

Construction of a new building

Sept-Îles, QC

**SPECIFICATIONS - ISSUED FOR TENDER
ELECTRICAL**

**PART 3 OF 3
AUGUST 4, 2016**

SPECIFICATIONS: PART 3 OF 3 ELECTRICAL

<u>Division</u>	<u>Section</u>
DIVISION 26	26 05 01 – Common Work Results
	26 05 20 – Wire and Box Connectors 0-1000 V
	26 05 21 – Wires and Cables (0-1000 V)
	26 05 27 – Grounding - Primary
	26 05 28 – Grounding - Secondary
	26 05 29 – Hangers and Supports for Electrical Systems
	26 05 31 – Splitters, Junction, Pull Boxes and Cabinets
	26 05 32 – Outlet Boxes, Conduit Boxes and Fittings
	26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings
	26 05 43.01 – Installation of Cables in Trenches and in Ducts
	26 09 23.04 – Lighting Control Devices LED/Fluorescent Dimming
	26 12 16.01 – Dry Type Transformers up to 600 V Primary
	26 24 16.01 – Panelboard Breaker Type
	26 27 26 – Wiring Devices
	26 28 13.01 – Fuses – Low Voltage
	26 28 16.02 – Molded Case Circuit Breakers
	26 28 23 – Disconnect Switches – Fused and Non-Fused
	26 29 10 – Motor Starters to 600 V
	26 32 13.04 – Diesel Electric Generating Units (Liquid Cooled)
	26 36 23 – Automatic Transfer Switches
	26 50 00 – Lighting
	26 52 01 – Unit Equipment for Emergency Lighting
	26 53 00 – Exit Lights
	26 82 33.02 – Commercial Convectors
	26 82 39.01 – Unit heaters - Electric
DIVISION 28	28 31 02 – Fire Alarm System

APPENDICES

ANNEX A LIGHTING FIXTURE LIST
ANNEX B DISTRIBUTION PANEL SCHEDULE

ELECTRICAL DRAWING LIST:

E000	DRAWING LIST AND LEGEND
E001	SITE PLAN – ELECTRICAL SERVICES AND SINGLELINE
E100	GROUND FLOOR, LIGHTING AND EMERGENCY EXIT
E101	GROUND FLOOR, POWER AND FIRE ALARM
E200	ROOF PLAN
E300	MISCELLANEOUS DETAILS – PART 1
E301	MISCELLANEOUS DETAILS – PART 2

END OF SECTION

PART 1 - GENERAL

- 1.1 General .1 This Section covers items common to Sections of Division 26 and 28. This section supplements requirements of Division 1.
- 1.2 Related Sections .1 Section 01 00 10 - General Instructions.
.2 Section 01 61 00 - Common Product Requirements.
.3 Section 26 05 32 - Outlet Boxes, Conduits Boxes and Fittings.
- 1.3 Codes and Standards .1 Except where specified otherwise, do complete installation in accordance with the following:
.1 CE Code, Part 1 (Canadian Electrical Code), CSA C22.1-15.
.2 National Building Code, 2010.
.3 CAN 3 - C235-83(R2015), Preferred Voltage Levels for AC Systems, 0 to 50 000 V.
.2 Do overhead and underground systems in accordance with CSA C22.3 No.1-15 except where specified otherwise.
.3 Electrical and Electronic Manufacturers Association of Canada - (EEMAC).
.1 2Y-1-1958, CEMA Standard for Light Grey Colour for Indoor Switchgear.
.2 Y1-2-1979, Finishing Systems for Outdoor Electrical Equipment.
- 1.4 Care, Operation and Start-up .1 Instruct Engineer and operating personnel in the operation, care and maintenance of systems, system equipment and components.
.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
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<u>1.4 Care, Operation and Start-up (Cont'd)</u>	.3	Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.
<u>1.5 Voltage Ratings</u>	.1	Operating voltages: to CAN3-C235.
	.2	Motors, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
<u>1.6 Permits, Fees and Inspection</u>	.1	Refer to Section 01 00 10 - General Instructions.
	.2	Submit to Electrical Safety Authority and Supply Authority, necessary number of drawings and specifications for examination and approval prior to commencement of work.
	.3	Pay associated fees.
	.4	Engineer will provide drawings and specifications required by Electrical Safety Authority and Supply Authority at no cost.
	.5	Notify Engineer of changes required by Electrical Safety Authority prior to making changes.
	.6	Furnish Certificates of Acceptance from Electrical Safety Authority on completion of work to Engineer.
<u>1.7 Materials and Equipment</u>	.1	Provide materials and equipment in accordance with Section 01 61 00 - Common Product Requirements.
	.2	Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Safety Authority.
	.3	Factory assemble control panels and component assemblies.

- 1.8 Electric Motors, Equipment and Controls
- .1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
 - .2 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 23 and shown on mechanical drawings.
- 1.9 Finishes
- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two (2) coats of finish enamel.
 - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1-1.
 - .2 Paint indoor switchgear and distribution enclosures light grey to EEMAC 2Y-1.
 - .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
 - .3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
- 1.10 Equipment Identification
- .1 Identify electrical equipment with nameplates and labels as follows:
 - .2 Nameplates:
 - .1 Lamicoid 3 mm thick plastic engraving sheet, black face, white core, mechanically attached with self tapping screws.

NAMEPLATE SIZES

10 letters high	Size 1	10 x 50 mm	1 line
12 letters high	Size 2	12 x 70 mm	1 line
12 letters high	Size 3	12 x 70 mm	2 lines
12 letters high	Size 4	20 x 90 mm	1 line
15 letters high	Size 5	20 x 90 mm	2 lines
18 letters high	Size 6	25 x 100 mm	1 line
18 letters high	Size 7	25 x 100 mm	2 lines

- 1.10 Equipment Identification (Cont'd)
- .3 Labels:
 - .1 Embossed plastic labels with 6 mm high letters unless specified otherwise.
 - .4 Wording on nameplates and labels to be approved by Engineer prior to manufacture.
 - .5 Allow for average of twenty-five (25) letters per nameplate and label.
 - .6 Identification to be English and French.
 - .7 Use one (1) nameplate or label for each language.
 - .8 Indicate receptacles with circuit number and associated panelboard.
 - .9 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
 - .10 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
 - .11 Terminal cabinets and pull boxes: indicate system and voltage.
 - .12 Transformers: indicate capacity, primary and secondary voltages.
 - .13 Contractor shall label all equipment with PMMS / CMMS identification. Provide list for co-ordination of all equipment and devices final numbering of last two digits of PMMS identifier. The remaining information will be supplied by the Engineer.
- 1.11 Wiring Identification
- .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
 - .2 Maintain phase sequence and colour coding throughout.
 - .3 Colour code: to CSA C22.1.
 - .4 Use colour coded wires in communication cables, matched throughout system.
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- 1.12 Conduit and Cable Identification .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.
- | | Prime | Auxiliary |
|-----------------------------|--------|-----------|
| up to 250 V | Yellow | |
| up to 600 V | Yellow | Green |
| up to 5 kV | Yellow | Blue |
| up to 15 kV | Yellow | Red |
| Telephone | Green | |
| Other Communication Systems | Green | Blue |
| Fire Alarm | Red | |
| Emergency Voice | Red | Blue |
| Other Security Systems | Red | Yellow |
- 1.13 Wiring Terminations .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper conductors.
- 1.14 Manufacturers and CSA Labels .1 Visible and legible, after equipment is installed.
- 1.15 Warning Signs .1 As specified and to meet requirements of Electrical Safety Authority and Engineer.
- .2 Decal signs, minimum size 175 x 250 mm.
- 1.16 Single Line Electrical Diagrams .1 Provide single line electrical diagrams in glazed frames as follows:
- .1 Electrical distribution system: locate in main electrical room.
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- 1.16 Single Line Electrical Diagrams (Cont'd)
- .2 Provide fire alarm riser diagram, plan and zoning of building in glazed frame at fire alarm control panel and annunciator.
 - .3 Drawings: 600 x 600 mm minimum size.
- 1.17 Location of Outlets
- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduits Boxes and Fittings.
 - .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
 - .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
 - .4 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor. Refer to latest architectural drawings for final door layouts.
- 1.18 Mounting Heights
- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
 - .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
 - .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1200 mm.
 - .2 Wall receptacles:
 - .1 General: 400 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical rooms: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and interphone outlets: 400 mm.
 - .5 Wall mounted telephone and interphone outlets: 1200 mm.
 - .6 Fire alarm stations: 1200 mm.
 - .7 Fire alarm bells: 2100 mm.
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<u>1.18 Mounting Heights (Cont'd)</u>	.3	(Cont'd) .8 Television outlets: 400 mm. .9 Wall mounted speakers: 2100 mm. .10 Clocks: 2100 mm. .11 Door bell pushbuttons: 1200 mm.
<u>1.19 Load Balance</u>	.1	Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
	.2	Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
	.3	Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.
<u>1.20 Conduit and Cable Installation</u>	.1	Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: plastic, sized for free passage of conduit, and protruding 50 mm.
	.2	If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
	.3	Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
<u>1.21 Field Quality Control</u>	.1	All electrical work to be carried out by qualified, licensed electricians or apprentices as per the conditions of the Provincial Act respecting manpower vocational training and qualification. Employees registered in a provincial apprentices program shall be permitted, under the direct supervision of a qualified licensed electrician, to perform specific tasks - the activities permitted shall be determined based on the level of training attained and the demonstration of ability to perform specific duties.

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- 1.21 Field Quality Control (Cont'd)
- .2 The work of this division to be carried out by a contractor who holds a valid Master Electrical contractor license as issued by the Province that the work is being contracted.
 - .3 Tests:
 - .1 Carry out testing and commissioning for electrical systems and equipment in accordance with relevant standards such as CSA, ULC, ANSI. Provide detailed test plan for Engineers review fourteen (14) days before testing. Test plan shall include all tests, descriptions, schedules, test equipment, shutdowns required, test sheets for all tests.
 - .2 Division 26 shall pay all associated costs for testing, studies and commissioning.
 - .3 Conduct and pay for following tests:
 - .1 Power generation and distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm system, emergency battery lighting system, telecommunications.
 - .4 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
 - .5 Insulation resistance testing.
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
 - .6 Carry out tests in presence of Engineer.
 - .7 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
 - .8 Submit test results for Engineer's review.
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1.22 Co-ordination of Protective Devices .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

PART 2 - PRODUCTS

2.1 Not Used .1 Not Used.

PART 3 - EXECUTION

3.1 Not Used .1 Not Used.

PART 1 - GENERAL

- 1.1 SECTION INCLUDES .1 Materials and installation for wire and box connectors.
- 1.2 RELATED SECTIONS .1 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- 1.3 REFERENCES .1 Canadian Standards Association (CSA International)
.1 CAN/CSA-C22.2 No.18-98 (R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
.2 CSA C22.2 No.65-13, Wire Connectors.
.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
.1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
.3 National Electrical Manufacturers Association (NEMA)
- 1.4 WASTE MANAGEMENT AND DISPOSAL .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
.3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
.4 Divert unused wiring materials from landfill to metal recycling facility as approved by Engineer.
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PART 2 - PRODUCTS

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

PART 3 - EXECUTION

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

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .3 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.
- .4 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- 1.2 References .1 CAN/CSA-C22.2 No. 131-14, Type TECK 90 Cable.
- 1.3 Product Data .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- 1.4 Waste Management and Disposal .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - PRODUCTS

- 2.1 Building Wires .1 Conductor material (wire in conduit): Annealed commercial grade, 98% conductivity copper; stranded for 10 AWG and larger. Minimum size: 12 AWG.
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| <u>2.1 Building Wires
(Cont'd)</u> | .2 | Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90. |
| <u>2.2 Armoured Cables</u> | .1 | Conductors: insulated, copper, size as indicated. |
| | .2 | Type: AC90. |
| | .3 | Armour: interlocking type fabricated from galvanized steel strip. |
| | .4 | Connectors: as recommended by the manufacturer. |

PART 3 - EXECUTION

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| <u>3.1 Installation of
Building Wires</u> | .1 | Install wiring as follows:
.1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
.2 In cabletroughs in accordance with Division 26. |
| <u>3.2 Installation of
Armoured Cables</u> | .1 | Group cables wherever possible. |
| | .2 | Install cable in trenches in accordance with Division 26. |
| | .3 | Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V. |

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2 Section 26 05 01 - Common Work Results - Electrical.
- 1.2 References .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE).
- .1 ANSI/IEEE 837-2014, Qualifying Permanent Connections Used in Substation Grounding.
- .2 Canadian Standards Association (CSA)
- .1 CSA C22.2 No.0.4-04(R2014), Bonding of Electrical Equipment.
- 1.3 Waste Management and Disposal .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

PART 2 - PRODUCTS

- 2.1 Materials .1 Rod electrodes: copper clad steel, 19 mm dia by 3 m long.
- .2 Conductors: bare, stranded, tinned soft annealed copper wire, size No 4/0 AWG for ground bus, electrode interconnections, metal structures, gradient control mats, transformers, switchgear, motors, ground connections.
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- 2.1 Materials (Cont'd)
- .3 Conductors: bare, stranded tinned soft annealed copper wire, size No. 4 AWG for grounding cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers, etc.
 - .4 Accessories: non-corroding, necessary for complete grounding system, type, size material as indicated, including:
 - .1 Grounding and bonding bushings,
 - .2 Protective type clamps,
 - .3 Bolted type conductor connectors,
 - .4 Thermit welded type conductor connectors,
 - .5 Bonding jumpers, straps,
 - .6 Pressure wire connectors.

PART 3 - EXECUTION

- 3.1 Grounding Installation
- .1 Install continuous grounding system including, electrodes, conductors, connectors and accessories in accordance with CSA C22.2 No.0.4 and requirements of local authority having jurisdiction.
 - .2 Install connectors in accordance with manufacturer's instructions.
 - .3 Protect exposed grounding conductors from mechanical injury.
 - .4 Make buried connections, and connections to electrodes, structural steel work, using permanent mechanical connectors to ANSI/IEEE 837.
 - .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
 - .6 Use No. 4/0 AWG bare copper cable for main ground bus of substation for taps on risers from main ground bus to equipment.
- 3.2 Electrode Installation
- .1 Install ground rod electrodes at transformer and switchgear locations.
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| <u>3.2 Electrode Installation
(Cont'd)</u> | .2 | Make special provision for installing electrodes that will give acceptable resistance to ground value, where rock or sand terrain prevails. |
| <u>3.3 Equipment
Grounding</u> | .1 | Install grounding connections as indicated to typical station equipment including: metallic water main, neutral. Non current carrying parts of: transformers, generators, motors, circuit breakers, reclosers, current transformers. Cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers. Meter and relay cases. Any exposed building metal, within or forming part of station enclosure. |
| | .2 | Ground hinged doors to main frame of electrical equipment enclosure with flexible jumper. |
| <u>3.4 Field Quality Control</u> | .1 | Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical. |
| | .2 | Perform earth loop test and resistance tests using method appropriate to site conditions and to approval of Engineer and local authority having jurisdiction. |
| | .3 | Perform test before energizing electrical system. |

PART 1 - GENERAL

- 1.1 RELATED SECTIONS
- .1 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
 - .2 Section 26 05 01 - Common Work Results - Electrical.
- 1.2 REFERENCES
- .1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE).
 - .1 ANSI/IEEE 837-2014, Qualifying Permanent Connections Used in Substation Grounding.
- 1.3 WASTE MANAGEMENT AND DISPOSAL
- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
 - .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Divert unused metal materials from landfill to metal recycling facility as approved by Engineer.
 - .5 Fold up metal banding, flatten and place in designated area for recycling.
- PART 2 - PRODUCTS
- 2.1 EQUIPMENT
- .1 Clamps for grounding of conductor: size as indicated to electrically conductive underground water pipe.
 - .2 System and Circuit, equipment, grounding conductor, bare stranded copper, un-tinned, soft annealed, un-armoured, size 4/0 AWG.
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- 2.1 EQUIPMENT
(Cont'd)
- .3 Insulated grounding conductors: green, type RW 90 XLPE.
 - .4 Ground bus in new electrical room; copper, size 6 mm x 75 mm x 1200 mm with supports, fastenings and connectors.
 - .5 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Bonding jumpers, straps.
 - .5 Pressure wire connectors.
 - .6 Compression-type bonding and connections.

PART 3 - EXECUTION

- 3.1 INSTALLATION
GENERAL
- .1 Install the complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories as indicated to conform to the requirements of the Engineer and the local authority having jurisdiction over installation. Where EMT is used, run separate green ground wire in conduit.
 - .2 Install connectors in accordance with manufacturer's instructions.
 - .3 Protect exposed grounding conductors from mechanical injury.
 - .4 Make buried connections, and connections to conductive water main, electrodes, using permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.
 - .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
 - .6 Soldered joints not permitted.
 - .7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
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3.1 INSTALLATION
GENERAL
(Cont'd)

- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Install separate ground conductor to outdoor lighting standards.
- .10 Make grounding connections in radial configuration only, with connections terminating at street side of water pipe. Avoid loop connections.
- .11 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- .12 Ground secondary service pedestals.

