in an optically clear epoxy resin. Sensor range between 0 fc and 750 fc.
- .4 Atrium sensors: Translucent dome with a 180 degree field of view. Range from 2 fc to 2,500 fc.
- .5 Skylight sensors: Translucent dome with a 180 degree field of view. Range between 10 fc and 7,500 fc.

2.11 SEQUENCES OF OPERATION

- .1 [Per drawings lighting control matrix and notes](#)
- .2 Vacancy Sensor Operation: Manual On, Auto Off.
- .3 In accordance with ASHRAE 90.1-2013.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 In accordance with manufacturer's instructions.
- .2 Minimum 14 AWG from the circuit control hardware relays.
- .3 It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have 90 per cent to 100 per cent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.
- .4 It is the contractor's responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at Owner's facility, to verify placement of sensors and installation criteria.
- .5 Proper judgement must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.
- .6 Install manual control devices and sensors in accordance with manufacturer's instructions for Vacancy Operation.

3.2 SYSTEM STARTUP

- .1 The lighting controls manufacturer's representative shall conduct system startup and submit startup report.

3.3 SITE TESTS AND INSPECTIONS

- .1 The lighting controls manufacturer's representative and Contractor shall conduct functional testing and provide report as described in ASHRAE 90.1-2013:

- .1 Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.
- .2 When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:
 - .1 Occupant Sensors
 - .1 Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
 - .2 For projects with up to seven (7) occupancy sensors, all occupancy sensors shall be tested.
 - .3 For projects with more than seven (7) occupancy sensors, testing shall be done for each unique combination of sensor type and space geometry.
 - .4 For each sensor to be tested, verify the following:
 - .1 Status indicator (as applicable) operates correctly.
 - .2 Controlled lights turn off or dim down to the specified level within the required time (20 minutes, or as noted), as applicable to the space type.
 - .3 For auto-on occupant sensors (occupancy mode), the lights turn on to the permitted level when someone enters the space.
 - .4 For manual-on sensors (vacancy mode), the lights turn on only when manually activated.
 - .5 The lights are not incorrectly turned on by movement in nearby areas or by HVAC operation.
 - .2 Automatic Time Switches
 - .1 Confirm that the automatic time switch control is programmed with appropriate weekday, weekend, and holiday (as applicable) schedules.
 - .2 Document for the owner automatic time switch programming, including weekday, weekend, and holiday schedules, as well as all setup and preference program settings.
 - .3 Verify that correct time and date are properly set in the time switch.
 - .4 Verify that any battery backup (as applicable) is installed and energized.
 - .5 Verify that the override time limit is set to no more than two (2) hours.
 - .6 Simulate occupied condition. Verify and document the following:
 - .1 All lights can be turned on and off by their respective area control switch.
 - .2 The switch only operates lighting in the enclosed space in which the switch is located.
 - .7 Simulate unoccupied condition. Verify and document the following:
 - .1 All non-exempt lighting turns off.

- .2 Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shut off occurs.
- .3 Daylight Controls
 - .1 All control devices (photocontrols) have been properly located, field-calibrated, and set for appropriate set points and threshold light levels.
 - .2 Daylight controlled lighting loads adjust to appropriate light levels in response to available daylight.
 - .3 The location where calibration adjustments are made is readily accessible only to authorized personnel.
- .3 The individual(s) responsible for the functional testing shall not be directly involved in either the design or construction of the project and shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria.
- .2 Test lighting controls with fire alarm system in accordance with Section 28 08 46 and Section 28 46 51.
- .3 Commissioning:
 - .1 Upon completion of the installation, the system shall be completely commissioned to verify all adjustments and sensor placement to ensure a trouble-free lighting control system.
 - .2 Submit commissioning report to the Consultant and the commissioning authority for review.
 - .3 Provide the Consultant and Commissioning Authority with ten working days written notice of the scheduled commissioning date.

3.4 TRAINING

- .1 Provide training session of minimum 4 hours duration in accordance with Section 01 79 00.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Emergency lighting units with battery back-up for emergency illumination of remote emergency fixtures and internally illuminated exit signs.
- .2 Remote emergency fixtures.

1.2 RELATED REQUIREMENTS

- .1 Section 26 51 19 – LED Interior Lighting.
- .2 Section 26 52 13.16 – Exit Signs.

1.3 REFERENCES

- .1 CSA Group:
 - .1 CSA C22.2 No. 141-15 (R2020), Emergency lighting equipment.
 - .2 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
 - .3 Ontario Electrical Safety Code (28th edition/2021).
- .2 Ontario Building Code.
- .3 National Building Code of Canada.
- .4 Underwriters Laboratories, Inc. (UL):
 - .1 UL 924 – Standard for Safety of Emergency Lighting and Power Equipment.

