

## **ELECTRICAL SPECIFICATION**

FOR

**32 Unit Affordable Housing Apartment Building  
20 South Street, Trenton, ON  
(Issued for Tender)**

Prepared by:

**e-Lumen International Inc.**  
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PROJECT NO. 23-019

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**BASE AND APPROVED EQUAL**

As required in Specification, I/we herewith submit a list of manufacturers (either base or approved equal) carried in the bid price. I/We agree that no changes will be made without prior written approval from the Consultant.

Electrical Contractor **MUST** submit this portion of the Tender Form with an (x) beside equipment manufacturer/supplier with Tender Form **24 hours after tender closing**. Failure to complete this schedule may disqualify the Electrical Contractor.

Spec. Section	Equipment	Base & Approved Equal			
260501	Coordination & Grounding Studies	<input type="checkbox"/>	Eastenghouse		
		<input type="checkbox"/>	Square D		
		<input type="checkbox"/>	G.T. Wood		
260501	Transformer and Switch Pads	<input type="checkbox"/>	Oaks Pre-cast		
		<input type="checkbox"/>	Duracon pre-cast		
		<input type="checkbox"/>	Hy-grade		
		<input type="checkbox"/>	Utilicon		
260521	Building Wires	<input type="checkbox"/>	Philips		
		<input type="checkbox"/>	Canada Wire		
		<input type="checkbox"/>	Pirelli		
262726	Wiring Devices	<input type="checkbox"/>	P&S		
		<input type="checkbox"/>	Hubbell		
		<input type="checkbox"/>	Leviton		
		<input type="checkbox"/>	Lutron		
262402	Service Entrance Board	<input type="checkbox"/>	Square D		
		<input type="checkbox"/>	Cutler-Hammer		
		<input type="checkbox"/>	Siemens		
262823	Disconnect Switches	<input type="checkbox"/>	Square D		
		<input type="checkbox"/>	Cutler-Hammer		
		<input type="checkbox"/>	Siemens		
261217	Dry Type Transformers	<input type="checkbox"/>	Square D		
		<input type="checkbox"/>	Hammond		
		<input type="checkbox"/>	Rex		
262417	Panelboards Breaker Type	<input type="checkbox"/>	Square D		
		<input type="checkbox"/>	Cutler-Hammer		
		<input type="checkbox"/>	Siemens		

Spec. Section	Equipment	Base & Approved Equal				
262418	Panelboards Switch and Fuse Type	( ) ( ) ( )	Square D Cutler-Hammer Siemens			
262821	Moulded Case Circuit Breakers	( ) ( ) ( )	Square D Cutler-Hammer Siemens			
262814	Fuses	( ) ( )	Gould Buss			
See on Fixture Types	Lamps	( ) ( ) ( )	Philips GE Osram/Sylvania			
See on Fixture Types	Ballasts	( ) ( ) ( )	Advance Lutron Osram/Sylvania			
See Fixture Types	Luminaires:					
	A1	( ) ( ) ( )	HI-LITE KEENE ORACLE			
	CA1	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS MAXILUME			
	CA1A	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS MAXILUME			
	CA2	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS MAXILUME			
	CA3	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS MAXILUME			

Spec. Section	Equipment	Base & Approved Equal		
	CA4	( ) ( ) ( )	DAY-O-LITE DECO LIGHTING TRIUMPH LIGHTING	
	CA5	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS MAXILUME	
	FA1	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	
	FA2	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	
	FA3	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	
	FA4	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	
	FA5	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	
	FA6	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	
	FB1	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	
	FB2	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	
	FP1	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	

Spec. Section	Equipment	Base & Approved Equal		
	FS1	( ) ( ) ( )	JESCO PHILIPS SG1 LIGHTING	
	FS2	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	
	FS3	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS VISIONEERING	
	W1	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS LSI LIGHTING	
	CL1	( ) ( ) ( )	H.E.-WILLIAMS PHILIPS MAXILUME	
	GL1	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	
	HLA1	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	
	HLA2	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	
	HLA3	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	
	HLA4	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	
	HLB1	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	

Spec. Section	Equipment	Base & Approved Equal		
	HLB4	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	
	HLB5	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	
	LA1	( ) ( ) ( )	JESCO PHILIPS MEDLEY	
	WL1	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	
	WL2	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	
	WL3	( ) ( ) ( )	VISIONAIRE PHILIPS LSI LIGHTING	
	WL4	( ) ( ) ( )	I-LED LIGHTING PHILIPS ARES LIGHTING	
	ST1	( ) ( )	TRADDEL PHILIPS	
	PICTOGRAM 'XT' ( INDOOR)	( ) ( )	BEGHELLI LUMACELL	
	PICTOGRAM 'XTW' ( OUTOOR)	( ) ( )	BEGHELLI LUMACELL	
See Drawing	Occupancy Sensors	( ) ( ) ( ) ( )	Wattstopper Hubbell Pass & Seymour Lutron	

Spec. Section	Equipment	Base & Approved Equal				
263214	Power Generation Diesel	( ) ( ) ( ) ( )	Caterpillar/Toromont Gal Power Generac/Total Power LMR (Gillette)			
	Load Bank	( ) ( ) ( )	Chromalox P.M. Wright Markel			
	Load Bank Controller	( ) ( )	Schneider Cutler-Hammer			
263623	Automatic Transfer Switches	( ) ( )	Asco GE.Zenith			
283101	Fire Alarm	( ) ( ) ( ) ( )	GE (Edwards) Notifier (Durham Central Fire) Simplex Siemens			
265620	Low Voltage Lighting Control	( ) ( )	Lutron Electronics Wattstopper			
266001	Slab Heating and Snow Melting	( )	Tyco			
266101	XL-Trace Freezing Protection System	( )	Tyco			

**PART 1        General**

**1.1            Related Sections**

- .1        This Section Supplements and forms part of every section of Division 26, 27 and 28.

**1.2            References**

- .1        Canadian Standards Association (CSA International)
  - .1        CSA C22.1-09, Canadian Electrical Code, Part 1 (20th Edition), Safety Standard for Electrical Installations.
  - .2        Ontario Electrical Safety Code (24<sup>th</sup> Edition) and all bulletins.
  - .3        Ontario Building Code Latest Edition.
  - .4        National Fire Code (NFPA) Latest Edition.
- .2        Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
  - .1        EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3        Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
  - .1        IEEE SP1122-2000, the Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

### **1.3 As-Built Drawings**

- .1 Provide As-Built drawings of the installation incorporating all changes from the Record Drawings, in the form of AutoCad format Release 2013 CD's.
- .2 As-built drawings shall include the final layout and location of all electrical equipment devices, outlets and pull boxes installed.
- .3 As-built drawings shall include routing of all electrical services such as feeders, and branch wiring for all electrical systems as noted in Division 26, 26 & 28 contract documents.

### **1.4 Cad Drawings**

- .1 An electronic copy (AutoCad format Release 2013) of all drawings will be handed to the electrical contractor by the Consultant at no cost. The drawings will reflect the tender and/or construction set of drawings. Should the Contractor require any additional electronic copies during construction a cost \$100.00 per drawing (plus GST/HST) will be charged by the Consultant.

### **1.5 Completion of Contract**

- .1 All the equipment must be cleaned and tested, before final acceptance by the Consultant.
- .2 From the date of issuance of a "Certificate of Substantial Performance", all equipment, materials and workmanship, other than lamps, must be unconditionally warranted for not less than 1 (one) year.
- .3 Replace, at no cost, all lamps burned out during a 60 (sixty) day period and all burned-out fluorescent and HID lamps for a period of 90 (ninety) days after date of issuance of certificate of "Substantial Performance" for the Contract for the building.
- .4 Defects and deficiencies which originate or become evident during the warranty period must be repaired or replaced, at no cost.
- .5 If, during the warranty period, transformers, ballasts or other noise and vibration producing equipment are considered by the Consultant to exceed acceptable standards, then these must be replaced without delay or additional cost to the Owner. All work relating to the replacement of defective items must be carried out after normal working hours and at a time which is acceptable to the Owner.

### **1.6 Definitions**

- .1 Wherever the words "equal", "approved", or "approved equal" are used, it shall be understood to mean, "equal", "approved", or "approved equal" in the opinion of the Consultant only.
- .2 Wherever the words "install", "provide", or "supply and install", are used, it shall be understood to mean "provide and install, inclusive of all labour, materials, installation, testing, and connections" for the item to which referred.
- .3 "Concealed" is defined as "out of sight" in "normal" viewing conditions, and includes buried in concrete, above acoustic tile or gypsum board ceilings, within masonry or gypsum board constructed walls, within cable trays or below raised access floors.

### **1.7 Contract Drawings**

- .1 The Drawings for the Electrical work are diagrammatic performance Drawings only, intended to convey the scope of work and indicate the general arrangement and approximate location of apparatus and fixtures, and the approximate sizes and locations of equipment and outlets. The Drawings do not intend to show Architectural, Mechanical or Structural details.
- .2 Do not scale or measure Drawings, but obtain information regarding accurate dimensions, from the dimensions shown on the Architectural Drawings, or by site measurements. Follow the Electrical Drawings for laying out the work.
- .3 Refer to the other Division's Coordination Drawings, to become familiar with all conditions affecting the work, and verify suitable spaces exist, in which the equipment will be installed.
- .4 Make, at no additional cost, any changes or additions to materials and equipment necessary to accommodate Structural conditions (offsets around beams, columns, etc.).
- .5 Alter at no additional cost, the location of materials and/or equipment as directed, provided that the changes are made before installation, and do not necessitate additional materials.
- .6 Install ceiling mounted components (such as lighting fixtures, heat detectors, speakers, etc.) in accordance with dimensioned reflected ceiling drawings, prepared by the (Architectural) Consultant.
- .7 Leave space clear, and install equipment to accommodate future materials and/or equipment as indicated or specified, or to accommodate equipment and/or materials supplied by other Contractors.
- .8 Verify that the spaces in which the equipment is to be installed is sufficient and install all equipment to maintain head room and clearances, to conserve space, comply with codes, and to ensure adequate space for future servicing.
- .9 Confirm at the site, the exact location of equipment, outlets and fixtures, and the location of outlets for equipment supplied by other Contractors, before installation.