3.2 ELECTRODES

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

3.3 SYSTEM AND
CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to neutral of, secondary 120/208 V system.
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| <u>3.4 EQUIPMENT
GROUNDING</u> | .1 | Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, distribution panels, outdoor lighting. |
| <u>3.5 GROUNDING BUS</u> | .1 | Install copper grounding bus mounted on insulated supports on wall of electrical room. |
| | .2 | Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections. |
| <u>3.6 COMMUNICATION
SYSTEMS</u> | .1 | Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:
.1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
.2 Sound, fire alarm, intercommunication systems as indicated. |
| <u>3.7 FIELD QUALITY
CONTROL</u> | .1 | Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical. |
| | .2 | Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Engineer and local authority having jurisdiction over installation. |
| | .3 | Perform tests before energizing electrical system. |

PART 1 - GENERAL

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| <u>1.1 RELATED SECTIONS</u> | .1 | Section 01 74 19 - Construction/Demolition Waste Management And Disposal. |
| <u>1.2 WASTE MANAGEMENT AND DISPOSAL</u> | .1 | Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal. |
| | .2 | Remove from site and dispose of all packaging materials at appropriate recycling facilities. |
| | .3 | Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan. |
| | .4 | Divert unused metal materials from landfill to metal recycling facility as approved by Engineer. |
| | .5 | Fold up metal banding, flatten and place in designated area for recycling. |

PART 2 - PRODUCTS

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| <u>2.1 SUPPORT CHANNELS</u> | .1 | Provide galvanized steel support channels. |
| | .2 | U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted, suspended and set in poured concrete walls and ceilings as indicated. |
| <u>2.2 Threaded Rod Hangers</u> | .1 | Provide galvanized steel threaded rod support hangers throughout. |
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PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.
 - .2 Secure equipment to poured concrete with expandable inserts.
 - .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
 - .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
 - .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
 - .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
 - .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
 - .8 For surface mounting of two or more conduits use channels at 1500mm on centre spacing.
 - .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
 - .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
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3.1 INSTALLATION
(Cont'd)

- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Engineer.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

PART 1 - GENERAL

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|---|----|--|
| <u>1.1 RELATED SECTIONS</u> | .1 | Section 01 33 00 - Submittal Procedures. |
| | .2 | Section 01 74 19 - Construction/Demolition Waste Management And Disposal. |
| | .3 | Section 26 05 01 - Common Work Results - Electrical. |
| <u>1.2 Shop Drawings and Product Data</u> | .1 | Submit shop drawings and product data for cabinets in accordance with Section 01 33 00 - Submittal Procedures. |
| <u>1.3 Waste Management and Disposal</u> | .1 | Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan. |
| | .2 | Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan. |
| | .3 | Fold up metal banding, flatten and place in designated area for recycling. |

PART 2 - PRODUCTS

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|------------------------------------|----|--|
| <u>2.1 Splitters</u> | .1 | Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position. |
| | .2 | Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated. |
| | .3 | At least three spare terminals on each set of lugs in splitters less than 400 A. |
| <u>2.2 Junction and Pull Boxes</u> | .1 | Welded steel construction with screw-on flat covers for surface mounting. |
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- 2.2 Junction and Pull Boxes (Cont'd) .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

PART 3 - EXECUTION

- 3.1 Splitter Installation .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.
- 3.2 Junction and Pull Boxes Installation .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Install terminal block as indicated in Type T cabinets.
- .3 Only main junction and pull boxes are indicated on drawings. Provide pull boxes so as not to exceed 30 m or three 90° elbows of conduit run between pull boxes and not more than two 90° elbows in feeder conduits, unless bends are long sweep type.
- 3.3 Identification .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Install size 2 identification labels indicating system name, voltage and phase in accordance with Section 26 05 01 - Common Work Results - Electrical.

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- 1.2 References .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.
- 1.3 Waste Management and Disposal .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

PART 2 - PRODUCTS

- 2.1 Outlet and Conduit Boxes General .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.
- 2.2 Sheet Steel Outlet Boxes .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
-

<u>2.2 Sheet Steel Outlet Boxes (Cont'd)</u>	.2	102 mm square or octagonal outlet boxes for lighting fixture outlets.
	.3	102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster/tile walls.
<u>2.3 Masonry Boxes</u>	.1	Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.
<u>2.4 Concrete Boxes</u>	.1	Electro-glavanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.
<u>2.5 Floor Boxes</u>	.1	Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or longer duplex receptacles. Minimum depth: 28 mm for receptacles; 73 mm for communication equipment.
	.2	Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12 mm and 19 mm conduit. Refer to detail on drawings.
<u>2.6 Conduit Boxes</u>	.1	Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.
<u>2.7 Fittings - General</u>	.1	Bushing and connectors with nylon insulated throats.
	.2	Knock-out fillers to prevent entry of debris.
	.3	Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
	.4	Double locknuts and insulated bushings on sheet metal boxes.

PART 3 - EXECUTION

- 3.1 Installation .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- 1.2 References .1 Canadian Standards Association (CSA)
.1 CSA C22.2 No. 45-M1981(R2003), Rigid Metal Conduit.
.2 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
.3 CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.
.4 CSA C22.2 No. 211.2-06(R2011), Rigid PVC (Unplasticized) Conduit.
- 1.3 Waste Management and Disposal .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
.2 Place materials defined as hazardous or toxic waste in designated containers.
.3 Ensure emptied containers are sealed and stored safely for disposal away from children.
.4 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

PART 2 - PRODUCTS

- 2.1 Conduits .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.
.2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.
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| <u>2.1 Conduits
(Cont'd)</u> | .3 | Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings. |
| | .4 | Rigid pvc conduit: to CSA C22.2 No. 211.2. |
| | .5 | Flexible metal conduit: to CSA C22.2 No. 56, steel liquid-tight flexible metal. |
|
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| <u>2.2 Conduit Fastenings</u> | .1 | One hole galvanized steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm. |
| | .2 | Beam clamps to secure conduits to exposed steel work. |
| | .3 | Channel type supports for two or more conduits at 1500 mm oc. |
| | .4 | 12 mm diameter galvanized Threaded rods to support suspended channels. |
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| <u>2.3 Conduit Fittings</u> | .1 | Fittings: manufactured for use with conduit specified. Coating: same as conduit. |
| | .2 | Factory "ells" where 90° bends are required for 25 mm and larger conduits. |
| | .3 | All couplings and connectors at the sprinkler - proof equipment shall be steel-compression type (binding collar). For all other applications, steel set screw type couplings and connectors shall be used. |
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| <u>2.4 Fish Cord</u> | .1 | Polypropylene. |

PART 3 - EXECUTION

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| <u>3.1 Installation</u> | .1 | Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass. |
|-------------------------|----|--|
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- 3.1 Installation (Cont'd)
- .2 Conceal conduits except in mechanical and electrical service rooms.
 - .3 In unfinished areas, run wiring concealed, except as otherwise specified or indicated on the drawings. Run exposed conduits neatly, parallel to building lines and maintain maximum headroom.
 - .4 Use electrical metallic tubing (EMT) above 2.4 m not subject to mechanical injury.
 - .5 Use rigid pvc conduit underground.
 - .6 Use flexible metal conduit for connection to motors in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures work in movable metal partitions.
 - .7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
 - .8 Use explosion proof flexible connection for connection to explosion proof motors.
 - .9 Minimum conduit size for lighting and power circuits: 19 mm.
 - .10 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
 - .11 Mechanically bend steel conduit over 19 mm dia.
 - .12 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
 - .13 Install fish cord in empty conduits.
 - .14 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
 - .15 Dry conduits out before installing wire.
- 3.2 Surface Conduits
- .1 Run parallel or perpendicular to building lines.
 - .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
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3.2 Surface Conduits
(Cont'd)

- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended and surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.3 Concealed Conduits

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

3.4 Conduits in
Cast-in-place
Concrete

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

3.5 Conduits in
Cast-in-place Slabs
on Grade

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

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

PART 1 - GENERAL

1.1 RELATED
SECTIONS

- .1 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2 Section 26 05 01 - Common Work Results - Electrical.
- .3 Section 31 23 10 - Excavating, Trenching and Backfilling.

1.2 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
 - .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Unused sealant material must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
 - .5 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Engineer.
 - .6 Do not dispose of preservative treated wood through incineration.
 - .7 Do not dispose of preservative treated wood with other materials destined for recycling or reuse.
 - .8 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Engineer.
 - .9 Fold up metal banding, flatten and place in designated area for recycling.
-

PART 2 - PRODUCTS

2.1 CABLE PROTECTION .1 38 x 140 mm planks pressure treated with water repellent preservative.

2.2 MARKERS .1 Concrete type cable markers: 600 x 600 x 100 mm with words: cable, joint or conduit impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

PART 3 - EXECUTION

3.1 DIRECT BURIAL OF CABLES .1 After sand bed specified in Section 31 23 10 - Excavating, Trenching and Backfilling, is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.

.2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.3 Underground cable splices not acceptable.

.4 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.

.5 Cable separation:
.1 Maintain 75 mm minimum separation between cables of different circuits.
.2 Maintain 300 mm horizontal separation between low and high voltage cables.
.3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.
.4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.

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- 3.1 DIRECT BURIAL OF CABLES (Cont'd)
- .5 (Cont'd)
- .5 Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.
- .6 Install treated planks on lower cables 0.6 m in each direction at crossings.
- .6 After sand protective cover specified in Section 31 23 10 - Excavating, Trenching and Backfilling, is in place, install continuous row of overlapping 38 x 140 mm pressure treated planks as indicated to cover length of run.
- 3.2 CABLE INSTALLATION IN DUCTS
- .1 Install cables as indicated in ducts.
- .1 Do not pull spliced cables inside ducts.
- .2 Install multiple cables in duct simultaneously.
- .3 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .4 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
- .5 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- .6 After installation of cables, seal duct ends with duct sealing compound.
- 3.3 MARKERS
- .1 Mark cable every 150 m along cable or duct runs and changes in direction.
- .2 Mark underground splices.
- .3 Where markers are removed to permit installation of additional cables, reinstall existing markers.
- .4 Install concrete cable markers within 180 m from each side of runway centreline; 45 m from each side of taxi way centreline; 50 m from edge of taxi ramps or aprons.
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- 3.3 MARKERS
(Cont'd)
- .5 Lay concrete markers flat and centred over cable with top flush with finish grade.
- 3.4 FIELD QUALITY CONTROL
- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance tests:
.1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
- .6 Acceptance Tests:
.1 Ensure that terminations and accessory equipment are disconnected.
.2 Ground shields, ground wires, metallic armour and conductors not under test.
.3 High Potential (Hipot) Testing.
.1 Conduct hipot testing at 300% of original factory test voltage in accordance with manufacturer's recommendations.
- .7 Provide Engineer with list of test results showing location at which each test was made, circuit tested and result of each test.
- .8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

PART 1 - GENERAL

- 1.1 General .1 Performance Requirements:
.1 Provide all system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.
- 1.2 Related Sections .1 Section 01 33 00 - Submittal Procedures.
.2 Section 01 91 13 - General Commissioning (Cx) Requirements.
.3 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
.4 Section 02 61 33 - Hazardous Materials.
.5 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequence of Operation.
.6 Section 26 05 01 - Common Work Results - Electrical.
.7 Section 26 50 00 - Lighting.
- 1.3 References .1 Canadian Standards Association (CSA)
.1 CSA C22.2 No.184.1-15, Solid-State Dimming Controls (Bi-national standard with UL 1472).
.2 American National Standards Institute - (ANSI).
.1 ANSI C82.11-2011, High Frequency Fluorescent Lamp Ballasts.
.3 Federal Communications Commission (FCC).
- 1.4 Product Data .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
.2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 61 33 - Hazardous Materials.
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- 1.4 Product Data (Cont'd) .3 Submit product data sheets for fluorescent lighting control equipment. Include product characteristics, performance criteria, physical size, limitations and finish.
- .4 Submit complete list of all parts needed to fully install selected System components.
- 1.5 Shop Drawings .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate shielded wiring requirements.
- 1.6 Waste Management and Disposal .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .4 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - PRODUCTS

- 2.1 General .1 Lighting control manufacturer to provide interface to EMCS through Lanworks or BACnet protocol. EMCS will have the ability to schedule the lights via the open protocol. Refer to Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequence of Operation.
- 2.2 Product Data .1 Lighting Control System:
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2.2 Product Data
(Cont'd)

- .1 (Cont'd)
 - .1 The system shall provide central energy control for the lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.
- .2 Central Control:
 - .1 Energy Control Software interface shall provide current status and enable configuration of all system zones including selected individual fixture availability, current light level, maximum light level, on/off status, occupancy status, emergency mode status.
- .3 Reports:
 - .1 Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.
- .4 Daylight Harvesting (Light Regulation Averaging):
 - .1 In a photo sensor-equipped system, the Energy Control Unit shall rationalize changes to light levels when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions. System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photo sensors required. The system shall operate with multiple users in harmony and not react adversely to manual override inputs. Daylight harvesting shall not impede lighting control and the ability to adjust light levels on a per fixture basis.
- .5 Time Clock Scheduling:
 - .1 The system shall be programmable for scheduling lights on or off via the Energy Control Software interface.
 - .1 Override: Manual adjustments and occupancy sensor detection shall temporarily override off status imposed by time clock schedule.
 - .2 Response to Power Failure: In the event of a power failure, the time clock shall execute schedules that would still be in progress had they begun during the power outage.
 - .3 Flick Warning: Five minutes prior to a scheduled lights-off event or expiry of a temporary override, the system shall provide two short light level drops as a warning to the affected occupants.

2.2 Product Data
(Cont'd)

.5 (Cont'd)

.1 (Cont'd)

.4 Emergency Mode: There shall be a mode, when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated. This setting shall override all other inputs. The system shall interface with the building emergency monitoring system at a convenient point and not require multiple connections.

.5 Addressing: I/O Modules shall be centrally addressable, on a per fixture basis, through the Energy Control Software. To simplify installation and maintenance, the system shall not require manual recording of addresses for commissioning or reconfiguration.

.6 Programmable Task Tuning: Maximum light level programmability shall be available by individual fixture.

.7 Unoccupied State: The system shall provide two states when occupancy status is vacant as per an occupancy sensor: lights turn off or lights adjust to configurable light level.

.8 Occupied State: The system shall not isolate occupants by turning off lights that are still required for convenience and safety, such as a hallway path to exit the premises.

.9 Low-Voltage Wiring: Wiring shall be topology independent and not require splicing or termination. Prefabricated, quick connecting wiring shall be utilized. The maximum connected length of wiring shall be no less than 425 metres per channel.

.10 Lamp Burn In: The system shall not permit dimming of new lamps prior to completion of manufacturer recommended 100 hour accumulated operation at full brightness.

.11 Reconfigurability: The assignment of individual fixtures to zones shall be centrally configurable by Energy Control Software such that physical rewiring will not be necessary when workspace reconfiguration is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.

2.3 I/O MODULE

.1

I/O Module shall be the common interface to a ballast or sensor.

- 2.3 I/O MODULE (Cont'd)
- .2 Addressing: I/O Module shall be individually addressable via Energy Control Software.
 - .3 Voltage Compatability: Universal voltage control capability to 208 VAC maximum.
 - .4 Primary Relay Rating: 1.2A/120V.
 - .5 Ballast Compatability: Suitable for use with electronic dimming ballasts using a 0 to 10 VDC dimming signal.
 - .6 Power: Shall supply 12 VDC @ 25 mA power to attached sensor.
 - .7 Control Signal: Shall supply 0 to 10 VDC dimming signal to attached ballast or receive control signals from attached sensor.
 - .8 Memory: Retains all system settings in non-volatile memory.
- 2.4 Wall Controllers
- .1 Addressing: All controllers shall be individually addressable via Energy Control Software.
 - .2 Ratings: Shall be low voltage input.
 - .3 Operations: Localized on/off switching, dimming up/down, and programmable scene selection for dimming loads shall be provided, as required.
 - .4 LED's: All controllers shall feature LED's to indicate light on and light off status, as required.
 - .1 Operating Temperature Range: 0°C to 55°C.
 - .2 Relative Humidity: 20% to 90% non-condensing.
 - .3 Style: All controllers shall feature Decorator styling.
 - .4 Colour: All controllers shall be available with an optional colour insert kit for changing colour without reinstalling switch.
 - .5 Accessories: Matching wall plate shall be available.
- 2.5 Photo Sensor
- .1 A sensor that measures ambient light in a finite area shall be available.
 - .2 Specifications:
-

- 2.5 Photo Sensor (Cont'd)
- .2 (Cont'd)
 - .1 The sensor shall measure light from any source in the visible spectrum within at least a 60° cone. It shall measure light between 0 and minimum 750 lux.
 - .3 Electrical Ratings:
 - .1 Maximum 24VDC input voltage.
 - .4 Mechanical:
 - .1 Mounting: The sensor shall be flush mounted on or recessed inside ceiling tile.
 - .5 Environmental Specifications:
 - .1 Operating temperature range: 0°C to 55°C.
 - .2 Relative humidity: 20% to 90% non-condensing.
- 2.6 Occupancy Sensors
- .1 Sensors using passive infrared, ultrasonic, acoustic, and multi-technology adaptive technology shall be available.
 - .2 Sensor timeouts shall be configurable by system software.
 - .3 Electrical:
 - .1 Rating: Maximum 24 VDC input voltage, 25 mA current draw.
 - .4 Mechanical:
 - .1 Mounting: Sensors for mounting on ceilings and walls, including corners, must be available to suit the view angle to cover the required field of view.
 - .5 Environmental:
 - .1 Operating temperature range: Operating temperature range: 0°C to 55°C.
 - .2 Relative humidity: 20% to 90% non-condensing.
- 2.7 Ballasts
- .1 Source Limitations: All dimming ballasts, per particular lamp and fixture type, must be manufactured by the same company in order to assure consistent dimming.
 - .2 Manufacturer Requirements: Manufacturer must have a demonstrated history of designing and manufacturing dimming electronic ballasts.
-