1.4 SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

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

1.6 EXTRA MATERIALS

- .1 Allow the cost for material and for installation of the following to be installed as directed by the Consultant during construction:
 - .1 An additional five dual head emergency remote units.
 - .2 An additional one battery unit, based on the maximum battery capacity as specified.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Products shall be free of defects in material and workmanship.
- .2 Furnished products are listed and/or certified by third party agencies as suitable for the intended purpose.
- .3 All units will be certified that they have been tested prior to shipping.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Section 01 61 00 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect emergency lighting from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 00.

1.9 WARRANTY

- .1 Product is warranted free of defects in material and workmanship.
- .2 Product is warranted to perform the intended function within design limits.
- .3 For batteries in this Section, 12 month warranty period is extended to 24 months.

PART 2 - PRODUCTS

2.1 EMERGENCY BATTERY UNITS

- .1 Manufacturers:
 - .1 Lumacell RG12S series.
 - .2 Aimlite.
 - .3 BeLuce (formerly Beghelli).
 - .4 Emergi-Lite.
 - .5 Lithonia (Acuity Brands Lighting).
 - .6 Stanpro.
- .2 Battery Unit Features:
 - .1 Self-contained unit equipment for LED emergency lighting shall be manufactured and labeled as certified to meet CSA C22.2 No 141.

- .2 Housing: Constructed of formed and welded 18 gauge cold rolled steel with knockouts for conduit, finished in baked white enamel. Cabinet suitable for direct or shelf mounting to wall. Removable or hinged front panel for easy access to batteries.
- .3 Charger:
 - .1 Solid-state micro-controller PCB, Pulse-Guard charger, features include; auto-equalized, temperature compensated, current limited, short circuit and reverse polarity protected.
 - .2 Recharges battery within 24 hours in accordance with CSA requirements.
- .4 Transfer: Upon failure of the power supply, or voltage dip below 75 per cent of nominal, a sealed relay automatically and instantaneously connects the battery to the emergency lighting load and disconnects when battery discharge reaches 87.5 per cent expectancy.
- .5 Batteries: seal lead calcium, maintenance free, and 10 year pro-rated service life.
- .6 Auto-test: Unit to perform self-test for 1 minute ever 30 days, 10 minutes on the 6th month, and 30 minutes every 12 months.
- .3 Battery Electrical Features:
 - .1 Input Voltage: 120-347 VAC universal input:
 - .1 Provided with plug and receptacle when connected to 120 volt source panelboard.
 - .2 direct connected to 347 volt source panelboard.
 - .2 Output Voltage: 12 VDC; balance loads to battery unit terminals.
 - .1 Normally "Off" output: wattage capacity as indicated for emergency remotes and internally illuminated exit signs.
 - .2 Battery Run Time at full load: must meet OBC minimum, 30 minutes.
 - .3 Voltage regulation: ± 5 per cent of nominal maximum.
 - .3 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
- .4 Lamp heads:
 - .1 Integral on unit, 345 degrees horizontal and 180 degrees vertical adjustment.
 - .2 Lamp type:
 - .1 Two 12 V, 6 W MR16 LED lamps mounted on top of the battery cabinet, shall be injection molded thermoplastic, white finish.
 - .2 Average lamp lumens: 170 lm.
 - .3 Centre Beam Candlepower: 440 cd.
 - .4 Beam angle: 30 degrees.
 - .5 Lamp efficacy: 42.5 lm/W.
- .5 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 Shelf Bracket.
- .8 Cord and single twist-lock plug connection for AC.
- .9 RFI suppressors.
- .10 Voltage Sensing Relay:
 - .1 Up to six inputs for line voltage detection from different normal lighting zone. The wire connection from each zone circuit shall be made with terminal blocks.
 - .2 Operation Sequence: In the case of power failure of one or several circuits feeding normal lighting, the output circuit will open and transfer the battery unit(s) in emergency lighting mode.
 - .3 Provide "push to test" push button and a pilot light for each zone circuit for manual testing and service.

2.2 VOLTAGE SENSING RELAY (VSR) ZONE CONTROL STAND-ALONE EXTENSION MODULE

- .1 Manufacturers: Lumacell VSR series (basis of design).
- .2 The equipment shall have an adequate quantity of inputs (up to 24 inputs) for line voltage detection from different building zones. The wire connection from each zone circuit shall be made with terminal blocks. The output circuit shall be a dry-contact relay, normally closed and shall be accessible for connection on a terminal block. The output circuit shall be connected at installation in series with the AC line supplying the battery unit equipment.
- .3 Operation Sequence: In the case of power failure of one or several circuits feeding normal lighting, the output circuit will open and transfer the battery unit(s) in emergency lighting mode.
- .4 Include a "push to test" push button and a pilot light for each zone circuit for manual testing and service.