## **1.8 Expediting**

- .1 Continuously check and expedite delivery of all materials and equipment required for the successful execution of the work.
- .2 If requested by Consultant, inspect at the source of manufacture, to confirm status, and submit an itemized flow chart of equipment order and delivery dates.
- .3 Continuously check and ensure that the necessary information is communicated to all parties involved.
- .4 Immediately inform the Consultant in writing of any anticipated delays.

## **1.9 Coordination of Drawings**

- .1 Prepare Drawings in conjunction with all Contractors concerned, showing new and existing sleeves and openings for passages through structure, and any sleeves, conduit sizes, buried conduit and locations for inserts in cast-in-place or precast concrete, required for this work.
- .2 Prepare the Drawings, at a scale of 1:50 3" = 1ft. and show cable and conduit runs, bus duct and equipment in vaults, tunnels, shafts, mechanical and electrical equipment rooms, switchgear rooms, ceiling spaces and all other critical locations to avoid conflict. Base the Drawings on Shop Drawings and include all details pertaining to clearances, access, sleeves, electrical connections, location and elevation of pipes, ducts, conduits, etc., obtained from consultation with and agreement of all other Contractors involved, or site conditions.
- .3 Prepare Base Drawings of new equipment bases, anchors, slabs, and floor and roof curbs, pertaining to the Electrical work.
- .4 Forward all the Drawings, approved by all Sub-Contractors, to all Consultants for their review. Provide electronic files (Autocad) and white print copies as required.
- .5 All drawings to be prepared in ample time for review and implementation. Failure to do so, and any problems that arise, will be the responsibility of the Contractor of this Division.
- .6 Should the Trade Contractor neglect or otherwise fail to provide co-ordination drawings, it shall assume the cost of any and all relocation work that could have been avoided through the submission of co-ordination drawings.

## **1.10 Coordination of Protective Devices**

- .1 Retain the services of a specialty coordination Consultant, for the purpose of providing coordination and testing services.
- .2 Ensure circuit protective devices such as over current trips, relays, circuit breakers and fuses are installed to values and settings so as to provide protection by means of opening the closest device to the fault.
- .3 Submit a short circuit, protection and coordination study as follows:
  - .1 Obtain and organize all electrical protection data for all the equipment. This will consist of obtaining the relay types and settings, transformer impedances, cable sizes, fuse sizes and types, motor data, etc., required to carry out the short circuit, protection and coordination study.

- .2 Perform a short circuit analysis to determine short circuit current levels at all critical points in the distribution system, having obtained the available short circuit current available from the Local Electrical Supply Authority.
- .3 Generate appropriate settings for all relays and protective devices from the level of the Local Electrical Supply Authority feeder protective devices to the largest downstream device on all the feeder secondary distribution levels.
- .4 Provide a complete, comprehensive report at the conclusion of the short circuit, protection and coordination study consisting of the following:
  - .1 A set of time current curve characteristics of all protective devices in the system plotted on log/log graph paper with corresponding short circuit current levels.
  - .2 Time current damage curves for all transformers, large motors generator(s) and cables are also to be plotted.
  - .3 Provide a complete schedule of all main protective relays, fuses and other protective device listing device locations, function number, manufacturer, model number, size, range, setting, etc.

#### **1.11 Field Supervision and Workmanship**

- .1 Throughout the construction of the Project, a properly qualified Electrical Superintendent must be available at all times. The Superintendent who starts the work must not be changed unless requested by the Consultant, or by the Contractor with written permission from the Consultant.
- .2 In addition, provide proper office supervision of the work. The person responsible for office supervision must visit the site as often as necessary, to ensure work is properly performed, and attend meetings when so requested.
- .3 Submit resume of proposed supervision staff when called upon to do so by Consultant.
- .4 Workmanship throughout to conform with the highest standards applicable.

#### **1.12 Design Requirements**

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.
- .4 Use one nameplate or label for each language equipment.

#### **1.13 Submittals**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit for review single line electrical diagrams under plexiglass in glazed frames and locate as indicated.

- .1 Electrical distribution system in main electrical room.
- .3 Submit for review fire alarm riser diagram, plan and zoning of building under plexiglass in glazed frames at fire alarm control panel and annunciator.
- .4 Shop drawings:
  - .1 Submit Seven (7) copies of drawings stamped by the General Contractor, Architect, Distributor and Electrical contractor licensed in the Province of Ontario, Canada.
  - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
  - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
  - .4 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
  - .5 Submit number of copies of 600 x 600 mm minimum size drawings and product data to authority having jurisdiction inspection authorities.
  - .6 If changes are required, notify the Consultant of these changes before they are made.
- .5 Quality Control: in accordance with Section 01 45 00 - Quality Control.
  - .1 Provide CSA certified equipment and material.
  - .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction inspection authorities for special approval before delivery to site.
  - .3 Submit test results of installed electrical systems and instrumentation.
  - .4 Permits and fees: in accordance with General Conditions of contract.
  - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
  - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Consultant.

#### **1.14 Quality Assurance**

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Territorial Act respecting manpower vocational training and qualification.
  - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
  - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
- .3 Site Meetings:
  - .1 In accordance with Section 01 32 16.06 - Construction Progress Schedule - Critical Path Method (CPM) Section 01 32 16.07 - Construction Progress Schedule - Bar (GANTT) Charts.

- .2 Site Meetings: as part of Manufacturer's Field Services described in Part 3 - FIELD QUALITY CONTROL, in appropriate Section, schedule site visits, to review Work, at stages listed.
  - .1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.
  - .2 Twice during progress of Work at 25% and 60% complete.
  - .3 Upon completion of Work, after cleaning is carried out.
- .4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

### **1.15 Delivery, Storage and Handling**

- .1 Material Delivery Schedule: provide Consultants representative with schedule within 2 weeks after award of Contract.

### **1.16 System Start-up**

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

### **1.17 Operating Instructions**

- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .2 Operating instructions to include following:
  - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
  - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
  - .3 Safety precautions.
  - .4 Procedures to be followed in event of equipment failure.
  - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
- .4 Post instructions where directed.
- .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

**PART 2 Products**

**2.1 Materials and Equipment**

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from authority having jurisdiction inspection authorities before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .3 Factory assembles control panels and component assemblies.

**2.2 Electric Motors, Equipment and Controls**

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

**2.3 Warning Signs**

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction inspection authorities Borden representative.
- .2 Porcelain enamel decal signs, minimum size 175 x 250 mm.

**2.4 Wiring Terminations**

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

**2.5 Equipment Identification**

- .1 Identify electrical equipment with nameplates and labels as follows:
  - .1 Nameplates: plastic laminate lamacoid 3 mm thick plastic engraving sheet melamine, black matt white finish face, black white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
  - .2 Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters
- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Consultants representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.

- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO." as directed by Borden representative.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

**2.6 Wiring Identification**

- .1 Identify wiring with permanent indelible identifying markings, numbered 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 coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

**2.7 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

**2.8 Finishes**

- .1 All shop finished metal equipment and enclosure surfaces, must be prepared by removal of rust and scale from the raw metal, degreasing, cleaning, application of rust resistant primer inside and outside, and at least two coats of finish enamel paint. Use factory standard colours unless otherwise specified. Colour reference numbers are Sico.
- .2 Maintain colour scheme for various systems throughout the building.
- .3 Clean, prime and paint exposed equipment conduit hangers, racks, fasteners, to prevent rusting. Colour to be Black, 10684.
- .4 Paint outdoor electrical equipment Green 10131 Equipment Grey 10003 other to EEMAC Y1-2.
- .5 Paint interior surfaces of all L.V. switchboards white 11306.
- .6 Paint exterior surfaces of indoor electrical equipment to manufacturer's standard, unless otherwise shown in the following schedule:

and Transformer	gloss black 10684	
lemon yellow 10109		
white 11306		
600V Switchboard transformer	standard, light grey blue 10167	10003
Ancillary 600V switchboards and equipment	light blue 10503	
Ancillary 208V switchboards and equipment	green 10827	
All emergency equipment including generator(s), transfer switch(es), life safety equipment and panelboard(s) except main FACP	Fire Engine Red 10095 standard	
Telephone and data equipment cabinets and cable trays	yellow 10109	
Security equipment cabinets	orange 10101	
Audio-Visual/PA equipment cabinets and cable trays	black 10684	
- .7 Clean and touch-up (to Consultant's acceptance) surfaces of shop-finished equipment that is scratched or marred during shipment or installation, so as to match original paint.
- .8 Leave with the Owner, 1l. (0.22 gal.) of paint of each colour used, in the form of liquid or spray, to allow for future touch-up of damaged areas.