- 2.7 Ballasts
(Cont'd)
- .3 Ballast must be manufactured in a facility certified to ISO Quality System Standards.
 - .4 Code Requirements:
 - .1 Ballast shall meet ANSI C82.11 limits for Total Harmonic Distortion.
 - .2 Ballast shall meet FCC Part 18 non-consumer standards for electrical equipment (Class A).
 - .3 Ballast shall meet Category A standards for Transient Voltage protection.
 - .4 Ballast shall meet CSA Approved.
 - .5 Ballast shall be UL Class P and Type 1 Outdoor.
 - .6 Ballast shall meet all Canadian provincial and federal efficacy laws.
 - .7 To CSA C22.2 No.184.1.
 - .5 Electrical Requirements:
 - .1 Ballast THD shall be less than 10% for the main lamp design (as indicated on the datasheet).
 - .2 Lamp Current Crest Factor shall not exceed 1.7 for the main lamp design.
 - .3 Ballast Power Factor must be greater than 98% for the main lamp design.
 - .4 Ballast must operate between $\pm 10\%$ of rated input voltage, 60Hz.
 - .6 Mechanical Requirements:
 - .1 Ballast shall be able to dim a fluorescent lamp from 100-10% of nominal light output.
 - .2 Ballast shall be able to start the lamp at any level without having to start at the high level first.
 - .3 Ballast input power (ANSI watts) shall be able to be reduced to less than 30% of nominal.
 - .4 Ballast shall be controlled via a 0 to 10V signal transmitted over Class 1 or Class 2 low voltage leads.
 - .7 Lighting Performance Requirements:
 - .1 Ballast must have a ballast factor of 0.85 to 0.96 for a normal light output design.
 - .2 Ballast must have a maximum input wattage (ANSI) as indicated on the data sheet.
 - .3 Ballast must have a ballast efficacy factor of at least what is indicated on the data sheet.
 - .4 Ballast must be able to start and operate the specified lamps at an average temperature of 60° F.
 - .5 Ballast must be sound rated A.
 - .6 Ballast must be designed and UL listed to operate the number and type of lamps as indicated on the data sheet.
-

2.7 Ballasts <u>(Cont'd)</u>	.7	(Cont'd)
	.7	Refer to Section 26 50 00 - Lighting.

PART 3 - EXECUTION

<u>3.1 Installation</u>	.1	The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans. The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.
	.2	Compliance: Contractor shall comply with manufacturer's product data, including shop drawings, technical bulletins, product catalog installation instructions, and product carton instructions for installation.
	.3	Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.
	.4	Related Product Installation: Refer to other sections listed in Related Sections for related products' installation.
	.5	Install Input / Output (I/O) Modules at each ballast, occupancy sensors, photo sensors, power pack / modules, switches and zone controllers and provide network wiring between each devices as required to the main control unit.
	.6	Install wiring, shielding, grounding in accordance with manufacturer's instructions.
	.7	Ensure shielded leads between intensity selector potentiometer and intensity controls have outer insulating jackets and are connected to ground at one point only.
	.8	Keep radio, VCR, TV and intercom wiring a minimum of 1.8 m away from dimming circuitry. Where crossing of wiring is essential, ensure that grounded shields surround such intercom wiring, and that crossings take place at 90°.
	.9	Locate intensity controls and "on-off" switches as indicated.

3.1 Installation

- (Cont'd)
- .10 Ensure positive, low resistance lamp to pin contact within lampholder.
 - .11 Season lamps by operating at full intensity for 100 h prior to final inspection. Operate ballasts in ambient temperature above 18 °C.
 - .12 Ensure connections are correctly made and to same phase before energizing.

3.2 Testing

- .1 Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, a qualified factory representative shall completely configure and test the system.
- .2 At the time of checkout and testing, the Engineer shall be thoroughly instructed in the proper operation of the system.

3.3 Protection

- .1 Contractor shall protect installed product and finished surfaces from damage during all phases of installation including preparation, testing, and cleanup.

3.4 Field Quality Control

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Demonstrate that dimming systems are installed as indicated.
- .3 Demonstrate that dimming systems operate as intended and that there are no problems in starting lamps, nor in keeping them lit, and free of perceptible flicker at any setting of dimming intensity control.
- .4 Demonstrate that no radio, VCR or TV interference is carried by system and that there is no interference between dimming system and locally used infrared-based remote/integral controls.

3.5 Commissioning

- .1 Refer to Section 01 91 13 - General Commissioning (Cx) Requirements.
-

3.5 Commissioning
(Cont'd)

.2

Commissioning shall be performed by at least one representative of supplier for this section and one representative from installation contractor.

PART 1 - GENERAL

- 1.1 REFERENCES
- .1 CSA International:
 - .1 CAN/CSA-C22.2 No.47-13, Air-Cooled Transformers (Dry Type).
 - .2 CSA C9-[02(R2016)], Dry-Type Transformers.
 - .3 CAN/CSA-C802.2-[12], Minimum Efficiency Values for Dry Type Transformers.
 - .2 National Electrical Manufacturers Association (NEMA)
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Submit in accordance with Section [01 33 00 - Submittal Procedures].
 - .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for [dry type transformers] and include product characteristics, performance criteria, physical size, finish and limitations.
- 1.3 CLOSEOUT SUBMITTALS
- .1 Submit in accordance with Section [01 78 00 - Closeout Submittals].
 - .2 Operation and Maintenance Data: submit operation and maintenance data for [dry type transformers] for incorporation into manual.
- 1.4 DELIVERY, STORAGE AND HANDLING
- .1 Deliver, store and handle materials in accordance with Section [01 61 00 - Common Product Requirements].
 - .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 [dry type transformers] from [nicks, scratches, and blemishes].
-

- 1.4 DELIVERY,
STORAGE AND
HANDLING
(Cont'd)
- .3 (Cont'd)
.3 Replace defective or damaged materials with new.
-

PART 2 - PRODUCTS

- 2.1 DESIGN
DESCRIPTION
- .1 Design [1].
.1 Type: [ANN].
.2 [3] phase, kVA as indicated, [347/600] V input,
[120/208] V output, 60 Hz.
.3 Voltage taps: [standard].
.4 Insulation: Class [H], [150] degrees C temperature rise.
.5 Basic Impulse Level (BIL): [standard].
.6 Hipot: [standard].
.7 Average sound level: [5%]
.8 Impedance at 17 degrees C: [standard]
.9 Enclosure: [CSA], removable metal front panel.
.10 Mounting: [floor] / [wall].
.11 Finish: [in accordance with Section 26 05 00 -
Common Work Results for Electrical].

- 2.2 EQUIPMENT
IDENTIFICATION
- .1 Provide equipment identification in accordance with Section
[26 05 00 - Common Work Results for Electrical].
.2 Label size: 7.

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Mount dry type transformers above 45 kVA on floor.
.2 Ensure adequate clearance around transformer for
ventilation.
.3 Install transformers in level upright position.
.4 Remove shipping supports only after transformer is installed
and just before putting into service.
.5 Loosen isolation pad bolts until no compression is visible.
-

3.1 INSTALLATION

(Cont'd)

- .6 Make primary and secondary connections in accordance with wiring diagram.
- .7 Energize transformers after installation is complete.
- .8 Make conduit entry into bottom 1/3 of transformer enclosure.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section [01 74 11 - Cleaning].
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section [01 74 11 - Cleaning].

3.3 PROTECTION

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

PART 1 - GENERAL

- 1.1 RELATED SECTIONS
- .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
 - .3 Section 01 91 13 - General Commissioning (Cx) Requirements.
 - .4 Section 06 10 10 - Rough Carpentry.
 - .5 Section 26 05 01 - Common Work Results - Electrical.
 - .6 Section 26 28 21 - Moulded Case Circuit Breakers.
- 1.2 REFERENCES
- .1 Canadian Standards Association (CSA International)
.1 CSA C22.2 No.29-2015), Panelboards and enclosed Panelboards.
- 1.3 SHOP DRAWINGS
- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
- 1.4 Plant Assembly
- .1 Install circuit breakers in panelboards before shipment.
 - .2 In addition to CSA requirements, manufacture's name plate shall identify fault current that panel and breakers have been built to withstand.
- 1.5 WASTE MANAGEMENT AND DISPOSAL
- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
-

1.5 WASTE
MANAGEMENT AND
DISPOSAL
(Cont'd)

- .3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Engineer.

PART 2 - PRODUCTS

2.1 PANELBOARDS

- .1 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
 - .1 Install circuit breakers in panelboards before shipment.
 - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .2 600 volts panelboards: bus and breakers rated for (symmetrical) interrupting capacity as indicated.
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Two keys for each panelboard and key panelboards alike.
- .6 Copper bus with neutral of same ampere rating as mains.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Trim and door finish: baked grey enamel.

2.2 BREAKERS

- .1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.
-

- 2.2 BREAKERS (Cont'd)
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
 - .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
 - .4 Lock-on devices for, fire alarm, emergency, door supervisory, intercom, stairway, exit and night light circuits.
- 2.3 EQUIPMENT IDENTIFICATION
- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
 - .2 Nameplate for each panelboard size 4 engraved as indicated.
 - .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
 - .4 Complete circuit directory with typewritten legend showing location and load of each circuit.
- 2.4 Material
- .1 Panelboard to be the product of one manufacturer.
- 2.5 Panel Schedule
- .1 Refer to Annex B for panel schedules.
- PART 3 - EXECUTION
- 3.1 INSTALLATION
- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
 - .2 Install surface mounted mounted panelboards on plywood backboards in accordance with Section 06 10 10 - Rough Carpentry. Where practical, group panelboards on common backboard.
 - .3 Mount panelboards to height specified in Section 26 05 01 - Common Work Results - Electrical or as indicated.
 - .4 Connect loads to circuits.
-

3.1 INSTALLATION

- (Cont'd) .5 Connect neutral conductors to common neutral bus with respective neutral identified.
- .6 All panelboard shall be tested and commissioning forms completed for each panel.

3.2 Commissioning

- .1 Refer to Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Commissioning shall be performed by at least one representative of supplier for this section and one representative of installation contractor.

PART 1 - GENERAL

<u>1.1 RELATED SECTIONS</u>	.1	Section 01 33 00 - Submittal Procedures.
	.2	Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
	.3	Section 26 05 01 - Common Work Results - Electrical.
<u>1.2 REFERENCES</u>	.1	Canadian Standards Association (CSA International)
	.1	CSA-C22.2 No.42-10(R2015), General Use Receptacles, Attachment Plugs and Similar Wiring Devices.
	.2	CSA-C22.2 No.42.1-13, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
	.3	CSA-C22.2 No.55-15, Special Use Switches.
	.4	CSA-C22.2 No.111-10 (R2015), General-Use Snap Switches (Bi-national standard, with UL 20).
<u>1.3 SHOP DRAWINGS AND PRODUCT DATA</u>	.1	Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
<u>1.4 WASTE MANAGEMENT AND DISPOSAL</u>	.1	Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
	.2	Remove from site and dispose of all packaging materials at appropriate recycling facilities.
	.3	Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
	.4	Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Engineer.

PART 2 - PRODUCTS

- 2.1 SWITCHES
- .1 20 A, 120 V, single pole, double pole, three-way, four-way switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111.
 - .2 Manually-operated general purpose ac switches with following features:
 - .1 Terminal holes approved for No. 12 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 Ivory toggle switch complete with stainless steel cover plate.
 - .6 Specification grade.
 - .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
 - .4 Switches of one manufacturer throughout project.
- 2.2 RECEPTACLES
- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA-C22.2 No.42 with following features:
 - .1 Ivory urea moulded housing.
 - .2 Suitable for No. 12 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
 - .6 Specification grade.
 - .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
 - .1 Ivory urea moulded housing.
 - .2 Suitable for No. 12 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
 - .3 Other receptacles with ampacity and voltage as indicated.
 - .4 Receptacles of one manufacturer throughout project.
- 2.3 COVER PLATES
- .1 Cover plates for wiring devices to: CSA-C22.2 No.42.1.
-

2.3 COVER PLATES

(Cont'd)

- .2 Cover plates from one manufacturer throughout project.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .4 Stainless steel, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .5 cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Mount toggle switches at height in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height in accordance with Section 26 05 01 - Common Work Results - Electrical.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Cover plates:
 - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 26 05 01 - Common Work Results - Electrical.
- 1.2 References .1 Canadian Standards Association (CSA)
- .1 CSA C22.2 No.248.12-11 (R2016), Low Voltage Fuses Part 12: Class R Fuses (Bi-National Standard with, UL 248-12 (1st Edition).
- 1.3 Shop Drawings and Product Data .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- 1.4 Waste Management and Disposal .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
- .1 Place materials defined as hazardous or toxic waste in designated containers.
- .2 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- 1.5 Delivery and Storage .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in moisture free location.
-

PART 2 - PRODUCTS

- 2.1 Fuses General .1 Fuse type references J1, etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer for entire project.
- .3 Plug and standard cartridge fuses based on CSA C22 No.248.
- 2.2 Fuse Types .1 Class J fuses (formerly HRCI- J).
- .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- 2.3 Fuse Storage Cabinet .1 Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door finished in accordance with Section 26 05 01 - Common Work Results - Electrical.

PART 3 - EXECUTION

- 3.1 Installation .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to assigned electrical circuit.

PART 1 - GENERAL

- 1.1 RELATED SECTIONS
- .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- 1.2 REFERENCES
- .1 Canadian Standards Association (CSA International).
 - .1 CSA-C22.2 No. 5-13, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE-2013).
- 1.3 SUBMITTALS
- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- 1.4 WASTE MANAGEMENT AND DISPOSAL
- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 Construction/Demolition Waste Management and Disposal.
 - .2 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .3 Separate for reuse and recycling and place in designated containers Steel, Metal and Plastic waste in accordance with Waste Management Plan.

PART 2 - PRODUCTS

- 2.1 BREAKERS GENERAL
- .1 Moulded-case circuit breakers, and Ground-fault circuit-interrupters: to CSA C22.2 No. 5.
 - .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
-

2.1 BREAKERS

GENERAL (Cont'd)

- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
 - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers minimum symmetrical rms interrupting capacity rating shall be 10kA at 120/208V and 18kV at 347/600V. Confirm the rating with value in coordination study.

2.2 THERMAL MAGNETIC BREAKERS DESIGN 'A'

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

2.3 MAGNETIC BREAKERS DESIGN 'B'

- .1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.
- .2 Series rated breakers to be manufacturer tested and listed. Breakers to be applied following manufacturer's guidelines and accepted best practice.
 - .1 Breakers applied following manufacturer's guidelines and accepted best practice.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.
- .2 Complete full operational test on all installed breakers.

PART 1 - GENERAL

- 1.1 RELATED SECTIONS
- .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 35 30 - Health and Safety Requirements.
 - .3 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
 - .4 Section 26 05 01 - Common Work Results - Electrical.
 - .5 Section 26 28 14 - Fuses - Low Voltage.
- 1.2 REFERENCES
- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4-16, Enclosed and dead-front Switches. (Tri-National standard, with NMX-J-162-ANCE-2016 and UL 98)
 - .2 CSA C22.2 No.39-M89 (R2003), Fuseholder Assemblies.
- 1.3 SUBMITTALS
- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- 1.4 HEALTH AND SAFETY
- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.
- 1.5 WASTE MANAGEMENT AND DISPOSAL
- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
-

1.5 WASTE
MANAGEMENT AND
DISPOSAL
(Cont'd)

- .3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers Steel, Metal and Plastic waste in accordance with Waste Management Plan.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - PRODUCTS

2.1 DISCONNECT
SWITCHES

- .1 Fusible and/or non-fusible, disconnect switch in sprinkler proof Enclosure, to CAN/CSA C22.2 No.4 size as indicated.
- .2 Provision for padlocking in on-off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, in accordance with Section 26 28 14 - Fuses - Low Voltage.
- .5 Fuseholders: to CSA C22.2 No.39 relocatable and suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.
- .8 Finish ASA-61.

2.2 EQUIPMENT
IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
 - .2 Indicate name of load controlled on size 4 nameplate.
-

PART 3 - EXECUTION

- 3.1 INSTALLATION .1 Install disconnect switches complete with fuses if applicable.
- .2 Mount on steel channel.
- .3 Where practical, group disconnects in a common location.
- .4 All disconnect switches shall be tested.

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 78 00 - Closeout Submittals.
- .3 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .4 Section 26 05 01 - Common Work Results - Electrical.
- 1.2 References .1 International Electrotechnical Commission (IEC)
- .1 IEC 947-4-1-1990, Part 4: Contactors and Motor-starters.
- 1.3 Shop Drawings and Product Data .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
- .1 Mounting method and dimensions.
- .2 Starter size and type.
- .3 Layout of identified internal and front panel components.
- .4 Enclosure types.
- .5 Wiring diagram for each type of starter.
- .6 Interconnection diagrams.
- 1.4 Closeout Submittals .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include operation and maintenance data for each type and style of starter.
- 1.5 Waste Management and Disposal .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
-

1.5 Waste Management
and Disposal
(Cont'd)

- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

PART 2 - PRODUCTS

2.1 Materials

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

2.2 Manual Motor
Starters

- .1 Single and Three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 One or Three overload heaters, manual reset, trip indicating handle.
- .2 Accessories:
 - .1 Toggle switch: heavy duty labelled as indicated.
 - .2 Indicating light: heavy duty type and colour as indicated.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 Full Voltage Magnetic
Starters

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
 - .2 Combination type starters to include fused disconnect switch with operating lever on outside of enclosure to control disconnect, and provision for:
 - .1 Locking in "OFF" position with up to 3 padlocks.
-

<u>2.3 Full Voltage Magnetic Starters (Cont'd)</u>	.2	(Cont'd) .2 Independent locking of enclosure door. .3 Provision for preventing switching to "ON" position while enclosure door open. .3 Accessories: .1 Selector switches: heavy duty labelled as indicated. .2 Indicating lights: heavy duty type and color as indicated. .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated. .4 Accessories: .1 Selector switches: standard heavy duty oil tight labelled as indicated. .2 Indicating lights: standard heavy duty oil tight, type and color as indicated. .3 Auxiliary control devices as indicated.
<u>2.4 Magnetic Starter Reduced Voltage Part Winding</u>	.1	Two-step reduced voltage, part winding starter of size, type, rating and enclosure type as indicated, with components as follows: .1 Two-3 pole contactors. .2 Adjustable pneumatic timer. .3 Six automatic reset overload relays. .2 Three step reduced voltage part winding starter of size, type, rating and enclosure type as indicated, with components as follows: .1 Three-3 pole contactors. .2 One set starting resistors. .3 Six automatic reset overload relays. .3 Accessories: .1 Selector switches: heavy duty labelled as indicated. .2 Indicating lights: heavy duty type and color as indicated. .3 Auxiliary control devices as indicated.
<u>2.5 Control Transformer</u>	.1	Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.