2.3 EMERGENCY LIGHTING EMERGENCY REMOTE HEADS

- .1 Refer to drawings and lighting schedule.
- .2 One or two lamps, shall be injection molded thermoplastic, white finish, lamps shall be MR16 LED 12 V, 540 lumen, 25 degree beam angle, 6 watt.
- .3 Remote heads to be mounted not less than 2100 mm (6'-10") AFF.
- .4 LED MR16 lamps:
 - .1 Lumacell MQM-x-12V4W-LD10 series.
 - .2 Equal by Emergi-Lite.
 - .3 Equal by Stanpro.
 - .4 Equal by Beluce (formerly Beghelli).

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections are acceptable for emergency lighting installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Owner.
 - .2 Inform Owner 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 Owner.

3.2 INSTALLATION

- .1 Install emergency lighting in compliance with local inspection authorities.
- .2 Wiring:
 - .1 Connect battery input to source panelboard. Balance the emergency lighting loads connected to battery output terminal blocks. Provide and connect remote fixtures and internally illuminated exit signs as specified and as required for system performance in compliance with OBC minimum egress illumination requirements. Install remotes in locations as shown on the drawings. Connect all remotes to normally "Off" output from battery units.
 - .2 Contractor is responsible for revisions to system, including relocations, aiming and additional remote heads as determined by testing results. All wiring shall be in accordance with manufacturer's recommendations.
 - .3 Use minimum #10 gauge or heavier if needed to provide a maximum voltage drop of 5 per cent. Consult manufacturer's table for sizing the minimum gage and length of wire runs permitted for connected loads to ensure a maximum voltage drop of 5 per cent from the battery unit to the farthest emergency remote, in accordance with OBC and local inspection authorities.
- .3 Mounting: Suitable for wall mounting, complete with bracket from manufacturer lighting heads, test switch and diagnostic LED indicator shall be visible.
- .4 Provide Voltage Sensing Relays internal or external to battery units to meet the intent of OESC Rule 46-304 (4). Unit equipment shall be installed in such a manner that it will be automatically actuated upon failure of the power supply to the normal lighting in the area covered by that unit equipment.

3.3 TESTING AND COMMISSIONING

- .1 When installation of emergency lighting equipment is complete, contractor shall commission and test the entire system and adjust if necessary.
- .2 Contractor is responsible for arranging and cost of a verification test of emergency illumination levels by the manufacturer's representative.
 - .1 Verification test shall be performed with a lux/footcandle meter at 1 m intervals along all paths of egress throughout the space, and record light level readings on floor plans provided by the consultant.

- .2 The contractor shall also provide consultant with a letter stating the recorded emergency lighting levels meet the OBC requirements of 10 lx (1 fc) average with minimum readings not less than 1 lx (0.1 fc) on the path of egress.
- .3 The manufacturer is to provide a letter of verification confirming testing and operation of all emergency lighting as well as installation to all applicable codes.
- .3 Contractor is to indicate in the letter the duration of emergency lighting run time that was observed.
- .4 Testing shall be performed during non-daylight hours. Contractor shall aim all remotes to optimise illumination on the floor and stair.
- .5 Contractor shall certify in writing to the Consultant that the system is complete, installed per CSA C22.2 No. 141, has been tested, and operates for the specified battery run time.
- .6 Contractor shall notify the Owner and the Consultant at least ten days prior to proposed testing date and schedule testing at time and date acceptable to the Owner.
- .7 Installation shall be in accordance with the electrical code and manufacturer's instructions.
- .8 The Contractor is to submit a letter on Contractor's letterhead confirming the criteria specified above is met, including light levels, and run time, and include a copy of the plans with light levels recorded.
- .9 Provide breaker lock on emergency lighting circuit at source panelboard.

3.4 PROTECTION

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

3.5 TESTING, MAINTENANCE, AND WARRANTY SERVICE

- .1 Provide complete instructions for the operation and care of the emergency power supply or unit equipment that shall specify testing at least once every month to ensure security of operation. Instructions to be framed under glass.
- .2 OBC testing obligations: Owner's facility maintenance personnel are required to document one manual test of the battery units each month, and conduct one full discharge test once a year per OBC and CSA C22.2 No. 141 requirements.
- .3 Annual Maintenance: The manufacturer recommends maintenance to be performed by a qualified service provider. Contact the manufacturer for any warranty service.

END OF SECTION