## **2.9 Fire Rating**

.1 All feeders for the systems listed below shall be MI cables:

Emergency Distribution System  
Life Safety (Fire Alarm) Systems  
Elevators  
Diesel Oil Pumps  
Fire Pumps/Sprinkler Pumps  
Emergency Motor Starters and MCC's  
Smoke Management Fans and Controls

## **2.10 Inserts, Hangers and Sleeves**

.1 Provide hangers, inserts, sleeves and supports as required.

.2 Inserts are to be of lead shield type.

.3 Hangers must not be welded to structural steel members and burning of holes in structural steel is prohibited.

.4 Sleeves in new construction are to be of a type suitable for the application, and be sealed and made watertight. Sleeves through concrete shall be sized for free passage of conduit, and installed flush with underside of concrete slab and extend 103mm (4") above finished floor unless otherwise shown. Provide 103mm (4") concrete base at all sleeve locations.

.5 Be responsible for the installation of sleeves in accordance with the Construction Schedule.

## **2.11 Intent**

.1 It is the intent of these drawings and specifications that the Contractor provides complete and operational systems as required.

.2 Where differences occur, the maximum condition shall govern.

.3 Any miscellaneous items, hardware, devices, wiring, etc., not specifically described, but required for the operation of the system, must be provided and included as part of the Bid.

**PART 3 Execution**

**3.1 Installation**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

**3.2 Nameplates and Labels**

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

**3.3 Conduit and Cable Installation**

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .1 Sleeves through concrete: schedule 40 steel pipe plastic sheet metal, 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 embedded or plastered over, close to building structure so furring can be kept to minimum.

**3.4 Location of Outlets**

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit 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.
  - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

**3.5 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: 1400 mm.
  - .2 Wall receptacles:
    - .1 General: 300 mm.

- .2 Above top of continuous baseboard heater: 200 mm.
- .3 Above top of counters or counter splash backs: 175 mm.
- .4 In mechanical rooms: 1400 mm.
- .3 Panelboards: as required by Code or as indicated.
- .4 Telephone and interphone outlets: 300 mm.
- .5 Wall mounted telephone and interphone outlets: 1500 mm.
- .6 Fire alarm stations: 1500 mm.
- .7 Fire alarm bells: 2100 mm.
- .8 Television outlets: 300 mm.
- .9 Wall mounted speakers: 2100 mm.
- .10 Clocks: 2100 mm.
- .11 Door bell pushbuttons: 1500 mm.

### 3.6 Field Quality Control

- .1 Load Balance:
  - .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 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
  - .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 communications.
  - .6 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.
- .3 Carry out tests in presence of Borden representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

**3.7 Cleaning**

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

**END OF SECTION**

**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-C22.2No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
  - .2          CSA C22.2No.65-93(R1999), 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          Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2          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.
- .3          Divert unused wiring materials from landfill to metal recycling facility as approved by Borden representative.

**PART 2 Products**

**2.1 Materials**

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

**PART 3 Execution**

**3.1 Installation**

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

**END OF SECTION**

**PART 1 General**

**1.1 Related Sections**

- .1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

**1.2 References**

- .1 CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 131-M89(R1994), 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 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .2 Fold up metal banding, flatten and place in designated area for recycling.

**PART 2 Products**

**2.1 Building Wires**

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper ACM alloy Aluminum conductors: size as indicated, with 600 1000 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90 RWU90.
- .3 Copper ACM alloy Aluminum conductors: size as indicated, with thermoplastic insulation type TWU TWH rated at 600 V.

**2.2 Teck Cable**

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Conductors:
  - .1 Grounding conductor: copper ACM alloy aluminum.
  - .2 Circuit conductors: copper ACM alloy aluminum, size as indicated.
- .3 Insulation:
  - .1 Type: ethylene propylene rubber.
  - .2 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 1000 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: flat interlocking galvanized steel aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride material.

- .7 Fastenings:
  - .1 One hole malleable iron steel aluminum zinc straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables at mm centers.
  - .3 Threaded rods: 6 mm dia. to support suspended channels.
- .8 Connectors:
  - .1 Watertight, explosion-proof approved for TECK cable.

### **2.3 Armoured Cables**

- .1 Conductors: insulated, copper aluminum, size as indicated.
- .2 Type: AC90 ACL90 - lead sheath over cable assembly and under armour.
- .3 Armour: interlocking type fabricated from galvanized steel aluminum strip.
- .4 Type: ACWU90 - PVC flame retardant jacket over thermoplastic armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No. 0.3 with maximum flame travel of 1.2 m.
- .5 Connectors: .

### **2.4 Aluminum Sheathed Cable**

- .1 Conductors: copper ACM alloy aluminum, size as indicated.
- .2 Insulation: typeRA90 rated 600 1000 V.
- .3 Sheath: aluminum applied to form continuous smooth corrugated seamless sheath.
- .4 Outer jacket of PVC applied over sheath for direct burial wet locations.
- .5 Fastenings for aluminum sheathed cable:
  - .1 One hole aluminum malleable iron steel straps to secure surface cables 25 mm and smaller. Two hole steel straps for cables larger than 25 mm. Use aluminum strap only with single conductor cable.
  - .2 Channel type supports for two or more cables at mm centers.
  - .3 Threaded rods: 6 mm dia. to support suspended channels.

## 2.5 Control Cables

- .1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of cotton braid thermoplastic jacket, and armour of closely wound aluminum wire.
- .2 Low energy 300 V control cable: solid stranded annealed copper conductors sized as indicated, with PVC insulation type TW TW -40EC TWH polyethylene insulation with shielding of tape coated with paramagnetic material tape coated with diamagnetic material wire braid metallized tapes over each conductor pair group over all conductors and overall covering of PVC jackets polyethylene jackets lead sheath aluminum sheath interlocked armour of flat galvanized steel aluminum strip copper strip.
- .3 600 V type: stranded annealed copper semi-annealed aluminum ACM alloy conductors, sizes as indicated with PVC insulation type TW TWH TW -40EC, butyl rubber insulation type RW75 R90, polyethylene insulation cross-linked polyethylene type RW75 (x-link) R90 (x-link) RW90 (x-link) ethylene-propylene rubber insulation type RW75 (EP) R90 (EP) RW90 (EP) with shielding of magnetic tape non-magnetic tape wire braid metallized tapes over each conductor each pair of conductors all conductors and overall covering of thermoplastic jacket thermosetting jackets with sheath of aluminum lead interlocked armour and jacket over sheath of PVC thermosetting compound.

## 2.6 Non-metallic Sheathed Cable

- .1 Non-metallic sheathed copper ACM alloy cable type: NMD-7 NMD-7 nylon NMW-9 NMW-10, size as indicated.

## PART 3 Execution

### 3.1 Installation Of Building Wires

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 16 .
  - .2 In cabletroughs in accordance with Section 16 .
  - .3 In underground ducts in accordance with Section 16 .
  - .4 In trenches in accordance with Section 16 .
  - .5 In underfloor distribution system in accordance with Section 16 .
  - .6 In cellular floor raceways in accordance with Section 16 .
  - .7 In surface and lighting fixture raceways in accordance with Section 16 .
  - .8 In wireways and auxiliary gutters in accordance with Section 16 .
  - .9 Overhead service conductors in accordance with Section 16 .

### 3.2 Installation Of Teck Cable 0 -1000 V

- .1 Install cables.
  - .1 Group cables wherever possible on channels.
- .2 Install cable in trenches in accordance with Section 16 .
- .3 Lay cable in cabletroughs in accordance with Section 16 .
- .4 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0 - 1000 V.

**3.3 Installation Of Armoured Cables**

- .1 Group cables wherever possible.
- .2 Install cable in trenches in accordance with Section 16 .
- .3 Lay cable in cabletroughs in accordance with Section 16 .
- .4 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

**3.4 Installation Of Aluminum Sheathed Cable**

- .1 Group cables wherever possible on channels.
  - .1 Install cable in trenches in accordance with Section 16 .
- .2 Lay cable in cabletroughs in accordance with Section 16 .
- .3 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0-1000 V.

**3.5 Installation Of Control Cables**

- .1 Install control cables in conduit under floor raceways cable troughs underground ducts by direct burial.
- .2 Ground control cable shield.

**3.6 Installation Of Non-metallic Sheathed Cable**

- .1 Install cables.
- .2 Install straps and box connectors to cables as required.

**END OF SECTION**

**PART 1        General**

**1.1            Section Includes**

- .1        Materials and installation for connectors and terminations.

**1.2            Related Sections**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 26 05 33 - Raceway and Boxes for Electrical Systems.

**1.3            References**

- .1        Canadian Standards Association (CSA International)
  - .1        CSA C22.2 No.,.
  - .2        CSA C22.2 No.41-M1987(R1999), Grounding and Bonding Equipment.

**1.4            Product Data**

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

**1.5            Waste Management And Disposal**

- .1        Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2        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.
- .3        Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Engineer Consultant.

**PART 2        Products**

**2.1            Connectors And Terminations**

- .1        Copper Aluminum long barrel short barrel compression connectors to CSA C22.2No. as required sized for conductors.
- .2        Contact aid for aluminum cables where applicable.

**PART 3      Execution**

**3.1          Installation**

- .1      Bond and ground as required to CSA C22.2No.41.

**END OF SECTION**

**PART 1            General**

**1.1                Related Sections**

- .1            Section 26 05 01 - Common Work Results - Electrical.