-
- | | | |
|---|----|--|
| <u>2.5 Control Transformer
(Cont'd)</u> | .2 | Size control transformer for control circuit load plus 20% spare capacity. |
| | | |
| <u>2.6 Finishes</u> | .1 | Apply finishes to enclosure in accordance with Section 26 05 01 - Common Work Results - Electrical. |
| | | |
| <u>2.7 Equipment
Identification</u> | .1 | Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical. |
| | .2 | Manual starter designation label, white plate, black letters, size 1, engraved as indicated. |
| | .3 | Magnetic starter designation label, white plate, black letters, size engraved as indicated. |
| | | |
| <u>2.8 Motor Starter
Schedule</u> | .1 | Refer to Annex C : Motor starter Schedules for details. |
| | | |
| <u>PART 3 - EXECUTION</u> | | |
| | | |
| <u>3.1 Installation</u> | .1 | Install starters, connect power and control as indicated. |
| | .2 | Ensure correct fuses and overload devices elements installed. |
| | | |
| <u>3.2 Field Quality Control</u> | .1 | Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical and manufacturer's instructions. |
| | .2 | Operate switches, contactors to verify correct functioning. |
| | .3 | Perform starting and stopping sequences of contactors and relays. |
| | .4 | Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated. |

PART 1 - GENERAL

1.1 RELATED
REQUIREMENTS

- .1 Section 26 36 23 - Automatic Transfer Switches.

1.2 REFERENCES

- .1 CSA International
.1 CSA-B139-15, Installation Code for Oil Burning Equipment.
.2 CAN3-Z299.3-85(R2006), Quality Assurance Program - Category 3.
- .2 Green Seal Environmental Standards (GSES)
.1 GS-11-2008, 2nd Edition, Paints and Coatings.
- .3 International Organization for Standardization (ISO)
.1 ISO 3046-1-2002, Reciprocating internal combustion engines - Performance - Part I: Declarations of power, fuel and lubricating oil consumptions, and test methods - Additional requirements for engines for general use.
.2 ISO 3046-4-1997, Reciprocating internal combustion engines - Performance - Part 4: Speed governing.
- .4 National Electrical Manufacturers Association (NEMA)
.1 NEMA MG1-2006(R2007), Motors and Generators.
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
.1 SCAQMD Rule 1113-A2007, Architectural Coatings.
- .6 The Master Painters Institute (MPI)
.1 Architectural Painting Specification Manual - current edition.
- .7 Underwriters' Laboratories of Canada (ULC)
.1 CAN/ULC-S601-14, Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids.
.2 ULC-S603-14, Standard for Steel Underground Tanks for Flammable and Combustible Liquids.
-

1.3 ACTION AND
INFORMATIONAL
SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and data sheets for generating units and include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Shop drawings and specifications to include the following:
 - .1 Engine: make, model, rating and performance curves.
 - .2 Starter motor, make model.
 - .3 Generator: make, model and rating complete with generator saturation curves, heat damage curves, reactive capability and special data.
 - .4 Voltage regulator: make, model, type.
 - .5 Governor: type, model.
 - .6 Battery: make, type, voltage, capacity.
 - .7 Charger: make, model, input and output rating.
 - .8 Submit general outline drawing of complete assembly showing engine, radiator and generator mounting, exhaust, recirculating and intake air louvre arrangement, exhaust gas silencer and pipe arrangement, locations of fuel and lubricating oil filters, fuel supply and return line connections, lubricating oil drain valve, radiator and coolant drain valves, air cleaner, engine instrument panel, starting motor, power and control junction boxes, engine and generator mounting feet. Indicate on drawings:
 - .1 Horizontal and vertical dimensions.
 - .2 Minimum door opening required for moving unit.
 - .3 Head room required for removal of piston and connecting rod.
 - .4 Weight of engine, generator, baseplate, radiator and exhaust silencer.
 - .9 Identify exact locations and details where necessary of interconnecting services.
 - .10 Baseplate construction details and materials.
 - .11 Transfer and bypass system: make, model, type.
 - .12 Outline and layout of panels.
 - .13 Schematic and wiring diagrams of engine, generator, control panel, automatic transfer isolation and bypass panel complete with interconnecting wiring diagrams.
 - .14 Single line diagram showing all breakers, switches, metering and protective relays.
 - .15 Field wiring diagrams.
 - .16 Complete bill of materials, including manufacturer's name, catalogue numbers and capacity.
-

1.4 CLOSEOUT
SUBMITTALS
(Cont'd)

- .4 Forward, within two weeks after factory tests, three copies of instruction manuals, with updated drawings, for each unit of different ratings.
- .1 Submit one set of sepias along with manuals.
 - .2 Where more than one unit of identical ratings is supplied on same purchase order, provide three copies for first unit, two copies per unit for each succeeding unit, up to total of six units, one copy per unit for each additional unit above this amount.

1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .1 Extra Material/Spare Parts: provide the following:
 - .1 One spare control circuit breaker per rating.
 - .2 Twenty four spare indicating light bulbs per rating.
 - .3 One spare control relay and socket per rating and contact arrangement.
 - .4 One spare contactor operating coil.
 - .5 One set of contacts (3) for transfer contactor.
 - .6 Six fuel filter elements for each type of fuel filter/water separator.
 - .7 Six lubricating oil filter elements.
 - .8 Three air cleaner elements.
 - .2 Provide conclusive evidence that Canadian distributor has been established and will stock in Canada spare parts likely to be required during normal life of engine.
 - .3 Provide conclusive evidence that Canadian distributor has been established and will stock in Canada spare parts likely to be required during normal life of engine.
 - .4 Tools:
 - .1 Supply suitable engine barring device and battery manufacturer's standard set of tools for battery service.
 - .1 Battery service tools to include hydrometer, one plastic bottle for topping up purposes and one insulated battery terminal wrench.
 - .2 Provide complete set of specialized tools required for proper care, adjustment and maintenance of equipment supplied.
 - .3 Where metric size nuts and bolts are used, provide one set of sockets complete with ratchet handle and set of combination wrenches, to fit sizes used.

1.6 QUALITY ASSURANCE .1 Do work to CAN3-Z299.3.

1.7 DELIVERY, STORAGE AND HANDLING .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

.2 Delivery and Acceptance Requirements:

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Prepare, crate and protect equipment against shipping and storage damage.
- .3 Provide minimum 12.5 mm plywood outer covering single vapour barrier inside.
- .4 Provide minimum 20 mm plywood outer covering with one side finished and double vapour barrier and sufficient dessicant for one year's remote storage.
- .5 Mount unit and panel on shipping skids with plank floor.
- .6 Each package to have shipping weight, address, dimensions and Department D number and brief description of contents stencilled on at least two sides.
 - .1 Staple on outside packing list contained in waterproof envelope.
 - .2 Place copy of packing list inside.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION .1 Provide automatic, unattended, emergency power supply system consisting of:

- .1 Liquid cooled high voltage diesel electric generating unit with control panel.
- .2 Liquid cooled low voltage diesel electric generating unit with combined control, transfer and by-pass panel.
- .3 High voltage power transfer and by-pass panel.
- .4 High voltage power isolating and by-pass panel.
- .5 Accessories and equipment specified in this specification.

.2 Provide design, fabrication, testing, transportation, demonstration and equipment warranty.

2.2 DESIGN CRITERIA .1 Design equipment to meet following requirements:

- 2.2 DESIGN CRITERIA .1 (Cont'd)
- (Cont'd)
- .1 Total capacity: 300 kW.
 - .4 Voltage: 600 V.
 - .5 Frequency: 60 Hz.
 - .6 Phase/Wire: 3/4.
 - .7 Power factor: 0.8.
 - .8 Load harmonic content: 20% THD.
 - .11 Duty rating: full load continuous plus 10% overload for 1 hour in every 12 hours period.
 - .12 Performance: automatic.
 - .13 Elevation above sea level: 100 m.
 - .14 Ambient temperature: 40 degree C.
 - .15 Relative humidity: 60%.
- .2 Design unit capable of starting, attaining settled voltage and frequency limits and accepting 100% full rated load with voltage and frequency settling to specified steady state bands, within 15 seconds for any temperature between 0 degree C to 40 degrees C.
- .3 Use engine manufacturer's standard, published continuous (prime) horsepower rating in assessing engine capacity and derate this rating for specified conditions and engine driven accessories in accordance with ISO 3046-1.
- .4 Description of generating set operation:
- .1 Automatic starting on abnormal or loss of normal voltage: voltage sensing relays to sense three phases of hydro supply.
 - .1 If voltage on any one phase should drop below preset limits (adjustable) for adjustable period of time, close engine start contact and start engine.
 - .2 When emergency supply has reached settled voltage and frequency preset limits (adjustable) transfer switch will transfer load to emergency supply.
 - .3 Continue to supply load until hydro supply returns or set is shut down manually or under failure conditions.
 - .4 On hydro restoration, confirmed by three phase sensing of voltage above adjustable preset, for time period in excess of three minutes (adjustable), transfer switch will transfer load to hydro supply.
 - .1 Provide dead bus timer to allow motor starters to drop out and motors to stop prior to connecting to hydro.
 - .5 Adjustable time delay relay to allow engine to run unloaded to cool down and subsequently to shut down, ready for next cycle.
-

- 2.2 DESIGN CRITERIA .4 (Cont'd)
(Cont'd)
- .6 Equip engine with key switch with following positions:
auto-off-crank-start, key removable in auto position only.
 - .7 Automatic shut down on:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temperature.
 - .4 Low lubricating oil pressure.
 - .5 Over and under frequency.
 - .6 Emergency breaker failure.
 - .7 Electrical fault lock-out on short circuit and
generator over and under voltage.
- 2.3 ASSEMBLY .1 Provide items as follows plus other items necessary to make
unit complete:
- .1 Diesel engine.
 - .2 Diesel engine accessories.
 - .3 Baseplate and drip pan.
 - .4 Vibration isolators.
 - .5 Governor.
 - .6 Engine exhaust system.
 - .7 Engine cooling system.
 - .8 Engine ventilating system.
 - .9 Starting motors.
 - .10 Batteries and rack.
 - .11 Battery charger.
 - .12 Generator and exciter.
 - .13 Voltage regulator and accessories.
 - .14 Combined control, transfer by-pass panel.
 - .15 High voltage isolating and by-pass panel.
 - .16 High voltage transfer and by-pass panel.
 - .17 Spares and accessories.
- 2.4 MOUNTING .1 Connect engine flywheel housing rigidly to generator stator
housing with SAE adapter.
- .1 Mount unit on common, heavy duty fabricated steel
baseplate.
 - .2 Obtain approval for design and materials of baseplate
from engine manufacturer.
- .2 Baseplate: rigid material to maintain alignment of
engine-generator shafts and frames under shipping,
installation and service conditions.
-

2.4 MOUNTING
(Cont'd)

- .3 Install machine engine-generator feet and baseplate sole plates parallel and true.
 - .1 Shims: steel type, installed under generator feet.
- .4 Support baseplate on spring type isolating fixtures from welded side brackets located to support bottom of baseplate 25 mm above supporting floor.
 - .1 Isolators: cast iron housings, complete with levelling bolts, adjustable oil proof snubbers and minimum 6 mm sound pads.
 - .2 Isolation efficiency 95% minimum.
- .5 Determine quantity and location of isolators.
 - .1 Locate each isolator to carry equal proportion of weight and that pressure exerted on floor by each isolator does not exceed 345 kPa.
- .6 Ship isolators loose for installation at project site.

2.5 DIESEL ENGINE

- .1 Full diesel, heavy duty, cold start, liquid cooled, vertical in-line or vee, and current manufacture of a type and size that has been service as a prime mover for electric power generation for not less than two years.
 - .1 Turbo supercharged engine acceptable providing brake mean effective pressure (BMEP) at rated output does not exceed 1800 kPa (225 psi).
 - .2 Mechanically driven superchargers not acceptable.
 - .2 Engine: minimum of four (4) cylinders.
 - .3 Engine with auxiliary starting aids (i.e., glow plug assist start) not acceptable.
 - .4 Equip engine air intakes with dry type heavy duty air cleaners located close to inlet manifold.
 - .1 Cleaner element: directly replaceable with elements of Canadian manufacture.
 - .5 Provide engine wiring in liquid-tight conduit and fittings with insulated bushings.
 - .1 Use stranded, minimum No.14 AWG, TEW 105 degree C and coloured coded wires .
 - .2 Terminate wiring with coded, insulated terminals flanged fork type. Terminal blocks heavy duty, screw type.
 - .3 Wire markers of slip on oil proof type.
 - .4 Junction boxes on unit of liquid-tight type..
-

- 2.5 DIESEL ENGINE
(Cont'd)
- .5 (Cont'd)
 - .5 Maximum of two wires per terminal block.
 - .6 Provide high quality lubricating oil pressure gauge, lubricating oil temperature gauge, tachometer, coolant temperature gauge thermocouple, exhaust pyrometer and other standard gauges and instruments.
 - .1 Calibrate and scale gauges and instrument in both metric and imperial units and symbols.
 - .2 Mount oil temperature sensors on engine full flow pressure line.
 - .3 Hoses or tubing for gauges: high pressure reinforced type.
 - .7 Mount unit accessories, including gauges, instruments, and protective sensors, to isolate or dampen vibrations.
 - .8 Dynamically balance complete engine-flywheel generator arrangement after assembly.
 - .1 Torsional or other vibration tolerance within 10% above or below rated speed of unit, when operating unloaded or connected to any load within its rating.
 - .2 Cyclic irregularity: 1/250 maximum.
 - .9 Provide engine flywheel with graduated marking around its periphery to facilitate fuel injection and valve timing.
 - .10 Provide removable wet type cylinder liners.
 - .1 Furnish cylinder head with removable valve seat insert and guides.
 - .11 Provide personnel safety guards for exposed moving parts and exhaust manifolds.
 - .1 Provide platform for servicing upper part of engine where applicable.
 - .12 Engine control panel complete with:
 - .1 Lubricating oil pressure gauge.
 - .2 Lubricating oil temperature gauge.
 - .3 Coolant temperature gauge.
 - .4 Low coolant level gauge.
 - .5 Engine switch auto-off-crank-start selector switch and crank pushbutton.
 - .6 D.C. main power supply circuit breaker.
 - .7 Terminal blocks for connection to D.C. power supply, engine monitoring and shutdown device.
-

- 2.5 DIESEL ENGINE (Cont'd) .12 (Cont'd)
- .8 Provide low oil pressure, high coolant temperature, low coolant level and overspeed protection to shut down engine on manual operation.
- 2.6 COOLING AND VENTILATING SYSTEM .1 Provide complete cooling and ventilating system for unit.
- .2 Thermostatically control system and maintain coolant, ethylene glycol, within engine manufacturer's tolerance, with unit operating at rated load under specified conditions. Cooling system engine mounted radiator type.
- .1 Design and supply complete ventilating system where engine mounted radiator is required.
- .1 Radiator cooling fan to be pusher type, minimum two belt drive with belt adjuster.
- .2 Fan, pulley and belt with removable protective cage.
- .2 Provide multi-fan system suitable for indoor or outdoor installation complete with electrical controls and breaker type combination starters.
- .1 Starters in wall mounting enclosures and mounted in control panel.
- .2 Motor of splash proof enclosure.
- .3 Provide braided corrugated flexible lines for pipe terminations at radiator and engine, isolating valves, fittings and pipe for installation of radiators approximately 9 m from front of engine.
- .3 Provide drain valves for draining coolant from engine block and radiator.
- .1 Drain coolant conveniently into large container through flexible extensions.
- .2 Dripping valves or leaking connections will not be permitted.
- .4 Ventilation system: complete with canvas connections, mounting hardware, modulating damper motors, dampers, inlet and outlet hoods, bird/insect/screen, air filters, manual potentiometer, damper linkages, low voltage transformer, thermostat, fan motor.
- .1 Provide positive seal, zero heat loss louvers. Air filter 25 mm deep disposable type with fiberglass filter media and initial static pressure drop not to exceed 25 Pa based on face velocity of 2.54 m/s.
- .5 Ventilating system operation as follows:
-

2.6 COOLING AND
VENTILATING SYSTEM
(Cont'd)

- .5 (Cont'd)
- .1 Air inlet and outlet damper closed when engine not running.
 - .2 On engine start, air inlet damper to open.
 - .3 Inlet damper minimum opening to be set by manual potentiometer.
 - .4 Thermostat to modulate inlet and outlet dampers to maintain set room temperature.
 - .5 Fan to start when inlet louvres 90% open (adjustable).

2.7 LUBRICATION
SYSTEM

- .1 Provide full pressure lubricating system complete with filters and oil cooler.
- .2 Oil pump: engine driven gear type complete with strainer.
- .3 Equip filters with automatic by-pass valve and full flow filter elements conveniently located for servicing and directly replaceable with elements of Canadian manufacture.
 - .1 Cooler to have sufficient capacity to maintain oil temperature within with unit operating at rated load under conditions specified.
- .4 Equip engine oil sump with oil drain pipe, gate valve and pipe cap.
 - .1 Permit complete drainage in a convenient manner.
- .5 Ensure unit is able to start and assume full rated load within the specified 15 second time period when, operational requirements are such that unit may lay idle for periods up to one month.
 - .1 Provide electrical motor driven, integrally mounted, gear type oil priming pump with interval timer and breaker type combination starter.
 - .2 Starter mounted in control panel.
 - .3 Lubrication oil pressure switch to stop priming pump when engine is running.
- .6 Metallic oil hoses: steel reinforced rubber type with crimped or swaged end fittings.

2.8 FUEL SYSTEM

- .1 Provide complete fuel system including fuel lift pump fuel transfer pump with hand primer and filters in accordance with CSA-B139.
-

- 2.8 FUEL SYSTEM
(Cont'd)
- .1 (Cont'd)
 - .1 Filter elements to be directly replaceable with elements of Canadian manufacture.
 - .2 Bring fuel supply and return lines to extreme forward part of baseplate with drop ear elbows.
 - .1 Connect other end of each elbow with 1 m of flexible neoprene hose.
 - .3 Provide, loose, approximately 9 m of copper tubing and necessary fittings including two SAE flare union nuts (long) with half unions for connecting 12 mm gate valves.
 - .4 Non-metallic fuel hoses: steel reinforced rubber type with crimped or swaged end fittings.
- 2.9 EXHAUST SYSTEM
- .1 Provide complete exhaust system including heavy duty industrial type silencer with condensate drain, plug and flanged couplings; stainless steel, corrugated expansion joints, length to suit, to absorb both vertical and horizontal expansion; flanges, bolts, gaskets, adjustable hangers and pipe and pipe-thimble to permit projection of pipe 1.0 m beyond wall.
 - .1 Exhaust tail pipe end at 45 degree angle and terminate in bird screen. Insulate interior exhaust piping and silencer.
 - .2 Arrange exhaust system to suit openings.
 - .1 Where schedule of dimensions does not indicate location of opening, arrange exhaust run best suited to engine.
 - .3 Provide exhaust pyrometers located on common exhaust manifold or two pyrometers on separate manifolds.
 - .1 Pyrometer range to include temperature at 110% load.
- 2.10 JACKET COOLANT HEATER
- .1 Provide engine jacket coolant heaters complete with 20 degree C to 60 degree C adjustable immersion type thermostat.
 - .1 Size heaters to maintain coolant at 40 degree C in an ambient temperature of 0 degree C.
 - .2 Obtain circulation of heated coolant on thermosyphon principle.
-

- 2.10 JACKET COOLANT HEATER (Cont'd) .2 (Cont'd)
- .1 However, if this does not provide sufficient circulation to avoid hot spots in system, provide electrical motor driven circulating pump to operate automatically when heater is energized.
 - .2 Motor: 120 V single phase splash-proof type complete with breaker type combination starter.
 - .3 Starter in wall-mounting enclosure.
- 2.11 SPEED GOVERNOR .1 Provide full electronic governor with speed changer and dry type actuator.
- .1 Governing system: in accordance with ISO 3046-4.
- .2 Governor with following features:
- .1 Ten turn locking type manual speed adjustment.
 - .2 Speed regulation, steady state, no-load to full load and vice versa: +/-0.25%.
 - .3 Transient peak, no-load to full-load and vice versa +/-10%.
 - .4 Recovery time to steady state condition on application of full load from no load not to exceed 3 seconds.
 - .5 Frequency: externally adjustable from zero to 5% while engine is running.
 - .6 Class A accuracy.
- 2.12 STARTING SYSTEM .1 Provide complete starting system including cranking starting motors, batteries, battery stand, heavy-duty battery cables and battery charger.
- .2 Provide positive engaging type cranking motor.
- .1 Cranking motor and flywheel ring gear arrangements which may permit tooth to tooth abutment not acceptable.
- .3 Provide lead acid battery with sufficient capacity in ambient room temperature of 0 degree C to crank unit at engine manufacturer's recommended cranking starting speed for period of 3 minutes.
- .1 Voltage measured at starting motor terminals at end of 3 minutes cranking, with cranking current flowing, not less than 1.75 V per cell.
 - .2 Size battery to suit engine and battery manufacturer's published data.
 - .3 Batteries: dry charged, specific gravity of electrolyte 1.220 when fully charged at 27 degree C.
-

- 2.12 STARTING SYSTEM
(Cont'd)
- .3 (Cont'd)
 - .4 Battery termination: bolt-on or study type.
 - .5 Protect terminals and exposed electrical connections from accidental short circuit by falling conductive objects on battery.
 - .4 Provide battery stand coated with acid resistant paint and fabricated from angle irons with 20 mm plywood bottom and heavy duty casters for ease of movement.
 - .5 Provide battery charger with 120 volt AC input and output equal to 1.20 of ampere-hour capacity of battery based on 8 hour rate.
 - .1 Output voltage ripple: 3% or less.
 - .2 Provide AC input circuit breaker and 24 hours terminating equalizer timer with approximately 4 m of connecting cord and permanent connectors for connecting to battery terminals.
 - .3 Provide 5 spare fuses inside charger panel.
 - .4 Charger: CSA approved.
 - .6 Provide necessary heavy duty, maintenance-free battery cables and connectors.
 - .1 Select cable wire size on the basis of allowing not more than 5% voltage drop at time of peak load.
 - .2 Cable length sufficient to allow battery location on either side of engine.
 - .7 Fit turbocharged engines with one spring actuated, two stage accumulator per turbocharger to automatically provide pre-start and post run lubrication to turbochargers.
- 2.13 GENERATOR
- .1 Provide generator, drip proof, single bearing and close coupled to engine with SAE housing: to NEMA MG 1.
 - .1 Generator: full amortisseur winding, direct connected brushless exciter with easily removable bolt-on diodes with surge protection.
 - .2 Maximum deviation of open circuit terminal voltage waveform not to exceed 5%.
 - .3 Provide permanent magnet generator (PMG) for generator short circuit sustaining capability not less than 2.4 times rated current.
-

- 2.13 GENERATOR (Cont'd)
- .4 Generator winding insulation: Class F; winding temperature rise not to exceed 80 degree C as measured by resistance in ambient temperature of 40 degree C.
 - .5 Identify generator windings with metal tags.
 - .1 Bring windings to insulated terminals in metal junction box mounted on side or top of generator.
 - .2 Size junction box to permit mounting of engine and generator low voltage controls and wiring terminals blocks.
 - .3 Provide barrier in junction box to separate low and high voltage wiring.
 - .6 Provide voltage regulation system complete with auto/manual control module.
 - .1 Voltage regulator: capable of withstanding continuous vibration, 15 G shock and temperature up to 50 degree C while maintaining accuracy to plus/minus 1%.
 - .7 Steady-state voltage regulation not to exceed 1%.
 - .1 Transient voltage regulation, when full load is applied or removed, not to exceed 10% when measured by oscilloscope or high speed strip chart recorder with recovery time to steady-state less than 3 seconds.
 - .8 Design equipment to minimize radio frequency interference (RFI) under operating conditions.
 - .1 Balanced telephone influence factor (TIF) to: NEMA MG 1.
- 2.14 PANEL - GENERAL
- .1 Panel: indoor, free-standing, dead front, metal-enclosed steel construction complete with lifting eye bolts.
 - .1 Doors: formed edges, reinforced by stiffeners and complete with lockable handles.
 - .2 Design and construct panel to withstand strains, jars, vibrations and other conditions incident to shipping, storage, installation and service.
 - .3 Panel CSA certified. Mount a nameplate bearing CSA monogram in a prominent position on panel.
 - .4 Identify instruments and controls with lamacoid or metal engraved nameplates fastened by rivets or screws for permanent identification.
 - .1 Identify door mounted items with nameplates.
-

- 2.14 PANEL - GENERAL .4 (Cont'd)
(Cont'd)
- .2 Attach nameplates to removable items such as relays and wireway covers.
 - .5 Provide panel with bolted rear covers.
 - .6 Factory wire panel completely. Use stranded, minimum No.14AWG, TEW 105 degree C and coloured for control wiring. Use No.10AWG for CT secondary connections:
 - .1 Blue - DC control.
 - .2 Red - AC control.
 - .3 Black - PT secondary connections.
 - .4 Orange - CT secondary connections.
 - .5 Green - non-current carrying ground.
 - .6 White - current carrying ground.
 - .7 Yellow - interlocks.
 - .8 Brown - generator excitation system.
 - .7 Code wiring at each wire end with permanent, non-aging slip on markers.
 - .1 Support and run wiring neatly.
 - .2 Protect wiring from mechanical damage by grommets and shields.
 - .8 Code terminal blocks, clamp type, serrated for positive grip and of tough, non-brittle, unbreakable nylon, size 3,453/0 or equivalent.
 - .1 For current transformer secondary circuits, provide terminals blocks of dual connector type.
 - .2 Provide test block for current transformer secondary connections.
 - .9 Provide door detent mechanism to maintain hinged door at open position.
 - .10 Supply loose 2 sets of wiring markers for each external wiring connection.
 - .1 Place markers in plastic bag and secured inside panel.
 - .11 Use wiring duct for interconnection within panel.
 - .12 Direct inter-panel connection not permitted, use terminal blocks.
- 2.15 CONTROL PANEL .1 Provide combined control and transfer panel for controlling engine generator unit.
-

2.15 CONTROL PANEL
(Cont'd)

- .2 Provide hinged front door.
- .3 Provide combined control, transfer and by-pass panel.
- .4 Provide instrumentation, switching and control as listed in bill of material.
- .6 Mount terminal blocks on common mounting strips for interconnection wiring between the following:
 - .1 Sub-panel and panel door.
 - .2 Sub-panel and external wiring from diesel generator unit circuits.
 - .3 Sub-panel and external indicating circuits.
 - .4 Sub-panel and secondary circuits of power sub-cubicle.
 - .5 Sub-panel and external wiring from power transfer panel.
- .7 Provide 1 cm x 4 cm horizontal copper ground bus for whole length of enclosure, and two ground lugs; one at each end.
 - .1 Lug: capable of accepting grounding conductor of range from No. 8 to No. 2/0 AWG.
- .8 Terminal blocks: CSA approved, clamp type, serrated for positive grip and of tough, non-brittle unbreakable nylon material; maximum two wires per terminal block.
 - .1 Use factory made terminal block jumpers wherever necessary.
- .9 Provide circuit breakers for equipment protection: use fuses where breakers are not applicable.
- .10 Provide top and bottom entry for power and control cables.

2.16
ENGINE-GENERATOR
TRANSFORMER
CONTROLLER

- .1 Provide solid state controller complete with control and power modules for sensing, timing, logic and instrumentation to control diesel generator set and automatic transfer system.
 - .2 Controller to include following features:
 - .1 Five position function selection switch - Reset, Off, Auto, Test No. Load, Test Full Load.
 - .2 Inverse time-voltage sensors for monitoring normal and emergency voltage and frequency.
 - .3 Controls necessary to provide system operation.
 - .4 Annunciator lights for following:
 - .1 Overcrank.
-

- 2.16 .2 (Cont'd)
ENGINE-GENERATOR .4 (Cont'd)
TRANSFORMER .2 Low Oil Pressure.
CONTROLLER .3 High Coolant Temperature.
(Cont'd) .4 Low Coolant Level.
.5 Overspeed.
.6 Frequency Limit.
.7 Voltage Limit.
.8 Contactor Failure.
.9 Fire Alarm.
- .3 Function selection to operate as follows:
.1 Reset: to reset the engine-generator set after it has been shut down on protective device.
.2 Off: the engine-generator set is shut off.
.3 Auto: provides automatic operation of engine generator set and transfer system.
.4 Test No. Load: exercises engine generator set without load. In event normal power fails during this mode, transfer system will operate to connect load to set.
.5 Test Full Load: simulates normal power failure and runs engine generator set under load. If emergency power fails under this mode, transfer system to operate to re-store normal power to load.
- .4 Provide sufficiently sized capacitors on power input terminals to controller to maintain supply voltage, especially on D.C. power input during engine start.
- .5 Controller to include following time delays and adjustments.
.1 Crank delay preset at 3-20 sec.
.2 Restart preset at 15 sec.
.3 Bypass preset at 10 sec.
.4 Anticipated fail preset at minimum time setting.
.5 Engine start preset at 2 sec.
.6 EM - normal preset at 20 sec.
.7 Dead bus preset at 2 sec.
.8 Cool down preset at 5 min.
- .6 Equip controller with cycle crank provision to crank engine three time with adjustable rest delay of 3-30 seconds preset at 5 seconds.
- .7 Equip controller with provision to reset controller and to select Category II operation from remote location.
.1 Category II operation to operate emergency supply as main source to load and use normal source as standby.
-

- 2.16 ENGINE-GENERATOR TRANSFORMER CONTROLLER
(Cont'd)
- .8 Provide controller with following features:
- .1 Front panel programming and display using keypad and to allow changing of parameters, operating configuration, status, and values.
 - .2 Security access code to prevent unauthorized changes.
 - .3 Self diagnostics, continually operating in the background, to ensure proper operation of microprocessor.
 - .4 Non-volatile memory to store operating logic, configuration and set points upon total loss of power.
 - .5 Sufficient internal power to maintain control outputs and operating sequence upon loss of DC supply from working battery.
 - .6 Isolation of inputs and outputs to ensure correct operation and no damage in event of transient voltages.
 - .7 Operation counter for number of diesel starts (non-resettable).
 - .8 Operating temperature 0-50 degree C.
 - .9 Equip controller with communications system and uninterruptible power supply for central remote monitoring and control. Provide system complete with modem 300 - 2400 baud, initialized by controller. Provide necessary hardware, software and configuration for controller as well as necessary software for central remote monitoring and control station. Provide Communications between controller and central station through switched telephone lines.
- 2.19 SIGNS
- .1 Provide at front top of each panel and on each generator junction box, lamacoid or metal engraved identification nameplate.
- .1 Provide nameplates with letter and number identification designation to be given at time of acceptance tests.
- .2 Provide and attach to unit in prominent location, bilingual warning sign.
- .3 Where metric tools are required to service engine-generator unit, provide bilingual warning sign.
- 2.20 FINISHES
- .1 Paints Coating: in accordance with manufacturer's recommendations for surface conditions, to be approved by Architect.
-

- 2.20 FINISHES (Cont'd)
- .2 Clean, finish and paint equipment with smooth and durable finish.
 - .1 Use grey gloss MPI EXT: paint inside of panel white gloss MPI INT in accordance with The Master Painters Institute (MPI) schedule of paint colours.
 - .3 Provide one half pint can of grey gloss paint for touch up.
- 2.21 QUALITY OF WORK
- .1 Manufacture and construct equipment free from blemishes, defects, burrs and sharp edges; accuracy of dimensions and marking of parts and assemblies; thoroughness of welding, brazing, painting and wiring, alignment of parts and tightness of assembly screws and bolts.
- 2.22 QUALITY CONTROL
- .1 General: before acceptance, assemble and set up the unit, complete with specified equipment, for tests at the supplier's plant in accordance with Section.
 - .1 Ensure tests are witnessed by Consultant on mutually agreed date.
 - .2 Provide suitable test area with adjustable loading facilities.
 - .3 Ensure that engine has run in sufficiently prior to load test, test forms completed, system debugged and recorders connected.
 - .2 Product examination: complete mechanical and electrical examination to determine compliance with specification and drawings with respect to materials, workmanship, dimensions and marking.
 - .3 Non-operational tests and checks: perform following test and checks before starting the unit:
 - .1 Shaft alignment, end float, angular and parallel.
 - .2 Cold resistance of generator windings.
 - .3 Belt tensioning.
 - .4 Equipment grounds.
 - .5 Electrical wiring.
 - .6 All grease lubricating points.
 - .7 Personnel safety guards.
 - .8 Air cleaner.
 - .9 Coolant.
 - .10 Lubricating oil type and level.
 - .11 Type of fuel.
 - .12 Vibration isolator adjustment.
-

2.22 QUALITY
CONTROL
(Cont'd)

- .3 (Cont'd)
 - .13 Temperature and pressure sensors.
 - .14 Engine exhaust system.
 - .15 Tools.
 - .16 Spares.

 - .4 Operation test and check: on completion of non-operational tests and checks, start unit cold. Provide multi-channel recorder and record following :
 - .1 Time for unit to start and reach settled voltage and frequency.
 - .2 Time from initiation of start to full load application, with voltage and frequency settled.
 - .3 Voltage and frequency transient and steady state limits for full load to no load, 3/4 load to no load, 1/2 load to no load, 1/4 load to no load and vice versa.
 - .4 Record battery voltage drop during cranking.

 - .5 Protection and control demonstration: on completion of operation test and check, demonstrate following:
 - .1 Overheat protection.
 - .2 Low oil pressure protection.
 - .3 Cranking cut out.
 - .4 Overcrank protection (3 tries).
 - .5 Overspeed protection.
 - .6 Under and over frequency.
 - .7 Under and over voltage.
 - .8 Electrical fault protection:
 - .1 Failure to close breaker.
 - .2 Failure to build up voltage.
 - .3 Generator short circuit and overcurrent.
 - .9 All control functions.