**1.2                References**

- .1            Canadian Standards Association, (CSA International)

**1.3                Waste Management And Disposal**

- .1            Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2            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.
- .3            Divert unused metal materials from landfill to metal recycling facility as approved by Engineer Consultant.
- .4            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 as required to electrically conductive underground water pipe.
- .2            Copper conductor: minimum 6 m long for each concrete encased electrode, bare, stranded, tinned, soft annealed, size as indicated.
- .3            Rod electrodes: galvanized steel copper clad steel stainless steel 19 mm dia by 3 m long.
- .4            Plate electrodes: galvanized steel iron copper, surface area 0.2 m<sup>2</sup>, 1.6 mm thick.
- .5            Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated.
- .6            Insulated grounding conductors: green, type .
- .7            Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .8            Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1            Grounding and bonding bushings.
  - .2            Protective type clamps.
  - .3            Bolted type conductor connectors.
  - .4            Thermal welded type conductor connectors.
  - .5            Bonding jumpers, straps.

- .6 Pressure wire connectors.
- .9 Grounding resistance bank: indoor outdoor, 3 phase, star connected, ohms, A, s rating, metallic liquid type, system voltage V.
- .10 Zig-zag grounding transformer: indoor outdoor, 3 phase, star connected, V, A, air cooled, iron core.

### **PART 3 Execution**

#### **3.1 Installation General**

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process 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 one ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Install separate ground conductor to outdoor lighting standards.
- .10 Install grounding resistance bank.
- .11 Install zig-zag grounding transformer on line side of main interrupter.
- .12 Connect building structural steel and metal siding to ground by welding copper to steel.
- .13 Make grounding connections in radial configuration only, with connections terminating at single grounding point street side of water pipe. Avoid loop connections.
- .14 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end and load end.
- .15 Ground secondary service pedestals.

#### **3.2 Electrodes**

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter.
- .2 Install water meter shunt.

- .3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
- .4 Install rod, plate electrodes and make grounding connections.
- .5 Bond separate, multiple electrodes together.
- .6 Use size 2/0 3/0 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 primary V system, secondary V system.

### **3.4 Equipment Grounding**

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

### **3.5 Grounding Bus**

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

### **3.6 Communication Systems**

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

### **3.7 Permafrost**

- .1 Bond non-current carrying metal parts together with size AWG copper equipotential conductor. Run conductor from separate lug or service neutral bar to, but not necessarily limited to, following indoor systems and equipment:
  - .1 Hot water heating system.
  - .2 Main water pipe.
  - .3 Main building drain.
  - .4 Oil line.
  - .5 Telephone, radio/tv, emergency and fire alarm lead-in or service conduits, near panels.
  - .6 Make connections to pipes on building side of main valves and tanks. Connect jumpers across boilers to supply and return hot water heating pipes.

- .2 Drive three -19 mm diam x 3 m copper clad ground rods at least 1.8 m apart in original undisturbed ground. If rods will not penetrate permafrost, drive at angle not more than 60o from vertical, and in same direction. Rods must be driven, not trenched.
- .3 Install ground wire from service neutral bar to rods and where buried use bare copper not smaller than size 1AWG7- strand or size 4AWG solid, and at least 460 mm below ground. Bond ground conductor, or short tap from it, to outside metal sheathing of building close to power service conduit. Use lug or cast clamp, with bronze or plated bolt, nut and washers (not sheet metal screw or wood screw). Remove paint from sheathing for good contact. Conduit is required only on outside wall of building. Indoors, run bare and fasten as specified for equipotential bonding wire.
- .4 Install electrode interconnections where metal parts, circuits or grounding conductors and/or electrodes are in proximity to lightning rod conductors.

### **3.8 Field Quality Control**

- .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 Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

**END OF SECTION**

**PART 1            General**

**1.1                Waste Management And Disposal**

- .1        Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2        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.
- .3        Divert unused metal materials from landfill to metal recycling facility as approved by Engineer Consultant.
- .4        Fold up metal banding, flatten and place in designated area for recycling.

**PART 2            Products**

**2.1                Support Channels**

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

**PART 3 Execution**

**3.1 Installation**

- .1 Secure equipment to hollow solid masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .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 malleable iron 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 m on centre spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Engineer Consultant.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

**END OF SECTION**

**PART 1            General**

**1.1                Shop Drawings And Product Data**

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

**1.2                Waste Management And Disposal**

- .1        Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .2        Fold up metal banding, flatten and place in designated area for recycling.

**PART 2           Products Splitters**

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

**2.2                Junction And Pull Boxes**

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

**2.3                Cabinets**

- .1        Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
- .2        Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing 19 mm G1S fir plywood sheet steel backboard for surface flush mounting.

**PART 3 Execution**

**3.1 Splitter Installation**

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

**3.2 Junction, Pull Boxes And Cabinets Installation**

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

**3.3 Identification**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Install size 2 identification labels indicating system name voltage and phase.

**END OF SECTION**

**PART 1        General**

**1.1            References**

- .1        CSA C22.1-1998, Canadian Electrical Code, Part 1.

**1.2            Waste Management And Disposal**

- .1        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.
- .2        Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .3        102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .4        102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster tile walls.

**2.3            Concrete Boxes**

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

**2.4            Conduit Boxes**

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

**2.5            Outlet Boxes For Non-metallic Sheathed Cable**

- .1        Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

**2.6 Fittings - General**

- .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.

**END OF SECTION**

**PART 1            General**

**1.1                Section Includes**

- .1        Materials and installation for cable splice and junction boxes.

**1.2                Related Sections**

- .1        Section 01 33 00 - Submittal Procedures.

**1.3                References**

- .1        Canadian Standards Association (CSA International)
  - .1        CSA C22.2No.40-M1989(R1999), Cutout, Junction and Pull Boxes.

**1.4                Product Data**

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

**1.5                Waste Management And Disposal**

- .1        Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2        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.
- .3        Divert unused metal and wiring materials from landfill to metal recycling facility as approved by the Consultant.
- .4        Fold up metal banding, flatten and place in designated area for recycling.

## **PART 2        Products**

### **2.1        Splice Boxes**

- .1 Splice boxes cast iron enclosures 6 mm thick painted with chromate primer and gray enamel to provide mechanical protection and moisture seal for direct buried cable splices rated 3 5 7.5 kV and consisting of:
  - .1 Two halves, split along cable axis, finely ground matching surfaces, fastened with silicon bronze galvanized steel bolts, top half with large filling holes with gasketed plugs for medium hard asphalt base compound, bottom half with screws on inside for bonding lead sheath armour, and box end openings sealed by:
    - .1 Wrapping cables with anhydrous tape and clamping to make snug fit, for 2 3 and 4 way splices.
    - .2 Fitting boxes with cable entrance fittings suitable for lead neoprene steel tape armour interlocking armour sheaths, for 2 3 and 4 way splices.
  - .2 Submarine splice boxes to provide mechanical protection and moisture seal for submarine cables to consist of:
    - .1 Cast iron split boxes with cast iron cones and split armour clamps painted with chromate primer and gray enamel with four bronze rods fastened rigidly to splice box and attached to armour clamps to relieve joint of longitudinal stress, designed to be filled with medium hard asphalt base compound, and rated 3 5 7.5 kV.
    - .2 Galvanized steel pipe with filling holes for medium hard asphalt base compound, gasketed plugs, with ends right hand and left hand threaded, cast steel end caps with wire armour clamps, to relieve conductors and splice from mechanical stresses.

### **2.2        Junction Boxes**

- .1 Cast iron octagonal box with joints ground smooth and sealed with gasket, painted with chromate primer and gray enamel fitted with contacts mounted on porcelain supports to which conductors are fastened by soldered-on lugs, air filled, suitable for 3 phase, 5 kV non-shielded cable up to 500 MCM, 2 3 ways, for direct burial.
- .2 Welded steel rectangular boxes, gasketed steel plate lid, fastened with silicon-bronze bolts, copper buses mounted on insulating supports, wiring sleeve stuffing box entrances, cable conductor lugs detachable from bus contacts at no voltage, rated 500 MCM maximum at 3 pole, 5 kV, 2 3 4 5 6 way, designed for wall mounting in manhole tunnel.
- .3 Welded steel rectangular boxes, painted with chromate primer and gray enamel, steel plate lids, galvanized forged steel C clamps, silicon-bronze screws, oil resistant gaskets, lined and phases partitioned with bakelite, copper strap buses plastic insulation enclosed mounted on porcelain supports, disconnecting links, insulated switch stick operated at no voltage, interchangeable unit cableheads compound filled, equipped with air valve, designed to operate at 14 kPa air pressure, rated 3 phase, 5 7.5 kV, 250 500 A with number of ways and sets of disconnecting links, for wall mounting in manholes tunnels.

**PART 3 Execution**

**3.1 Installation**

- .1 Install splice boxes at cable joint, on floor of trench. Tighten armour clamps and fill with compound.
- .2 Install submarine splice boxes at cable joints, tighten clamps and fill with compound before lowering cable to river lake sea bed.
- .3 Install junctions boxes on trench floor around cable splice to CSA C22.2No.40. Connect cable terminals to box contacts. Fasten lid securely and check for air leaks before trench is backfilled.
- .4 Install subway level steel boxes on wall of manholes tunnels. Connect cables to bus, install links, fasten lid and test for air leaks fill with compound.
- .5 Install distribution level steel boxes on walls of manholes tunnels. Splice main cable in box and connect branch feeder. Fasten cover and fill with compound.
- .6 Install power level boxes as follows:
  - .1 Cast iron type: on trench floor, connect cable terminals to box contacts, fasten lid and fill with compound before trench is backfilled.
  - .2 Steel type: mount on wall of manhole tunnel; connect cables to box terminals; install disconnect links, fasten lid securely fill with oil check for air leaks.