 - .6 Load tests: load test the unit for 24 hours at full rated load and further 1 hour at 110% rated load in ambient room temperature of 40 degree C. Take following data at start of load test and every one hour interval thereafter:
 - .1 Frequency.
 - .2 Voltage.
 - .3 Current.
 - .4 Kilowatts.
 - .5 Generator winding temperature.
 - .6 Generator frame temperature.
 - .7 Engine coolant temperature.
 - .8 Oil temperature and pressure.
 - .9 Manifold pressure.
 - .10 Ambient room temperature.
 - .11 Generator cooling air outlet temperature.
-

2.22 QUALITY
CONTROL
(Cont'd)

- .6 (Cont'd)
 - .12 Exciter field current and voltage.
 - .13 Vibration displacement.
 - .14 Ambient air temperature inside panel with doors closed.

 - .7 Miscellaneous: provide accurate means for determining fuel and lubricating oil consumption.
 - .1 Provide strip chart recorders for monitoring frequency, voltage and load.
 - .2 Provide recorder with ability to select speeds to allow accurate measurement of voltage, frequency and time during tests.
 - .3 Calibrate recorder by the recorder manufacturer (or designated representative) within three months of factory testing.

 - .8 Interpretation of ambient room temperature: consider ambient room temperature as that temperature, which is lowest temperature registered out of a group of three thermometers when placed in engine room as follows:
 - .1 One thermometer located on each side of engine block, approximately two-thirds of length of block back from front (radiator) end of block, 900 mm out from block and at height equal to height of block.
 - .2 Locate third thermometer over end of exciter on unit centre line, approximately 150 mm above top of exciter.
 - .3 Take thermometer showing lowest temperature to give true ambient air temperature.
 - .4 Adjust temperature to maintain this thermometer at 40 degree C during heat test.

 - .9 Voltage and frequency regulation tests: on completion of load tests take hot resistance reading of generator windings.
 - .1 Subject the unit to hot voltage and frequency regulation tests for full load to no load, 3/4 load to no load, 1/2 load to no load, 1/4 load to no load and vice versa.

 - .10 Panel performance and functions: check sequence of operation under service conditions.
 - .1 Make provision for supplying and connecting required levels of voltage for primary circuits.
 - .2 Test overcurrent relays by impressing current in secondary circuits.

 - .11 Hi-pot tests: perform over potential tests on primary and secondary wiring in accordance with NEMA.
-

PART 3 - EXECUTION

- 3.1 EXAMINATION .1 Verification of Conditions:
- .1 Verify that substrate conditions, which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer's instructions prior to installation of liquid cooled diesel electric generating units.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.
- 3.2 INSTALLATION .1 Install liquid cooled Diesel electric generating units to CAN3-Z299.3 and in accordance with manufacturer's written instructions.
- 3.3 CLEANING .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- 3.4 CLOSEOUT ACTIVITIES .1 Demonstration and Training:
- .1 As directed by Consultant and in accordance with Section 01 79 00 - Demonstration and Training carry out demonstrations of complete interruptible power unit for Project Acceptance Board.
 - .2 Provide familiarization training of operating and maintenance staff.
 - .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.
 - .4 Provide fuel required for performing site test and top-up after acceptance test completion.
-

3.5 MAINTENANCE -
CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and CSA-B139.

PART 1 - GENERAL

1.1 REFERENCES

- .1 CSA International:
 - .1 CSA C22.2 No.5-13, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).
 - .2 CSA C22.2 No.178.1-14, Automatic Transfer Switches.
 - .3 CAN/CSA C60044-1-07(R2011), Instrument Transformers.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA ICS 2-1996(R2009), Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for transfer switches and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Quebec, Canada.
 - .1 Indicate on drawings:
 - .1 Make, model and type.
 - .2 Single line diagram showing controls and relays.
 - .3 Description of equipment operation including:
 - .1 Automatic starting and transfer to standby unit and back to normal power.
 - .2 Test control.
 - .3 Manual control.
 - .4 Automatic shutdown.

1.3 CLOSEOUT
SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.
- .3 Detailed instructions to permit effective operation, maintenance and repair.
- .4 Technical data:
 - .1 Schematic diagram of components, controls and relays.
 - .2 Illustrated parts lists with parts catalogue numbers.
 - .3 Certified copy of factory test results.

1.4 DELIVERY,
STORAGE AND
HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .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 and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 SYSTEM
DESCRIPTION

- .1 Automatic load transfer equipment to:
 - .1 Monitor voltage on phases of normal power supply.
 - .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
 - .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.
-

<u>2.1 SYSTEM DESCRIPTION (Cont'd)</u>	.1	(Cont'd) .4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period. .5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.
<u>2.2 MATERIALS</u>	.1	Instrument transformers: to CAN/CSA C60044-1.
	.2	Contactors: to NEMA ICS2.
<u>2.3 CONTACTOR TYPE TRANSFER EQUIPMENT</u>	.1	Contact Type Transfer Equipment: to CSA C22.2 No.178.1.
	.2	Two-4 pole contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked, solenoid operated, with CSA enclosure.
	.3	Rated: 600V/3/60, 60Hz, 400A, 4 wire.
	.4	Main contacts: silver surfaced, protected by arc disruption means.
	.5	Switch and relay contacts, coils, spring and control elements accessible for inspection and maintenance from front of panel without removal of switch panel or disconnection of drive linkages and power conductors.
	.6	Auxiliary contact: silver plated, to initiate emergency generator start-up on failure of normal power.
	.7	Fault withstand rating: 35 kA symmetrical for 3 cycles with maximum peak value of 50 kA.
	.8	Lever to operate switch manually when switch is isolated.
	.9	Neutral bar, solid switch rated: 400 A.
	.10	Overlapping neutral contacts on contactor type transfer equipment.

2.4 CONTROLS

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

2.5 ACCESSORIES

- .1 Ensure pilot lights indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel and remote in the electrical room.
- .2 Plant exerciser: 168 hours timer to start standby unit once each week for selected interval but does not transfer load from normal supply transfers load to emergency supply and retransfers to normal supply on standby unit shutdown. Timer adjustable 0-168 hours in 15 minute intervals.
- .3 Auxiliary relay to provide 4 N.O. and 4 N.C. contacts for remote alarms.
- .4 Instruments:
 - .1 Digital true RMS, indicating type 2 % accuracy, flush panel mounting:
 - .1 Voltmeter: ac, scale 0 to 750 V.
 - .2 Ammeter: ac, scale 0 to 500 A.
 - .3 Frequency meter: scale 55 to 65 Hz.
- .5 Voltmeter selector switch: rotary, maintained contacts, panel mounting type, round notched handle, four position, labelled "OFF-Phase A-Phase B-Phase C".
- .6 Potential transformers - dry type for indoor use:
 - .1 Ratio: 600 to 120.
 - .2 Rating: 600 V, 60Hz, BIL 10 kV.
- .7 Ammeter selector switch: rotary, maintained contacts, panel mounting type, designed to prevent opening of current circuits, round notched handle, four position labelled "OFF - Phase A - Phase B - Phase C".
- .8 Current transformers - dry type for indoor use:
 - .1 Ratio: 1 to 5.
 - .2 Rating: 600 V, 60Hz, BIL 18 kV.
 - .3 Accuracy rating: 1%.
 - .4 Positive action automatic short-circuiting device in secondary terminals.
- .9 Manual bypass and isolator: to emergency supply to both supplies.

2.6 EQUIPMENT
IDENTIFICATION

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.
-

2.6 EQUIPMENT
IDENTIFICATION
(Cont'd)

- .2 Control panel:
 - .1 For selector switch and manual switch: size 5 nameplates.
 - .2 For meters, indicating lights, minor controls: use size 3 nameplates.

2.7 SOURCE QUALITY
CONTROL

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested.
- .2 Notify 5 days minimum in advance of date of factory test.
- .3 Tests:
 - .1 Operate equipment both mechanically and electrically to ensure proper performance.
 - .2 Check selector switch, in modes of operation Test, Auto, Manual, Engine Start and record results.
 - .3 Check voltage sensing and time delay relay settings.
 - .4 Check:
 - .1 Automatic starting and transfer of load on failure of normal power.
 - .2 Retransfer of load when normal power supply resumed.
 - .3 Automatic shutdown.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for transfer switches installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Locate, install and connect transfer equipment as indicated.
 - .2 Check solid state monitors and adjust as required to ensure correct operation.
-

3.2 INSTALLATION

(Cont'd)

- .3 Install and connect battery and remote alarms.

3.3 FIELD QUALITY
CONTROL

- .1 Perform tests in accordance with Section 26 05 00 -
Common Work Results for Electrical.
- .2 Energize transfer equipment from normal power supply.
- .3 Set selector switch in "Test" position to ensure proper
standby start, running, transfer, retransfer. Return selector
switch to "Auto" position to ensure standby shuts
down.
- .4 Set selector switch in "Manual" position and check to ensure
proper performance.
- .5 Set selector switch in "Engine start" position and check to
ensure proper performance. Return switch to "Auto" to stop
engine.
- .6 Set selector switch in "Auto" position and open normal power
supply disconnect. Standby should start, come up to rated
voltage and frequency, and then load should transfer to
standby. Allow to operate for 20 minutes, then close main
power supply disconnect. Load should transfer back to
normal power supply and standby should shutdown.
- .7 Repeat, at 1 hour intervals, 3 times, complete test with
selector switch in each position, for each test.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section
01 74 11 - Cleaning.
.1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials,
rubbish, tools and equipment in accordance with Section
01 74 11 - Cleaning.

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 45 00 - Quality Control.
- .4 Section 26 09 35 - Lighting Control Devices - Fluorescent Dimming.
- 1.2 References .1 American National Standards Institute (ANSI)
- .1 ANSI C82.1-1998, Electric Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.
- .2 ANSI C82.4-2004, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps.
- .2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
- .1 ANSI/IEEE C62.41-2002, Surge Voltages in Low-Voltage AC Power Circuits.
- .3 American Society for Testing and Materials (ASTM)
- .1 ASTM F 1137-00(R2006), Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 Canadian Standards Association (CSA).
- .5 Federal Communications Commission (FCC).
- 1.3 Shop Drawings and Product Data .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Engineer.
-

- 1.4 Waste Management and Disposal .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

PART 2 - PRODUCTS

2.1 Lamps .1 Tungsten halogen lamps.

Lamp Design	Bulb shape Wattage	Base	Initial Lumens	Life h	Description
PAR-30L	75W	Med	10000	3000	clear

.2 Fluorescent lamps.

Cold Lamp % Design	Bulb shape Wattage	Base	Typical Lumens	Life h	Description
4100T8-32	32W	med	RS3150	20000	CW CRI 85
4100PL-18	13W	GX12	860	15000	CW CRI 85
4100PL-42	18W	G24	1250	12000	CW CRI 85
4100PL-13	42W	G24	3100	12000	CW CRI 85

2.1 Lamps .3 Metal halide lamps.

Lamp Design	Bulb shape Wattage	Base Position	Operating	Initial Lumens	Life h	Description
ED-17P	100W	Med	hor	9500	16000	CRI 85
ED-28P	250W	Mog	hor	23750	15000	CRI 70

- .4 LED lamps:
 .1 LED fixtures are to have LM-80, LM-79, and TM-21 testing, 4000K with dimming capabilities, minimum 50,000 hour lamp life at L70, CRI 80 and above. LED fixtures are to be DLC or Energy Star listed. Fixtures are to be CSA/ULC certified.

2.3 Finishes

- .1 Baked enamel finish:
 .1 Conditioning of metal before painting:
 .1 For corrosion resistance conversion coating to ASTM F 1137.
 .2 For paint base, conversion coating to ASTM F 1137.
 .2 Metal surfaces of luminaire housing and reflectors finished with high gloss baked enamel to give smooth, uniform appearance, free from pinholes or defects.
 .3 Reflector and other inside surfaces finished as follows:
 .1 White, minimum reflection factor 90%.
- .2 Alzak finish:
 .1 Aluminium sheet fabricated from special aluminum alloys and chemically brightened, subsequently anodically treated to specifications established by Alcoa, to produce:
 .1 Finish for regular industrial service, minimum density of coating 14.8 g/m², minimum reflectivity 82% for specular and 73% for diffuse.

2.4 Light Control Devices

- .1 Design.
 .1 Lens thickness: 0.90 mm.
 .2 Material: injection moulded clear prismatic virgin acrylic and open aluminum.
 .3 Light distribution: direct/indirect as shown.
 .4 Treatment: ultraviolet inhibited.
 .5 Frame: hinged spring loaded extruded aluminum.

2.5 Luminaires .1 Refer to Annex A of the specification for lighting fixture schedules.

PART 3 - EXECUTION

3.1 Installation .1 Locate and install luminaires as indicated.

3.2 Wiring .1 Connect luminaires to lighting circuits:
.1 Directly for luminaire.
.2 Through rigid conduit for luminaire. Conduits shall be hidden within the roof/wall assembly in areas where there is no suspended ceiling installed.

3.3 Luminaire Supports .1 For suspended ceiling installations support luminaires independently of ceiling from the roof structure.

3.4 Luminaire Alignment .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

PART 1 - GENERAL

- 1.1 RELATED SECTIONS
- .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
 - .3 Section 01 91 13 - General Commissioning (Cx) Requirements.
 - .4 Section 26 05 21 - Wires and Cables (0-1000 V).
 - .5 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- 1.2 REFERENCES
- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.141-15, Unit Equipment for Emergency Lighting.
- 1.3 SUBMITTALS
- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Data to indicate system components, mounting method, source of power and special attachments.
- 1.4 WASTE MANAGEMENT AND DISPOSAL
- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Engineer.
-

1.4 WASTE
MANAGEMENT AND
DISPOSAL
(Cont'd)

- .5 Dispose of unused batteries at official hazardous material collections site approved by Engineer.
- .6 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- .1 Emergency lighting equipment: to CSA C22.2 No. 141.
 - .2 Supply voltage: 120 V, ac.
 - .3 Output voltage: 24 V dc.
 - .4 Operating time: 30 min.
 - .5 Battery: sealed, maintenance free.
 - .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations.
 - .7 Solid state transfer circuit.
 - .8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
 - .9 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
 - .10 Lamp heads: integral on unit and remote, 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: High Intensity Tungsten 9, W, minimum 175 lumen output and 18, W, minimum 360 lumen output.
 - .11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
 - .12 Finish: beige.
 - .13 Auxiliary equipment:
 - .1 Ammeter.
 - .2 Voltmeter.
 - .3 Test switch.
-

- 2.1 EQUIPMENT (Cont'd) .13 (Cont'd)
- .4 Time delay relay.
 - .5 Battery disconnect device.
 - .6 AC input and DC output terminal blocks inside cabinet.
 - .7 Shelf.
 - .8 Cord and plug connection for AC.
 - .9 RFI suppressors.

- 2.2 WIRING OF REMOTE HEADS .1 Conduit: type EMT, in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Conductors: RW90 XLPE type in accordance with Section 26 05 21 - Wires and Cables 0-1000 V, sized as indicated.

PART 3 - EXECUTION

- 3.1 INSTALLATION .1 Install unit equipment and remote mounted fixtures.
- .2 Direct heads accordingly.
- .3 Connect exit lights to unit equipment.

- 3.2 FIELD TESTING INSTALLATION .1 Complete test form and submit to the Engineer. Include completed test form on the Operation and Maintenance manual.

- 3.3 COMMISSIONING .1 Refer to Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Commissioning shall be performed by at least one representative of supplier for this section and one representative from installation contractor.

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management.
- .3 Section 01 91 13 - General Commissioning (Cx) Requirements.
- 1.2 References .1 Canadian Code for Preferred Packaging.
- .2 Canadian Standards Association (CSA)
- .1 CSA C22.2 No.141-15, Unit Equipment for Emergency Lighting.
- .2 CSA C860-01, Performance of Internally-Lighted Exit Signs.
- .3 National Fire Protection Association (NFPA) requirements.
- 1.3 Submittals .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- 1.4 Waste Management and Disposal .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with Waste Reduction Workplan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .4 Collect and separate plastic, paper, packaging and corrugated cardboard in accordance with Waste Management Plan.
- .5 Fold up metal banding, flatten and place in designated area for recycling.
-

PART 2 - PRODUCTS

- 2.1 Standard Units
- .1 Exit lights: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Code for Preferred Packaging guidelines.
 - .2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish.
 - .3 Face and back plates: die formed cold rolled steel.
 - .4 Lamps: LED panel inserts and consumes less than 2 watts per face, rated for 120 volt normal operation. Emergency power supply is 24 VDC.
 - .5 Operation: designed for over 100,000 hours of continuous operation without relamping.
 - .6 Display: 150 mm high 'Running Man' pictogram, with 13 mm thick stroke, green in colour through a white stencil face plated.
 - .7 Downlight: translucent acrylic in bottom of unit.
 - .8 Face plate to remain captive for relamping.

PART 3 - EXECUTION

- 3.1 Installation
- .1 Install exit lights.
 - .2 Connect fixtures to exit light circuits.
 - .3 Connect emergency lamp sockets to emergency circuits.
 - .4 Ensure that exit light circuit breaker is locked in on position.
- 3.2 Commissioning
- .1 Refer to Section 01 91 13 - General Commissioning (Cx) Requirements.

PART 1 - GENERAL

- 1.1 REFERENCES .1 CSA International
.1 CSA C22.2 No.46-M1988(R2006), Electric Air-Heaters.
- .2 Underwriters' Laboratories (UL)
.1 UL 1042-2009, Standard for Electric Baseboard Heating Equipment.
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for convectors and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, cleaning procedures.
- 1.3 CLOSEOUT SUBMITTALS .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for convectors for incorporation into manual.
- 1.4 DELIVERY, STORAGE AND HANDLING .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .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.
-

-
- 1.4 DELIVERY,
STORAGE AND
HANDLING
(Cont'd)
- .3 (Cont'd)
 - .2 Store and protect convectors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

- 2.1 BASEBOARD
CONVECTORS
- .1 Heaters: to CSA C22.2 No.46 UL 1042 low standard wattage density with connection box one at both ends.
 - .1 Element through-type fitted with aluminum convector vanes and resistor wire enclosed in mineral insulation in copper sheath.
 - .2 Element: locked to cabinet and supported at additional points throughout length to allow for linear expansion with non metallic supports.
 - .3 Cabinet: to CSA C22.2 No.46 UL 1042, pre-drilled back for securing to wall. Integral air diffusion reflector with wireway at bottom and built-in clamps.
 - .1 Bottom inlet/top outlet.
 - .2 Bottom inlet/front outlet.
 - .3 Front inlet/front outlet.
 - .4 Sloping inlet/sloping front outlet.
 - .5 Panel: steel, metal thickness, bottom 1 mm, front 1.6 mm thick.
 - .6 Finish: phosphatized metallic surfaces.
 - .4 Blank cabinet sections and outside corners complete with wireway in sections including splice plates, to match heater cabinets in respects for continuous baseboard effect as indicated.
- 2.2 CONTROLS
- .1 Wall mounted thermostats: type low voltage electronic, Energy Star certified, in accordance with Section 23 09 33 - Electric and Electronic Control System for HVAC.
 - .2 Integral thermostats 12 pole to control load as indicated.
 - .3 Relays and transformers temperature controller and power module to switch loads in excess of thermostat rating.
-

2.2 CONTROLS .4 Double pole, double throw switch and receptacle terminal box
(Cont'd) assembly for combination heater and air conditioner power supply.

PART 3 - EXECUTION

3.1 EXAMINATION .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for convectors installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval from Consultant.

3.2 INSTALLATION .1 Install baseboard convector heaters, blank sections and controls.

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

3.3 FIELD QUALITY CONTROL .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

- .2 Ensure heaters and controls operate correctly.

3.4 CLEANING .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

- .1 Leave Work area clean at end of each day.

- 3.4 CLEANING
(Cont'd)
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- 3.5 PROTECTION
- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by commercial convectors installation.

PART 1 - GENERAL

- 1.1 REFERENCES .1 CSA International
.1 CSA C22.2 No.46-M1988(R2006), Electric Air-Heaters.
- .2 National Electrical Manufacturers Association (NEMA)
.1 NEMA 250-08, Enclosures for Electrical Equipment (1000 V Maximum).
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for unit heaters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, cleaning procedures and commissioning.
- 1.3 CLOSEOUT SUBMITTALS .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for unit heaters for incorporation into manual.
- 1.4 DELIVERY, STORAGE AND HANDLING .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
-

1.4 DELIVERY,
STORAGE AND
HANDLING
(Cont'd)

- .3 (Cont'd)
 - .1 Store materials off ground indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect unit heaters from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 UNIT HEATERS

- .1 Unit heater: to CSA C22.2 No.46, horizontal discharge complete with adjustable louvers finished to match cabinet.
- .2 Fan type unit heaters with built-in high-heat limit protection, fan-delay switches.
- .3 Fan motor: permanently lubricated ball bearing type with resilient mount.
 - .1 Built-in fan motor thermal overload protection.
- .4 Hangers: as indicated.
- .5 Elements: mineral insulated stainless steel sheath with, single brazed fins.
- .6 Cabinet: aluminum, 7 mm thick, fitted with 4 brackets for rod or wall mounting.
 - .1 Phosphatized and finished with 4 coats baked enamel to Architect's choice of colour.

2.2 CONTROLS

- .1 Thermostats: type low voltage electronic, Energy Star certified, to Section 23 09 33 - Electric and Electronic Control System for HVAC.
- .2 Built in thermostat and support controls.

PART 3 - EXECUTION

- 3.1 EXAMINATION .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for unit heaters installation in accordance with manufacturer's written instructions.
- .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.
- 3.2 INSTALLATION .1 Suspend unit heaters from ceiling or mount on wall as indicated.
- .2 Install thermostats in locations indicated.
 - .3 Make power and control connections.
- 3.3 FIELD QUALITY CONTROL .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Test cut-out protection when air movement is obstructed.
 - .3 Test fan delay switch to assure dissipation of heat after element shut down.
 - .4 Test unit cut-off when fan motor overload protection has operated.
 - .5 Ensure heaters and controls operate correctly.
- 3.4 CLEANING .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
- .1 Leave Work area clean at end of each day.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
-

3.5 PROTECTION

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

PART 1 - GENERAL

- 1.1 Related Sections
- .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
 - .3 Section 01 78 00 - Closeout Submittals.
 - .4 Section 01 91 13 - General Commissioning (Cx) Requirements.
 - .5 Section 26 05 01 - Common Work Results - Electrical.
 - .6 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.
- 1.2 References
- .1 Government of Canada
 - .1 NBC-2010, National Building Code of Canada.
 - .2 TB OSH Chapter 3-03 (1997-01-28), Treasury Board of Canada, Occupational Safety and Health, Chapter 3-03, Standard for Fire Protection Electronic Data Processing Equipment.
 - .3 TB OSH Chapter 3-04, (1994-12-22), Treasury Board of Canada, Occupational Safety and Health, Chapter 3-04, Standard for Fire Alarm Systems.
 - .2 Canadian Fire Alarm Association (CFAA).
 - .3 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524:2014, Installation of Fire Alarm Systems.
 - .2 ULC-S525:2016, Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories.
 - .3 ULC-S526:2016, Visible Signaling Devices for Fire Alarm Signaling Systems, Including Accessories.
 - .4 CAN/ULC-S527-11-AMD-1 (2014), Standard for Control Units for Fire Alarm Systems.
 - .5 CAN/ULC-S528-14, Manual Pull Stations for Fire Alarm Systems, Including Accessories.
 - .6 CAN/ULC-S529:2016, Standard for Smoke Detectors for Fire Alarm Systems.
 - .7 CAN/ULC-S530-1991, Standard for Heat Actuated Fire Detectors for Fire Alarm Systems.
 - .8 CAN/ULC-S537-13, Verification of Fire Alarm Systems.
-

- 1.3 System Description
- .1 Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data transmission.
 - .2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm in a temporal pattern; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to monitoring agency.
 - .3 Zoned, addressable non-coded single stage system with provision for two stage in the future.
 - .4 Modular in design to allow for future expansion.
 - .5 Operation of system shall not require personnel with special computer skills.
 - .6 System to include:
 - .1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.
 - .2 Power supplies.
 - .3 Initiating/input circuits.
 - .4 Output circuits.
 - .5 Auxiliary circuits.
 - .6 Wiring.
 - .7 Manual and automatic initiating devices.
 - .8 Audible and visual signalling devices.
 - .9 End-of-line resistors.
 - .10 Local annunciator displays.
 - .11 Printer.
 - .12 Historic event recorder.
- 1.4 Requirements of Regulatory Agencies
- .1 System:
 - .1 To TB OSH Chapter 3-04.
 - .2 System components: listed by ULC and comply with applicable provisions of National Building Code, and meet requirements of local authority having jurisdiction.
- 1.5 Shop Drawings
- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
-

1.5 Shop Drawings
(Cont'd)

- .2 Include:
- .1 Detail assembly and internal wiring diagrams for control units.
 - .2 Overall system riser wiring diagram identifying control equipment, initiating zones and signaling circuits; identifying terminations, terminal numbers, conductors and raceways.
 - .3 Details for devices.
 - .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
 - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.

1.6 Closeout Submitt

- als.1 Provide operation and maintenance data for fire alarm system for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

- .1 Include:
- .1 Instructions for complete fire alarm system to permit effective operation and maintenance.
 - .2 Technical data - illustrated parts lists with parts catalogue numbers.
 - .3 Copy of approved shop drawings with corrections completed and marks removed except review stamps.
 - .4 List of recommended spare parts for system.

1.7 Waste Management
and Disposal

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

1.8 Qualifications

- .1 The work to be done on the fire alarm system must be performed by qualified electrical personnel holding CFAA (Canadian Fire Alarm Association) Accreditation Certification Program on Fire Alarm System.
-

1.8 Qualifications
(Cont'd)

- .2 All individuals who will repair, replace or alter components of the existing fire alarm system must be certified in accordance with the requirements of the Ontario Fire Code (O.F.C.) 1997.
- .3 All persons who perform the verification or testing of the fire alarm system must be qualified in accordance with Annex A of CAN/ULC-S537 and CAN/ULC-S536.

PART 2 - PRODUCTS

2.1 Materials

- .1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- .2 Power supply: to CAN/ULC-S524.
- .3 Audible signal devices: to ULC-S524.
- .4 Visual signal devices: to CAN/ULC-S526.
- .5 Control unit: to CAN/ULC-S527.
- .6 Manual pull stations: to CAN/ULC-S528.
- .7 Thermal detectors: to CAN/ULC-S530.
- .8 Smoke detectors: to CAN/ULC-S529.

2.2 System
Operation: Single
Stage - Signals
Only

- .1 Actuation of any alarm initiating device to:
 - .1 Cause electronic latch to lock-in alarm state at central control unit.
 - .2 Indicate zone of alarm at central control unit.
 - .3 Cause audible signalling devices to sound in a temporal pattern continuously throughout building and at central control unit.
 - .4 Transmit signal to external monitoring agency.
 - .2 Acknowledging alarm: indicated at central control unit.
 - .3 Possible to silence signals by "alarm silence" switch at control unit, after 60s period of operation.
-

- 2.2 System
Operation: Single
Stage - Signals
Only
(Cont'd)
- .4 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.
 - .5 Actuation of supervisory devices to:
 - .1 Cause electronic latch to lock-in supervisory state at central control unit.
 - .2 Indicate respective supervisory zone at central control unit.
 - .3 Cause audible signal at central control unit to sound.
 - .4 Activate common supervisory sequence.
 - .6 Resetting alarm and supervisory device not to return system indications/functions back to normal until control unit has been reset.
 - .7 Trouble on system to:
 - .1 Indicate circuit in trouble at central control unit.
 - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.
 - .8 Trouble on system: suppressed during course of alarm.
 - .9 Trouble condition on any circuit in system not to initiate alarm conditions.
- 2.3 Control Panel
- .1 Central control unit (CCU).
 - .1 Suitable for DCLA communication style and zoned class B alarm circuits: to CAN/ULC-S524.
 - .2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.
 - .3 Minimum capacity of 250 addressable monitoring and 250 addressable control/signal points. Points may be divided between 2 communication channels in distributed system, each channel operating independently of other. Faults on one communication channel not to affect operation of other channel.
 - .4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.
-

- 2.3 Control Panel (Cont'd)
- .1 (Cont'd)
 - .5 Integral power supply, battery charger and standby batteries.
 - .6 Basic life safety software: retained in non volatile Erasable Programmable Read-Only-Memory (EPROM). Extra memory chips: easily field-installed. Random-Access-Memory (RAM) chips in panel to facilitate password-protected field editing of simple software functions (e.g. zone labels, priorities) and changing of system operation software.
 - .7 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.
 - .8 Support up to 2 RS-232-C I/O ports. CCU output: parallel ASCII with adjustable baud rates to allow interface of any commercially available printer, terminal or PC.
 - .9 Equipped with software routines to provide Event-Initiated-Programs (EIP); change is status of one or more monitor points, may be programmed to operate any or all of system's control points.
 - .10 Software and hardware to maintain time of day, day of week, day of month, month and year.
 - .11 On-board, 20-column, DC strip printer, thermal head with automatic paper take-up, and silent operation; operational while system is operating on standby power.
 - .12 Printer to record activities on system controlled by EIA RS-232-C link from within CCU.
 - .13 Software to operate variable sensitivity addressable smoke detectors and annunciate their status and sensitivity settings at control panel.
- 2.4 Power Supplies
- .1 120 V, 60 Hz as primary source of power for system.
 - .2 Voltage regulated, current limited distributed system power.
 - .3 Primary power failure or power loss (less than 102 V) will activate common trouble sequence.
 - .4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
 - .5 During normal operating conditions fault in battery charging circuit, short or open in battery leads to activate common trouble sequence and standby power trouble indicator.
 - .6 Standby batteries: sealed, maintenance free.
-

2.4 Power Supplies
(Cont'd)

- .7 Continuous supervision of wiring for external initiating and alarm circuits to be maintained during power failure.
- .8 Provide battery capacity to handle 30 minutes of alarm preceded with 24 hours of supervision after a normal power failure.

2.5 Initiating/ Input
Circuits

- t.1 Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCLA configuration to central control unit.
 - .1 Alarm receiving circuits (active and spare): compatible with smoke detectors and open contact devices.
 - .2 Actuation of alarm initiating device: cause system to operate as specified in "System Operation".
 - .3 Receiving circuits for supervisory, N/O devices. Devices: wired in DCLA configuration to central control unit.
 - .4 Actuation of supervisory initiating device: cause system to operate as specified in "System Operation".

2.6 Alarm Output Circuits

- ts.1 Alarm output circuit: connected to signals, wired in class B configuration to central control unit.
 - .1 Signal circuits' operation to follow system programming; capable of sounding horns continuously at 20 spm. Each signal circuit: rated at 2 A, 24 VDC; fuse-protected from overloading/overcurrent.
 - .2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.

2.7 Auxiliary Circuits

- ts.1 Auxiliary contacts for control functions.
 - .1 Actual status indication (positive feedback) from controlled device.
 - .2 Alarm and supervisory trouble on system to cause operation of programmed auxiliary output circuits.
-

<u>2.7 Auxiliary Circuits (Cont'd)</u>	.3	Auxiliary circuits: rated at 2 A, 24 Vdc or 120 Vac, fuse-protected.
<u>2.8 Wiring</u>	.1	Solid bare copper conductors: rated CSA FAS 105/NEC FPLR. Non-shielded multi-conductor PVC jacket - red, voltage rating 300 volts and temperature rated 105 deg C.
	.2	To initiating circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
	.3	To signal circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.
	.4	To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.
<u>2.9 Manual Alarm Stations</u>	.1	Addressable manual pull station: .1 Pull lever, break glass rod, semi-flushwall mounted type, double action, 2 stage programmed for single stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field. .2 Bilingual signage.
<u>2.10 Automatic Alarm Initiating Devices</u>	.1	Addressable multi-sensor, variable-sensitivity smoke detectors. .1 Ionization, Photo-electric and heat sensing type. .2 Electronics to communicate detector's status to addressable module/transponder. .3 Detector address to be set on detector base in field. .4 Sensitivity settings: 3 settings, determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters. .5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.
<u>2.11 Audible Signal Devices</u>	.1	Mini-horns: 90 db, flushmounting, red colour, 24 V dc.

- 2.12 Visual Alarm Signal Devices
- gnal.1 Strobe type: Self synchronized flash light pattern, clear lense markings with fire /feu 15 cd or 15/75 cd as indicated on common plate with horn, 2 wire 24 V dc.
 - .1 Designed for surface mounting on combination horn and strobe mounting plates.
- 2.13 End-of-line Devices
- ices.1 End-of-line devices to control supervisory current in alarm circuits and signalling circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel.
- 2.14 As-Built Riser Diagram
- .1 Fire alarm system riser diagram: in glazed frame on black lamicoid sheet with bevelled edges, minimum size 600 x 600 mm.

PART 3 - EXECUTION

- 3.1 Installation
- .1 Install systems in accordance with CAN/ULC-S524.
 - .2 Install central control unit and connect to ac power supply, dc standby power.
 - .3 Install manual alarm stations and connect to alarm circuit wiring.
 - .4 Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.
 - .5 Connect alarm circuits to main control panel.
 - .6 Install horns and visual signal devices and connect to signalling circuits.
 - .7 Connect signalling circuits to main control panel.
-

- 3.1 Installation (Cont'd)
- .8 Install end-of-line devices at end of alarm and signalling circuits.
 - .9 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
 - .10 Splices are not permitted.
 - .11 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
 - .12 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
 - .13 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
- 3.2 Field Quality Control
- ntrol.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical and CAN/ULC-S537.
 - .1 Fire alarm system:
 - .1 Test such device and alarm circuit to ensure manual stations, thermal and smoke detectors, sprinkler system, transmit alarm to control panel and actuate first stage alarm ancillary devices.
 - .2 Check annunciator panels to ensure zones are shown correctly.
 - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of systems.
 - .4 Addressable circuits system style DCLA:
 - .1 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals on each side of single open-circuit fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
 - .2 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
-

3.2 Field Quality Co
(Cont'd)

- .1 (Cont'd)
- .4 (Cont'd)
- .2 Provide final PROM program re-burn for system incorporating program changes made during construction.

3.3 Demonstration and
Training

- d.1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system. Allow two 2 hour sessions. Sessions to be available in English and French.

3.4 Commissioning

- .1 Refer to Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Commissioning shall be performed by at least one representative of fire alarm supplier and one representative from installation contractor.