**END OF SECTION**

**PART 1        General**

**1.1            Related Sections**

- .1        Section 26 05 01 - Common Work Results - Electrical.

**1.2            References**

- .1        Canadian Standards Association (CSA International)
  - .1        CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
  - .2        CSA C22.2 No. 45-M1981(R2003), Rigid Metal Conduit.
  - .3        CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4        CSA C22.2 No. 83-M1985(R2003), Electrical Metallic Tubing.
  - .5        CSA C22.2 No. 211.2-M1984(R2003), Rigid PVC (Unplasticized) Conduit.
  - .6        CAN/CSA C22.2 No. 227.3-05, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

**1.3            Submittals**

- .1        Provide submittals in accordance with Section 01 33 00 - Submittal Procedures .
- .2        Product data: submit manufacturer's printed product literature, specifications and datasheets.
  - .1        Submit cable manufacturing data.
- .3        Quality assurance submittals:
  - .1        Test reports: submit certified test reports.
  - .2        Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .3        Instructions: submit manufacturer's installation instructions.

**1.4            Waste Management And Disposal**

- .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.

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**PART 2            Products**

**2.1                Cables And Reels**

- .1            Provide cables on reels or coils.
  - .1            Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2            Each coil or reel of cable to contain only one continuous cable without splices.
- .3            Identify cables for exclusively dc applications.
- .4            Reel and mark shielded cables rated 2,001 volts and above.

**2.2                Conduits**

- .1            Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel hot dipped galvanized steel aluminum threaded.
- .2            Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3            Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings with expanded ends.
- .4            Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .5            Flexible metal conduit: to CSA C22.2 No. 56, steel aluminum liquid-tight flexible metal.
- .6            FRE conduit: .
- .7            Flexible pvc conduit: to CAN/CSA-C22.2 No. 227.3 .

**2.3                Conduit Fastenings**

- .1            One hole malleable iron steel straps to secure surface conduits NPS 2 50 mm and smaller.
  - .1            Two hole steel straps for conduits larger than NPS 2 50 mm.
- .2            Beam clamps to secure conduits to exposed steel work.
- .3            Channel type supports for two or more conduits at m on centre.
- .4            Threaded rods, 6 mm diameter, to support suspended channels.

**2.4                Conduit Fittings**

- .1            Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2            Ensure factory "ells" where 90 degrees bends for NPS 1 25 mm and larger conduits.

**2.5                Expansion Fittings For Rigid Conduit**

- .1            Weatherproof expansion fittings with internal bonding assembly suitable for 100 200 mm linear expansion.

- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

**2.6 Fish Cord**

- .1 Polypropylene .

**PART 3 Execution**

**3.1 Manufacturer's Instructions**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

**3.2 Installation**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms in unfinished areas.
- .3 Surface mount conduits except .
- .4 Use epoxy coated conduit underground in corrosive areas.
- .5 Use electrical metallic tubing (EMT) except in cast concrete above 2.4 m not subject to mechanical injury.
- .6 Use rigid pvc conduit underground in corrosive areas.
- .7 Use flexible metal conduit for connection to motors in dry areas connection to recessed incandescent fixtures without prewired outlet box connection to surface or recessed fluorescent fixtures work in movable metal partitions.
- .8 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations .
- .9 Use explosion proof flexible connection for connection to explosion proof motors.
- .10 Install conduit sealing fittings in hazardous areas.
  - .1 Fill with compound.
- .11 Minimum conduit size for lighting and power circuits: NPS 3/4 19 mm.
- .12 Install rigid metal EMT conduit from computer room branch circuit panel to outlet boxes located in sub floor.
- .13 Install rigid metal EMT conduit from computer room branch circuit panel to junction box in sub-floor immediately below panel.
  - .1 Run flexible conduit from junction box to outlet boxes for each computer in sub-floor.
- .14 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .15 Mechanically bend steel conduit over 19 mm diameter.
- .16 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .17 Install fish cord in empty conduits.

- .18 Run 2-NPS 1 25 mm spare conduits up to ceiling space and 2-NPS 1 25 mm spare conduits down to ceiling space from each flush panel.
  - .1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in flush concrete surface type box.
- .19 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .20 Dry conduits out before installing wire.

### **3.3 Surface Conduits**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended 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.

### **3.4 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.

### **3.5 Conduits In Cast-in-place Concrete**

- .1 Locate to suit reinforcing steel.
  - .1 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.
  - .1 Use cold mastic between sleeve and conduit.
- .5 Conduits in slabs: minimum slab thickness 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.

**3.6 Conduits Underground**

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

**3.7 Cleaning**

- .1 Proceed in accordance with Section 01 74 11 - Cleaning .
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1**

**General**

**1.1 SECTION INCLUDES**

- .1 Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .3 Section 26 05 01 - Common Work Results - Electrical.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C9-[M1981(R2001)], Dry-Type Transformers.
- .2 National Electrical Manufacturers Association (NEMA)

**1.4 PRODUCT DATA**

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

**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 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 Divert unused wiring materials from landfill to metal recycling facility as approved by the Consultant.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

**Part 2 Products**

**2.1 TRANSFORMERS**

- .1 Use transformers of one manufacturer throughout project and in accordance with CAN/CSA-C22.2No.47 and CSA-802.
- .2 Design.
  - .1 Type: ANN.
  - .2 Three (3) phase, kVA, Volt input, Volt output, 60 Hz as indicated.
  - .3 Voltage taps: Four (4) 2-1/2%, 2 FCAN and 2 FCBN.
  - .4 Insulation: Class: 150 degrees C temperature rise.
  - .5 Basic Impulse Level (BIL): Standard.
  - .6 Hipot: standard.
  - .7 Design K Factor: 13
  - .8 Average sound level: 44db ( up to 45kva) 50db (75kva to 150kva) 55db (150kva and higher)
  - .9 Impedance at 170 degrees C: 5%.
  - .10 Enclosure: EEMAC 1 Sprinklerproof construction and removable metal front panel.
  - .11 Mounting: floor ceiling mounted as indicated.
  - .12 Finish: in accordance with Section 26 05 01 - Common Work Results - Electrical.
  - .13 To be wired Delta-Wye, unless otherwise noted. T-T connected winding taps are not acceptable.
  - .14 Windings: Copper.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Label size: 7.
- .3 Nameplate wording: As indicated in Transformer Schedule.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1        Mount dry type transformers up to 75 kVA as indicated.
- .2        Mount dry type transformers above 75 kVA on floor.
- .3        Ensure adequate clearance around transformer for ventilation.
- .4        Install transformers in level upright position.
- .5        Remove shipping supports only after transformer is installed and just before putting into service.
- .6        Loosen isolation pad bolts until no compression is visible.
- .7        Make primary and secondary connections in accordance with wiring diagram.
- .8        Energize transformers after installation is complete.

**END OF SECTION**

**PART 1      General**

**1.1            Section Includes**

- .1      Materials and installation for service entrance board.

**1.2            Related Sections**

- .1      Section 01 33 00 - Submittal Procedures.
- .2      Section 01 78 00 - Closeout Submittals.
- .3      Section 26 05 01 - Common Work Results - Electrical.

**1.3            References**

- .1      CAN/CSA-C22.2 No.31-M89(R2000), Switchgear Assemblies.

**1.4            Shop Drawings And Product Data**

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

**1.5            Quality Assurance**

- .1      Submit copies of certified test results.

**1.6            Closeout Submittals**

- .1      Provide maintenance data for service entrance board for incorporation into manual specified in Section 01 78 00 - Closeout Submittals .
- .2      Submit copies maintenance data for complete assembly including components.

**1.7            Waste Management And Disposal**

- .1      Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2      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.
- .3      Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Borden Representative.

**1.8 Extra Materials**

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals
- .2 Include:
  - .1 3 fuses for each type above 600A.
  - .2 6 fuses for each type up to and including 600A.

**PART 2 Products**

**2.1 Service Entrance Board**

- .1 Service Entrance Board: to CAN/CSA-C22.2 No.31.
- .2 Rating: **600A@347/600V, 3phase, 4wire**, A, short circuit current 50kA (rms symmetrical). 100% rated unless otherwise noted.
- .3 Cubicles: wall-mounted, free standing, dead front, size as indicated.
- .4 Barrier metering section from adjoining sections.
- .5 Provision for installation of power supply authority metering in barriered section.
- .6 Surge Suppression, Ground Fault.
- .7 Distribution section.
- .8 Hinged access panels with captive knurled thumb screws.
- .9 Bus bars and main connections: 99.3% copper aluminum .
- .10 Bus from load terminals of main breaker disconnect switch via metering section to main lugs of distribution section.
- .11 Cable from load terminals of main breaker disconnect switch to metering section and cable bus from metering section to lugs of distribution section.
- .12 Identify phases with colour coding.

**2.2 Breakers/Trip Settings**

- .1 As indicated.

**2.3 Grounding**

- .1 Copper ground bus extending full width of cubicles and located at bottom.
- .2 Lugs at each end for size grounding cable.

**2.4 Power Supply Authority Metering**

- .1 Separate cubicle compartment and metal raceway for exclusive use of power supply authority metering.