TYPE	N° DU FABRICANT	VOLTAGE	LAMP		MOUNTING	ACCESSORIES
			Qté-watts	Type		
B	PHILIPS LEDALITE #24-G5-L-A-C-A-A-04-7-3-E-W	347	1x 36	LED 4500 LUMENS/4ft	SUSPENDED	
C	PHILIPS DAY-BRITE INDUSTRIAL #APX-12LL40-347-W-LCP	347	1x 96	LED 11,262 LUMENS	SURFACE MOUNT	
D	PHILIPS CUBELITE CSW #CSW-48-47-40-3--LED-ZO LUMENALPHA DOWNLIGHT	347	52.1	LED 4700 LUMENS	SURFACE / WALL	STAIRS/WASHROOMS
E	#LASS-A-347-L13-30K-CR80-W-RD- WH-NO-NC	347		LED 1300 LUMENS	RECESSED MOUNT	
E1	LUMENALPHA DOWNLIGHT #LASS-A-347-L13-30K-CR80-W-RD- WH-NO-NC-WET	347		LED 1300 LUMENS	RECESSED MOUNT	WET APPLICATION
E2	LUMENALPHA DOWNLIGHT #LASS-A-347-L20-30K-CR80-W-RD- WH-NO-NC-WET	347		LED 1300 LUMENS	RECESSED MOUNT	WET APPLICATION
F	KENALL CORNER # CC-4-0/3-45L35K-DCC-347-B-1	347	1x 45	LED	SURFACE MOUNT AT CEILING/WALL EDGE	CELL APPLICATION
G	PHILIPS DAY-BRITE FLUXSTREAM #LF-4-FR-38-40-3-DZT	347	1x 40	LED 4000 LUMENS	SURFACE	WITH WIREGUARD
L1	FLUXWERX VIEW # VU1-A-D-35-A-4-G-F1-M-06	347	1x 38	LED 3700 LUMENS	SURFACE/SUSPENDED	
L2	FLUXWERX PROFILE # PF1-F-F-C-35-A-04-G-F1-M-06	347	1x 29	LED 3250 LUMENS	SURFACE/SUSPENDED	3500K COLOUR
L3	FLUXWERX VIEW # VU1-A-C-40-A-4-G-F1-M-06	347	1x 38	LED 3700 LUMENS	SURFACE/SUSPENDED	4000K COLOUR

TYPE	N° DU FABRICANT	VOLTAGE	Qté-watts	LAMP	MOUNTING	ACCESSORIES
				Type		
L4	LUMENLINE 2 PENDANT # LLI2P-DI-SU2-dHO30k-iRO30K- WH	347	1x 24	LED 3541 LUMENS	SUSPENDED	3000K COULEUR
L5	LUMENLINE 2 RECESSED # LLI2R-TBAR-SU2-dHO35k- iRO35K-WH-NO	347	1x 24	LED 3615 LUMENS	RECESSED	3500K COLOUR
P1	LUMENAREA LAMPADAIRE P100-LE3-58L-347-STD FINISH	347	1x 60	LED 6000 LUMENS	POLE MOUNT	4000K COLOUR
W	PHILIPS CARDCO SCONE #161-3-70LA-6435-NW-347 LUMACELL LCS SERIES #LCS-SP	347	1x 70	2 LED ARRAYS - 7,105 LUMENS	MOUNTING HEIGHT - 3.0m	
		347	4.2w	LED	CEILING, WALL, END MOUNT CAPABLE	RUNING MAN PICTOGRAM EXIT SIGN
	LUMACELL LCS SERIES #LCSC-2LEDWR	347	4.2w	LED	CEILING, WALL, END MOUNT CAPABLE	RUNING MAN PICTOGRAM EXIT SIGN

ANNEX B

Fed from ATS Panel Identification: PD1 Location: MAIN ELECTRICAL ROOM Main Bus/Breaker Amps: 400A				Date: August 8, 2016 Main Breaker: 350 Supply Volts: 347/600V, 3PH, 4W Installation: SURFACE							
DESCRIPTION	WATTS	AMP.	CIR.	A	B	C	CIR.	AMP.	WATTS	DESCRIPTION	
HEATING PANEL 'PC1'	35,617	200	1	⋮	*	⋮	2	100	28,076	LIGHTING PANEL 'PE1'	
	35,617		3	⋮	*	⋮	4		28,076		
	35,617		5	⋮	*	⋮	6		28,076		
TRANSFORMER 'PS1'	84	100	7	⋮	*	⋮	8	100	2,200	SERVICE PANEL 'PS2' VIA TRANSFORMER 'T2'	
	84		9	⋮	*	⋮	10		2,200		
	84		11	⋮	*	⋮	12		2,200		
ROOF TOP UNIT 'RTU-1'	3,800		13	⋮	*	⋮	14	15	2,200	ROOF TOP UNIT 'RTU-3'	
	3,800		15	⋮	*	⋮	16		2,200		
	3,800		17	⋮	*	⋮	18		2,200		
ROOT TOP UNIT 'RTU-2'	3,800		19	⋮	*	⋮	20	80	18,000	FIRE PROTECTION PUMP STATION	
	3,800		21	⋮	*	⋮	22		18,000		
	3,800		23	⋮	*	⋮	24		18,000		
CONDENSATE UNIT 'CU-1'	-		25	⋮	*	⋮	26		-		
	-		27	⋮	*	⋮	28		-		
	-		29	⋮	*	⋮	30		-		
CONDENSATE UNIT 'CU-2'	-		31	⋮	*	⋮	32		-		
	-		33	⋮	*	⋮	34		-		
	-		35	⋮	*	⋮	36		-		
	-		37	⋮	*	⋮	38		-	SPARE	
	-		39	⋮	*	⋮	40		-		
	-		41	⋮	*	⋮	42		-		
Total Phase A		93.78	kW								
Total Phase B		93.78	kW								
Total Phase C		93.78	kW								
					<GFI> = Ground fault detector <k> = Breaker locking device Total Panel Load : 281.33 kW						

ANNEX A

Fed from 'PD1'							Date: August 8, 2016			
Panel Identification: PC1							Main Breaker: 200			
Location: MAIN ELECTRICAL ROOM							Supply Volts: 347/600V, 3PH, 4W			
Main Bus/Breaker Amps: 225A							Installation: SURFACE			
DESCRIPTION	WATTS	AMP.	CIR.	A	B	C	CIR.	AMP.	WATTS	DESCRIPTION
SPARE		15	1	-	*	-	2	15	1,500	EXTERIOR PUMPING STATION
	-		3	-	-	*	-		4	
UNIT HEATER - ROOMS 301 & 308	4,500	20	5	-	-	*	6	20	1,500	
	4,500		7	-	*	-	8		5,300	
BB HEATER - ROOMS 310 & 311	3,000	20	9	-	-	*	10	20	5,300	FORCE FLOW HEATER ROOM 601
	3,000		11	-	-	*	12		5,000	
BB HEATER - ROOM 203	4,500	20	13	-	*	-	14	20	5,000	
	4,500		15	-	-	*	16		5,000	
BB HEATER - ROOMS 201, 202, 204, 205	3,500	20	17	-	-	*	18	20	5,000	SPARE
	3,500		19	-	*	-	20			
CONVECTOR & BB HEATER ROOMS 101, 103, 306	4,750	20	21	-	-	*	22	15		
	4,750		23	-	-	*	24			
BB HEATERS ET FORCE FLOW ROOMS 302, 404, 405, 408, 513	5,750	20	25	-	*	-	26			
	5,750		27	-	-	*	28		-	
BB HEATERS ROOMS 309, 312, 402A, 402B, 406, 407, 701	5,375	20	29	-	-	*	30		-	
	5,375		31	-	*	-	32			
FORCE FLOW HEATERS SALLES 501, 502A-B, 506, 510	4,500	20	33	-	-	*	34		-	
	4,500		35	-	-	*	36		-	
			37	-	*	-	38			
	-		39	-	-	*	40			
	-		41	-	-	*	42			
Total Phase A		35.43 kW								
Total Phase B		34.30 kW								
Total Phase C		37.13 kW								
									<GFI> = Ground fault detector <k> = Breaker locking device Total Panel Load : 106.85 kW	

ANNEX A

Fed from 'T1'/PD1				Date: August 8, 2016						
Panel Identification: PE1				Main Breaker: 200						
Location: MAIN ELECTRICAL ROOM				Supply Volts: 347/600V, 3PH, 4W						
Main Bus/Breaker Amps: 225A				Installation: SURFACE						
DESCRIPTION	WATTS	AMP.	CIR.	A	B	C	CIR.	AMP.	WATTS	DESCRIPTION
EXTERIOR LIGHTING	3,500	20	1	~	*		2	20	200	EXIT SIGNS
EXTERIOR LIGHTING	1,000	20	3	~		*	4	20	1,000	NIGHT LIGHT (Emergency)
ÉCLAIRAGE INTÉRIEUR	1,034	20	5	~		*	6	20		SPARE
ÉCLAIRAGE INTÉRIEUR	1,000	20	7	~	*		8			
ÉCLAIRAGE INTÉRIEUR	1,000	20	9	~		*	10			
ÉCLAIRAGE INTÉRIEUR	1,000	20	11	~		*	12			
			13	~	*		14			
			15	~		*	16			
			17	~		*	18			
			19	~	*		20			
			21	~		*	22			
			23	~		*	24			
			25	~	*		26			
Total Phase A				4.70 kW			<GFI> = Ground fault detector			
Total Phase B				3.00 kW			<k> = Breaker locking device			
Total Phase C				2.03 kW			Total Panel Load : 9.73 kW			

ANNEX B

Fed from PD1/T1							Date: August 8, 2016			
Panel Identification: PS1							Main Breaker: 100A			
Location: MAIN ELECTRICAL ROOM							Supply Volts: 120/208V, 3PH, 4W			
Main Bus: 100A							Installation: SURFACE			
DESCRIPTION	WATTS	AMP.	CIR.	A	B	C	CIR.	AMP.	WATTS	DESCRIPTION
2 PRISES - SALLE 301	500	15	1	⋯	*	⋯	2	15	1,200	PRISE CHAUFFE-MOTEUR
2 PRISES - SALLE 301	500	15	3	⋯	⋯	*	4	15	1,200	PRISE CHAUFFE-MOTEUR
2 PRISES - SALLE 301	500	15	5	⋯	⋯	⋯	6	15	1,200	PRISE CHAUFFE-MOTEUR
2 PRISES - SALLE 301	500	15	7	⋯	*	⋯	8	15	1,200	PRISE CHAUFFE-MOTEUR
2 PRISES - SALLE 301	500	15	9	⋯	⋯	*	10	15	1,200	PRISE CHAUFFE-MOTEUR
2 PRISES - SALLE 301	500	15	11	⋯	⋯	⋯	12	20	300	ÉCLAIRAGE CORRIDOR
2 PRISES - SALLE 301	500	15	13	⋯	*	⋯	14	20	1,000	Room 302 - Recept.
2 PRISES - SALLE 301	500	15	15	⋯	⋯	*	16	20	1,000	Room 302 - Recept.
Room 310/311/Corridor Utility	1,000	20	17	⋯	⋯	*	18	20	1,000	Room 302 - Recept.
2 PRISES - SALLE 305A-B GFI	500	15	19	⋯	*	⋯	20	20	1,000	Room 302 - Recept.
Room 305B Recept	500	15	21	⋯	⋯	*	22	20	1,000	Room 506 - Recept.
SPARE		15	23	⋯	⋯	*	24	20	1,000	Room 506 - Recept.
SPARE		15	25	⋯	*	⋯	26	20	1,000	Room 506 - Recept.
Room 310 & 311 Hand Dryer	950	15	27	⋯	⋯	*	28	20	1,000	Room 506 - Recept.
	950		29	⋯	⋯	*	30	15	500	Motor. Damper/ EF-12 - RM 302
RoomS 310 & 311- EF-5 & EF-6	342	15	31	⋯	*	⋯	32	15	500	Motorized Damper - RM506
SPARE		15	33	⋯	⋯	*	34		3,600	Room 302 - HRV-1
BORNE DE RECHARGE DE VEHICULE ÉLECTRIQUE	14,500	70	35	⋯	⋯	*	36	40	3,600	
	14,500		37	⋯	*	⋯	38		3,600	
Opérateur - barrière coulissante	420	15	39	⋯	⋯	*	40	15	500	Room 501 Recept.
	420		41	⋯	⋯	*	42	15	500	Room 501 Recept.
Room 404 - Recept.	500	15	43	⋯	*	⋯	44	15	500	Room 501 Recept.
Room 404 - Recept.	500	15	45	⋯	⋯	*	46	15	500	Room 511 Recept.
Room 405 - Recept.	500	15	47	⋯	⋯	*	48	15	500	Room 602 - Motorized Damper/ EF-9
Room 405 - Recept.	500	15	49	⋯	⋯	*	50	20	1,000	Room 602 - Recept.
Room 408 - Recept.	500	15	51	⋯	⋯	*	52	20	1,000	Room 602 - Recept.
Room 408/513 - Recept.	500	15	53	⋯	⋯	*	54	20	1,000	Room 602 - Recept.
Room 601/603 Recept.	1,000	20	55	⋯	*	⋯	56	20	1,000	Room 602 - Recept.
Room 601 Recept.	1,000	20	57	⋯	⋯	*	58	20	1,000	Room 601 Recept.
Room 601 Recept.	1,000	20	59	⋯	⋯	*	60	20	1,000	Room 601 Recept.
Room 601 Recept.	1,000	20	61	⋯	*	⋯	62	20	1,000	Room 601 Recept.
Room 601 Recept.	1,000	20	63	⋯	⋯	*	64	20	1,000	Room 601 Recept.
Room 601 Recept.	1,000	20	65	⋯	⋯	*	66	15	500	Room 601 -
Space		15	67	⋯	*	⋯	68	15	47	Room 604 - EF-3
Space		20	69	⋯	⋯	*	70	15		Space
Space			71	⋯	⋯	*	72			Space

Total Phase A	32.89 kW	<GFI>	= Ground fault detector
Total Phase B	19.37 kW	<k>	= Breaker locking device
Total Phase C	31.97 kW	Total Panel Load :	84.23 kW

ANNEX A

Fed from PD1/T1 Panel Identification: PS1 Location: MAIN ELECTRICAL ROOM Main Bus: 100A				Date: August 8, 2016 Main Breaker: 100A Supply Volts: 120/208V, 3PH, 4W Installation: SURFACE						
DESCRIPTION	WATTS	AMP.	CIR.	A	B	C	CIR.	AMP.	WATTS	DESCRIPTION
Workstation Area - Recept.	500	15	1	⎓	*	⎓	2	15	500	ROOM 201 - 3 RECEPTACLES
Workstation Area - Recept.	500	15	3	⎓	⎓	*	4	15	500	ROOM 201 - 3 RECEPTACLES
Workstation Area - Recept.	500	15	5	⎓	⎓	⎓	6	15	500	Room 201 - Recept
Workstation - Power Pole	250	15	7	⎓	*	⎓	8	15	500	Room 204 - Recept
	250		9	⎓	⎓	*	10	15	500	Room 204 - Recept
Workstation - Power Pole	250	15	11	⎓	⎓	*	12	15	500	Room 204 - Recept
	250		13	⎓	*	⎓	14	15	500	Room 205 - Recept
Workstation - Power Pole	250	15	15	⎓	⎓	*	16	15	500	Room 205 - Recept
	250		17	⎓	⎓	*	18	15	500	Room 205/202 - Recept
Workstation - Power Pole	250	15	19	⎓	*	⎓	20	15	500	Room 205/202 - Recept
	250		21	⎓	⎓	*	22	15	500	Room 205/202 - Recept
Workstation Area - Recept.	500	15	23	⎓	⎓	*	24	20	1,000	Room 205 - Printer
Room 306 - Recept	500	15	25	⎓	*	⎓	26	15	500	Room 204 - Floor Monument
Room 306 - Recept	500	15	27	⎓	⎓	*	28	15	1,400	Room 103 - Hand Dryer
Room 306 - Recept	500	15	29	⎓	⎓	⎓	30	15	97	Room 103 - EF-4
Room 306 - Floor Monument	500	15	31	⎓	*	⎓	32	15	500	Room 304 - Recept
Room 406 - Recept	500	15	33	⎓	⎓	*	34	20	1,000	Corridor - Utility Recept.
Room 406 - Recept	500	15	35	⎓	⎓	*	36	15	500	Workstation Area - Recept.
Room 309 - Recept	500	15	37	⎓	*	⎓	38	15	500	Room 303 - Recept
Room 309 - 3 Recept.	500	15	39	⎓	⎓	*	40	20	1,000	Room 701 - Utility Recept
Room 309 - Recept	500	15	41	⎓	⎓	*	42	15	500	Room 701 - Recirc. Pump/VAV
Room 309 - SPLIT RECEPT.	500	15	43	⎓	*	⎓	44	15	500	Room 402A/402B - Recept
	500	15	45	⎓	⎓	*	46	15	216	Room 402A/402B - EF-7/EF-8
Room 309 - MICROWARE REC.	500	15	47	⎓	⎓	*	48	15	500	Room 307 - Recept
SPARE		15	49	⎓	*	⎓	50	15	500	Room 307 - Recept
Room 309 -Fridge Recept.	750	20	51	⎓	⎓	*	52	15	500	Room 307 - Recept
Room 309/312 - EF-1/EF-2	185	15	53	⎓	⎓	*	54	15	500	Room 307 - Recept
Room 312 - Recept	500	15	55	⎓	*	⎓	56	15	500	Room 403 - Recept
Room 407 - Recept	500	15	57	⎓	⎓	*	58	15	500	Room 403 - Recept
Room 407- Recept	500	15	59	⎓	⎓	*	60	15		Spare
Spare		15	61	⎓	*	⎓	62	15		Spare
Spare		15	63	⎓	⎓	*	64			Space
Space			65	⎓	⎓	*	66			Space
Space			67	⎓	*	⎓	68			Space
Space			69	⎓	⎓	*	70			Space
Space			71	⎓	⎓	*	72			Space

Total Phase A	8.75	kW	<GFI>	=	Ground fault detector
Total Phase B	11.12	kW	<k>	=	Breaker locking device
Total Phase C	8.78	kW	Total Panel Load :		28.65 kW