- .2 Mounting accessories and wiring for metering supplied by power supply authority :
  - .1 potential transformers.
  - .2 current transformers.
  - .3 Watthour meter.
  - .4 Demand meter with kW.h register .

## **2.5 Finishes**

- .1 Apply finishes in accordance with Section 26 05 01 - Common Work Results - Electrical .
  - .1 Service entrance board exterior: gray .

## **2.6 Equipment Identification**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical .
- .2 Nameplates:
  - .1 White plate, black letters, size7 .
  - .2 Complete board labelled: "120/208 600V."
  - .3 Main disconnect labelled: "Main Breaker Switch".
  - .4 Branch disconnects labelled: "Feeder No1", "Feeder No.2", "Feeder No.3", as indicated .

## **2.7 Source Quality Control**

- .1 Departmental Representative Consultant to witness final factory tests.
- .2 Notify Departmental Representative Consultant in writing 5 days in advance that service entrance board is ready for testing.

**PART 3 Execution**

**3.1 Installation**

- .1 Locate service entrance board and fasten to wall .
- .2 Connect main secondary service to line terminals of main breaker disconnect switch .
- .3 Connect load terminals of distribution breaker's switches to feeders.
- .4 Check factory made connections for mechanical security and electrical continuity.
- .5 Run one grounding conductor 4/0 AWG bare copper in 1" 25 mm conduit from ground bus to building ground .
- .6 Check trip unit settings and fuse sizes against co-ordination study to ensure proper working and protection of components.

**END OF SECTION**

**PART 1          General**

**1.1              Section Includes**

- .1          Materials and installation for standard and custom breaker type panelboards.

**1.2              Related Sections**

- .1          Section 01 33 00 - Submittal Procedures.

**1.3              References**

- .1          Canadian Standards Association (CSA International)
  - .1          CSA C22.2No.29-M1989(R2000), Panelboards and enclosed Panelboards.

**1.4              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.

**1.5              Waste Management and Disposal**

- .1          Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .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          Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Owner's representative or General Contractor.

**PART 2          Products**

**2.1              Panelboards**

- .1          Panelboards: to CSA C22.2No.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 V panelboards: bus and breakers rated for A (symmetrical) interrupting capacity or 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 Aluminum 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 air dried grey enamel as per colour schedule.

## **2.2 Custom Built Panelboard Assemblies**

- .1 125 mm relay section on one both sides of panels as indicated for installation of low voltage remote control switching components.
- .2 Double stack panels as indicated.
- .3 Contactors in mains as indicated.
- .4 Feed through lugs as indicated.
- .5 Isolated ground bus.

## **2.3 Breakers**

- .1 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .2 Main breaker: mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .3 Lock-on devices for receptacles, fire alarm clock outlet, emergency, door supervisory, intercom, stairway, exit and night light circuits.

## **2.4 Equipment Identification**

- .1 Nameplate for each panelboard size 4 engraved as indicated .
- .2 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated .
- .3 Complete circuit directory with typewritten legend showing location and load of each circuit.

**PART 3      Execution**

**3.1          Installation**

- .1      Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2      Connect loads to circuits.
- .3      Connect neutral conductors to common neutral bus with respective neutral identified .

**END OF SECTION**

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Materials and installation for fuse and switch type panelboards.

**1.2 RELATED SECTIONS**

- .1 Section 01 35 30 - Health and Safety Requirements.
- .2 Section 02 61 33 - Hazardous Materials.
- .3 Section 06 10 10 - Rough Carpentry: Plywood Backboard.
- .4 Section 26 05 01 - Common Work Results - Electrical..
- .5 Section 26 28 14 - Fuses - Low-Voltage.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA C22.2 No.29-[M1989 (R2000)], Panelboards and Enclosed Panelboards.
- .2 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .4 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

**1.4 SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and include electrical detail and dimensions of panel, branch switch type, fuse types, ampacity and quantity.
- .3 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 61 33 - Hazardous Materials.

**1.5 HEALTH AND SAFETY**

- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

**1.6 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for 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.
- .3 Collect and separate for disposal packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
- .4 Place materials defined as hazardous or toxic waste in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with Regional and Municipal regulations.
- .6 Ensure emptied containers are sealed, labelled and stored safely for disposal away from children.

**Part 2 Products**

**2.1 PLANT ASSEMBLY**

- .1 Assemble panelboard interior before shipment. Ship fuses loose for on site installation.
- .2 In addition to CSA requirements, manufacturer's nameplates must show fault current that panelboard has been built to withstand.

**2.2 CONSTRUCTION FEATURES**

- .1 Fuse and switch type panelboards: to CSA C22.2 No.29.
- .2 Panelboards: product of one manufacturer.
- .3 Sequence phase bussing with odd numbered sections on left and even on right, with each section identified by permanent number identification as to circuit number and phase.
- .4 Panelboards with mains, number of circuits, and number and size of branch sections as indicated.
- .5 Two keys for each panelboard and key panelboards alike.
- .6 Copper bus with neutral of same ampere rating as mains.
- .7 Suitable for bolt-on fusible sections.
- .8 Trim and door finish: as per colour schedule.
- .9 Fusible pull-outs or door-operated type switches not acceptable.
- .10 Fuse clips: suitable for type of fuses specified for each unit.
- .11 Fuses: in accordance with Section 26 28 14 - Fuses - Low Voltage and sizes as indicated.

**2.3 CUSTOM BUILT PANELBOARD ASSEMBLIES**

- .1 Double stack panels as indicated.
- .2 Contactors in mains as indicated.
- .3 Feed through lugs as indicated.

**2.4 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Nameplate for each panel size 4 engraved "Panel ".
- .3 Nameplate for each circuit in distribution panels size 2 engraved "name of load" as indicated.

- .4 Complete circuit directory with typewritten legend showing location and load of each circuit. Install circuit directory under plastic protective cover on front of panel.

**Part 3 Execution**

**3.1 INSTALLATION GENERAL**

- .1 Locate panelboards as indicated and mount securely, plumb, and square, to adjoining surfaces.
- .2 Install surface-mounted panelboards on plywood backboards [in accordance with Section 06 10 10 - Rough Carpentry. Where practical group panelboards on common backboard.
- .3 Mount panels to height [specified in Section 26 05 01 - Common Work Results – Electrical as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus.

**END OF SECTION**

**PART 1 General**

**1.1 Section Includes**

- .1 Switches, receptacles, wiring devices, cover plates and their installation.

**1.2 Related Sections**

- .1 Section 01 33 00 - Submittal Procedures.

**1.3 References**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA-C22.2 No.42-99(R2002), General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2 CSA-C22.2 No.42.1-00, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  - .3 CSA-C22.2 No.55-M1986(July 2001), Special Use Switches.
  - .4 CSA-C22.2 No.111-00, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

**1.4 Shop Drawings And Product Data**

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

**1.5 Waste Management and Disposal**

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .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.
- .1 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Borden Representative.

**PART 2 Products**

**2.1 Switches**

- .1 15 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. 10 AWG wire.
  - .2 Silver alloy contacts.
  - .3 Urea or melamine moulding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 Ivory brown toggle.

- .3 Toggle operated locking 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.
- .5 Acceptable materials: .Hubbell, Leviton, P&S

## **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. 10 AWG for back and side wiring.
  - .3 Break-off links for use as split receptacles.
  - .4 Eight back wired entrances, four side wiring screws.
  - .5 Triple wipe contacts and rivetted grounding contacts.
- .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. 10 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 Coverplates for wiring devices to: CSA-C22.2 No.42.1.
- .2 Coverplates from one manufacturer throughout project.
- .3 Ivory Coverplates throughout unless otherwise indicated.
- .4 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in Utility Rooms and Storage Rooms.
- .5 Sheet metal 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 as indicated.

.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 as indicated.

.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.

**END OF SECTION**

**PART 1**      **GENERAL**

**1.1**            **RELATED SECTIONS**

- .1      Section 01 78 00 – Closeout Submittals.
- .2      Section 01 91 13 – General Commissioning (Cx) Requirements.
- .3      Section 26 05 00 – Common Work Results - Electrical.

**1.2**            **REFERENCES**

- .1      Codes and standards referenced in this section refer to the latest edition thereof.
- .2      Canadian Standards Association (CSA)
  - .1      CSA C22.2No.248.12 , Low Voltage Fuses Part 12: Class R (Bi-National Standard with, UL 248-12 (1st Edition).

**1.3**            **SUBMITTALS**

- .1      Submit fuse performance data characteristics for each fuse type and size above 600 A. Performance data to include: average melting time-current characteristics.

**1.4**            **DELIVERY AND STORAGE**

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

**1.5**            **MAINTENANCE MATERIALS**

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

**PART 2**      **PRODUCTS**

**2.1**            **FUSES GENERAL**

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

**2.2**            **FUSE TYPES**

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

**2.3**            **FUSE STORAGE CABINET**

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

**PART 3**      **EXECUTION**

**3.1**            **INSTALLATION**

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

**END OF SECTION**

**Part 1            General**

**1.1            SECTION INCLUDES**

- .1        Equipment and installation for ground fault circuit interrupters (GFCI).

**1.2            RELATED SECTIONS**

- .1        Section [01 29 83 - Payment Procedures: testing Laboratory Services].
- .2        Section [01 33 00 - Submittal Procedures].
- .3        Section [01 74 19 - Construction/Demolition Waste Management And Disposal].
- .4        Section [01 45 00 - Quality Control].
- .5        Section [26 05 01 - Common Work Results - Electrical].

**1.3            PAYMENT PROCEDURES**

- .1        Payment for field testing of ground fault equipment performed by [Contractor] [independent testing laboratory] [equipment manufacturer] in accordance with Section [01 29 83 - Payment Procedures: Testing Laboratory Services].

**1.4            REFERENCES**

- .1        Canadian Standards Association (CSA International)
  - .1        CAN/CSA-C22.2 No.144-[M91(R2001)], Ground Fault Circuit Interrupters.
- .2        National Electrical Manufacturers Association (NEMA)
  - .1        NEMA PG 2.2-[1999], Application Guide for Ground Fault Protection Devices for Equipment.

**1.5            SUBMITTALS**

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

**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        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 Divert unused metal and wiring materials from landfill to metal recycling facility approved by [Engineer] [Consultant].
- .5 Fold up metal banding, flatten and place in designated area for recycling.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Equipment and components for ground fault circuit interrupters (GFCI): to [CAN/CSA-C22.2 No.144] [NEMA PG 2.2].
- .2 Components comprising ground fault protective system to be of same manufacturer.

### **2.2 BREAKER TYPE GROUND FAULT INTERRUPTER**

- .1 [Single] [Two] pole ground fault circuit interrupter for [\_\_\_] A, [\_\_\_] V, 1 phase circuit c/w test and reset facilities.

### **2.3 GROUND FAULT LIFE PROTECTOR**

- .1 [\_\_\_] A, [2] pole circuit breaker to supply power to mains of [\_\_\_] A, [\_\_\_] V, [\_\_\_] phase panel and complete with:
  - .1 Automatic shunt trip breaker.
  - .2 Zero sequence current sensor.
  - .3 Facilities for testing and reset.
  - .4 CSA Enclosure [1] [3], surface mounted.
  - .5 Ground fault trip indicator light.

### **2.4 ROUND FAULT PROTECTOR UNIT**

- .1 Self-contained with 15 A, 120 V circuit interrupter and [duplex] [single] receptacle complete with:
  - .1 Solid state ground sensing device.
  - .2 Facility for testing and reset.
  - .3 CSA Enclosure [1], [surface] [flush] mounted with [stainless steel] [painted] [\_\_\_] face plate.

### **2.5 SYSTEM GROUND FAULT PROTECTION PANEL**

- .1 Self-contained panel suitable for [\_\_\_] V, [\_\_\_] phase, [\_\_\_] wire, [grounded] [ungrounded] supply. Panel to have following features:
  - .1 [Non] [\_\_\_] automatic [100] [225] A breaker with shunt trip.
  - .2 Ground fault relay factory set at [10] [20] [35] [50] mA with inverse time delay characteristics from pick-up 1 s to 0.025 s.
  - .3 Zero sequence current sensor.
  - .4 Provision for testing and reset.
  - .5 CSA Enclosure 1, [surface] [flush] [\_\_\_] mounted.
  - .6 Ground fault trip indicating light.

- .7 Resistor type fused artificial neutral.

## **2.6 PUMP PROTECTION PANEL**

- .1 Ground fault personnel protection panel for pump circuits rated for [[20 hp] [35 hp] [15 kW] [26 kW] at 208 V] [[50 hp] [90 hp] [37 kW] [67 kW] at 600 V], 3 phase [grounded] [ungrounded] [\_\_\_] supply with following features:
  - .1 Test button, ground indicator light, reset button.
  - .2 Line and load terminal blocks and control terminal block for wiring to starter control.
  - .3 Unit sensitivity: [10] [20] [35] [\_\_\_] mA.
  - .4 CSA Enclosure 1, surface mounted.
  - .5 Contact rating: 5 A, 120 V, 60 Hz.
  - .6 Fused resistive type artificial neutral.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Do not ground neutral on load side of ground fault relay.
- .2 Pass phase conductors [including neutral] [\_\_\_]through zero sequence transformers.
- .3 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section [26 05 01 - Common Work Results - Electrical] [and co-ordinate with Section [01 45 00 - Quality Control] [\_\_\_] if required].
- .2 Arrange for field testing of ground fault equipment by [independent testing laboratory] [ground fault equipment manufacturer] [Contractor] [\_\_\_]before commissioning service.
- .3 Demonstrate simulated ground fault tests.

**END OF SECTION**

**PART 1 General**

**1.1 References**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA-C22.2 No. 5-02, 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).

**1.2 Submittals**

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

**1.3 Waste Management And Disposal**

- .1 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.
- .2 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.

**PART 2 Products**

**2.1 Breakers General**

- .1 Moulded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters, Fused circuit breakers, and Accessory high-fault protectors: to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient .
- .3 Plug-in moulded case circuit breakers: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient .
- .4 Common-trip breakers: with single handle for multi-pole applications.
- .5 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.
- .6 Circuit breakers with interchangeable trips as indicated .
- .7 Circuit breakers to have minimum symmetrical rms interrupting capacity rating.

**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.

**2.4 Current Limiting And Series Rated Thermal Magnetic Breakers Design C**

- .1 Thermal magnetic breakers with current limiters.
  - .1 Time current limiting characteristics of fuses limiters coordinated with time current tripping characteristics of circuit breaker.
  - .2 Co-ordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker.
- .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.

**2.5 Solid State Trip Breakers Design D**

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

**2.6 Optional Features**

- .1 Include:
  - .1 Shunt trip.
  - .2 Auxiliary switch.
  - .3 Motor-operated mechanism c/w time delay unit .
  - .4 Under-voltage release.
  - .5 On-off locking device.
  - .6 Handle mechanism.

**2.7 Enclosure**

- .1 .

**PART 3 Execution**

**3.1 Installation**

- .1 Install circuit breakers as indicated .

**END OF SECTION**

**PART 1        General**

**1.1            References**

- .1 Canadian Standards Association (CSA International).
  - .1 CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.
  - .2 CSA C22.2 No.39-M89 (R2003), Fuseholder Assemblies.

**1.2            Submittals**

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

**PART 2        Products**

**2.1            Disconnect Switches**

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

**2.2            Equipment Identification**

- .1 Indicate name of load controlled on size 4 nameplate.

**PART 3        Execution**

**3.1            Installation**

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

**END OF SECTION**

**PART 1      General**

**1.1      Related Sections**

- .1      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      Extra Materials**

- .1      Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2      Provide listed spare parts for each different size and type of starter:
  - .1      3 contacts, stationary.
  - .2      3 contacts, movable.
  - .3      1 contacts, auxiliary.
  - .4      1 control transformers.
  - .5      1 operating coil.
  - .6      2 fuses.
  - .7      10% indicating lamp bulbs used.

**1.6      Waste Management And Disposal**

- .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.

## **PART 2 Products**

### **2.1 Materials**

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

### **2.2 Manual Motor Starters**

- .1 Single 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 Three overload heater s, manual reset, trip indicating handle.
- .2 Accessories:
  - .1 Toggle Key switch pushbutton: standard heavy duty oil tight labelled as indicated.
  - .2 Indicating light: standard heavy duty oil tight type and colour as indicated.
  - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

### **2.3 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 motor circuit interrupter circuit breaker with operating lever on outside of enclosure to control disconnect motor circuit interrupter circuit breaker, and provision for:
  - .1 Locking in "OFF" position with up to 3 padlocks.
  - .2 Independent locking of enclosure door.
  - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
  - .1 Pushbuttons Selector switches: standard heavy duty oil tight labelled as indicated.
  - .2 Indicating lights: standard heavy duty oil tight type and color as indicated.
  - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

### **2.4 Full Voltage Reversing Magnetic Starters**

- .1 Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
  - .1 Two - 3 pole magnetic contactors mounted on common base.
  - .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
  - .3 Three overload relays with heater elements, manual automatic reset.
- .2 Accessories:

- .1 Pushbuttons 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.

## **2.5 Multi-speed Starters**

- .1 2 speed starters of size, type, rating and enclosure type as indicated. Starter suitable for constant torque variable torque constant kW type motor and with components as follows:
  - .1 One-3 pole contactor for each winding for separate winding motors.
  - .2 One-3 pole and one-5 pole contactor for each reconnectable winding for consequent pole type motors.
  - .3 Three overload relays with 3 heater elements and manual reset for each speed.
- .2 Accessories:
  - .1 Pushbuttons 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.
  - .4 Low speed compelling relay automatic sequence accelerating decelerating relays for each speed.

## **2.6 Magnetic Starter, Reduced Voltage, Auto-transformer**

- .1 Auto-transformer starter closed circuit transition type, of size, type, rating and enclosure type as indicated and with following components:
  - .1 Three-3 pole contactors.
  - .2 Auto-transformer with 50%, 65% and 80% 65% and 85% taps.
  - .3 One adjustable pneumatic timing relay.
  - .4 One-3 pole manual reset overload device.
  - .5 Thermal overload protection of auto-transformers.
- .2 Accessories:
  - .1 Pushbuttons 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.

## **2.7 Magnetic Starter Reduced Voltage Star-delta**

- .1 Reduced voltage star-delta open transition starter, of size, type, rating and enclosure type as indicated, with components as follows:
  - .1 Two-3 pole delta contactors with auxiliary relays and interlocks.
  - .2 One-3 pole star contactor with auxiliary relays and interlocks.
  - .3 Mechanical interlock to interlock one delta contactor and the star contactor.
  - .4 One timing relay.
  - .5 Three pole manual automatic reset overload relays.
- .2 Reduced voltage star-delta closed transition starter, of size, type, rating and enclosure type as indicated, with components as follows:
  - .1 Two-3 pole delta contactors with auxiliary relays and interlocks.

- .2 One-3 pole star contactor with auxiliary relay and interlocks.
  - .3 One-3 pole transition contactor.
  - .4 One set of transition resistors.
  - .5 Mechanical interlock, to interlock one delta contactor and the star contactor.
  - .6 One timing relay.
  - .7 Three pole manual automatic reset overload relays.
- .3 Accessories:
- .1 Pushbuttons 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.

## **2.8 Magnetic Starter Reduced Voltage Part Winding**

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

## **2.9 Three Phase Manual Reversing Starter**

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

## **2.10 Three Phase Manual Two Speed Separate Winding Starters**

- .1 Three phase manual two speed separate winding starters of size, type, rating and enclosure type as indicated with components as follows:
- .1 Two-3 pole manual motor starters, quick make and break.

- .2 Six overload relays and manual reset.
- .3 Mechanical interlock to prevent both switches from closing at same time.

.2 Accessories:

- .1 Pushbuttons Selector switches: standard heavy duty oil tight labelled as indicated.
- .2 Indicating lights: standard heavy duty oil tight type and colour as indicated.

**2.11 Dc Full Voltage Non-reversing Starters**

- .1 dc full voltage non-reversing starters of size, type, rating and enclosure type as indicated, with components as follows:

- .1 Contactor: single two pole solenoid operated type.
- .2 Indirectly-heated, manual reset thermal overload relay.

.2 Accessories:

- .1 Pushbuttons: standard heavy duty oil tight labelled as indicated.
- .2 Selector switches: standard heavy duty oil tight labelled as indicated.
- .3 Indicating lights: standard heavy duty oil tight type and colour as indicated.

**2.12 Dc Full Voltage Reversing Starters**

- .1 dc full voltage reversing starter of size, type, rating and enclosure type as indicated, with components as follows:

- .1 Two contactors: single two pole solenoid operated type, mechanically and electrically interlocked.
- .2 Indirectly-heated, manual reset thermal overload relay.

.2 Accessories:

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

**2.13 Control Transformer**

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

**2.14 Finishes**

- .1 Apply finishes to enclosure in accordance with Section 26 05 01 - Common Work Results - Electrical.

**2.15 Equipment Identification**

- .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.

**PART 3 Execution**

**3.1 Installation**

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

**3.2 Field Quality Control**

- .1 Perform tests in accordance with Section 26 05 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.

**END OF SECTION**

Part 1 – GENERAL

1.1 DESCRIPTION OF SYSTEM

- (a) The plant shall be in accordance with applicable DEMA, IEEE, NEMA, ANSI standards and ISO-3046, ISO-8528 and IEC-34-1.
- (b) Standby plant shall be the responsibility of one manufacturer.
- (c) Prior to installation of standby power plant, obtain approval of all authorities having jurisdiction.
- (d) Generator set consists of:
  - (i) Gas Engine.
  - (ii) Alternator.
  - (iii) Alternator control panel.
  - (iv) Battery charger and battery.
  - (v) Automatic engine ventilation system.
  - (vi) Exhaust system.
  - (vii) Structural steel mounting base.
- (e) The set shall be designed to operate as emergency standby source in remote location for electrical lighting, motors, fans, and miscellaneous loads. It shall be capable of running continuously in standby mode each time in use.
- (f) Indoor type enclosure.

1.2 SHOP DRAWINGS

- (a) Include:
  - (i) Engine: make and model, with performance curves, and British standard or DIN rating.
  - (ii) Alternator: make and model.
  - (iii) Voltage regulator: make, model and type.
  - (iv) Battery: make, type and capacity.
  - (v) Battery charger: make, type and model.
  - (vi) Alternator control panel: make and type of meters and controls.
- (b) Governor type, model and full load efficiency.
- (c) Cooling air and combustion air requirements in lps (cfm).
- (d) Provide a dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, and total weight.
- (e) Dimensions and structural specifications of engine-generator foundation.
- (g) Continuous full load output of set at 0.8, .9 and .95 lagging, and unity power factors.

- (h) Description of system operation including:
  - (i) Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
  - (ii) Manual starting method.
  - (iii) Automatic shut down confirmation on:
    - (iv) Over cranking.
    - (v) Overspeed.
    - (vi) High engine temperature.
    - (vii) Low lube oil pressure.
    - (viii) Air damper malfunction.
    - (ix) Alternator overvoltage/under frequency.
    - (x) High temperature lube oil.
    - (xi) Manual remote emergency stop method.

### 1.3 OPERATION AND MAINTENANCE DATA

- (a) Provide above data for incorporation into Operation and Maintenance manual as specified.
- (b) Include instructions for particular unit supplied and not general description of units manufactured by supplier.
- (c) Include operation and maintenance instructions for engine alternator, and accessories, and the following technical data:
  - (i) Illustrated parts list with parts catalogue numbers.
  - (ii) Schematic diagram of electrical controls.
  - (iii) Flow diagrams for fuel system, lubricating oil and cooling system.
  - (iv) Certified copy of factory test results.

### 1.4 WARRANTY

- (a) Two Year Standby (ISO 8528-1: ESP) Generator Set Warranty The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor. Submittals received without written warranties as specified will be rejected in their entirety.

## Part 2 – PRODUCTS

### 2.1 PARTS AND SERVICE QUALIFICATIONS

- (a) The engine-generator supplier shall maintain 24-hour parts and service capability within 100 miles of the project site. The distributor shall stock parts as needed to support the generator set package for this specific project. The supplier must carry sufficient inventory to cover no less than 80% parts service within 24hrs and 95% within 48 hours.
- (b) Service Personnel
- (c) The dealer shall maintain qualified factory trained service personnel.

### 2.2 PRODUCT SUPPORT

- (a) Preventive Maintenance Agreement
- (b) The authorized generator dealer shall provide a preventive maintenance agreement using qualified factory trained service personnel, for a period of 1-year minimum. The dealer shall provide genuine Caterpillar parts and filters, shall provide all recommended fluids, dealer labor, travel labor and travel mileage to complete the suggested preventive maintenance as defined in the manufacturer's Operation and Maintenance Manual.
- (c) Standby Generator Set Extended Service Coverage
- (d) Extended Service Coverage shall be provided for a period of 5 or 10 years, and shall include no deductible. Extended Service Coverage provides for 100 percent of usual and customary parts and labor costs for failures due to defects in materials and workmanship to the "as shipped consist" from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches. Platinum Extended Service Coverage provides for a rental power unit due to unscheduled failures causing unexpected downtime to the customer in excess of 48 hours from the time of diagnoses. All repairs will be performed by factory trained dealer service personnel, and allows for repairer travel and mileage for all repairs up to 8 hours and 320 miles per incident.

### 2.3 GAS ENGINE

- (a) The engine shall be manufactured to ISO 3046:
- (b) It shall be the standard product of current manufacture.
- (c) It shall be four cycle, naturally aspirated with a synchronous speed of 1800 r/min.
- (d) Its capacity shall be based on:
- (e) The required continuous rated power in kW after adjustment for power losses in auxiliary equipment necessary for engine operation, calculated under following site conditions:
- (f) Altitude:  
Ambient temperature: 105 deg. F.  
  
Relative humidity: 60% as follows:  
Rated continuous output =  $\frac{\text{Generator kW}}{\text{Generator Efficiency at Full Load}}$
- (g) That Brake Mean Effective Pressure (BMEP) required to prevent engine malfunction or manual adjustment, necessary to maintain the continuous rated output with the voltage and frequency responses as defined, under the specified testing requirements.
- (h) Cooling System:
- (i) Radiator cooling system: Radiator set mounted complete with inlet cooling and outlet ducting flanges.
- (j) Fan: pusher type, engine driven with V-belts.
- (k) Flexible canvas boot: flanged on both sides, length 100 mm minimum, mounted on front of radiator.
- (l) Water circulating pump: Engine driven.
- (m) Make-up and expansion tanks: With filling cap and vent over-flow pipe. For filling cap located higher than 1500 mm above the floor furnish a level indicator visible and legible from floor level.
- (n) Tank low level condition: operate engine shut-down switch to open engine start circuit.
- (o) Temperature regulating valve: With bypass feature, located in cylinder head water outlet.
- (p) Piping: Furnish necessary water pipes, flexible hoses and similar items.
- (q) Drain cocks: Located to completely drain system.
- (r) Safety protection: Guard moving parts.

- (s) Coolant: Suitable for -40°C. Furnish first filling.
- (t) Block heater: 208V 1ph plug connected, thermo-statically controlled lube oil or liquid coolant heater of sufficient capacity to allow engine to start in room ambient of 32 deg. F.
- (u) Governor:
- (v) The engine governor shall be a electronic Engine Control Module (ECM) with 24-volt DC Electric Actuator. The ECM shall be enclosed in an environmentally sealed, die-cast aluminum housing which isolates and protects electronic components from moisture and dirt contamination. Speed droop shall be adjustable from 0 (isochronous) to 10%, from no load to full rated load. Steady state frequency regulation shall be +/- 6 RPM. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. The ECM shall adjust fuel delivery according to exhaust smoke, altitude and cold mode limits. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position:
- (w) Frequency transient as per CSA282-05.
- (x) Lubrication system:
  - (i) Pressure lubrication by engine driven pump.
  - (ii) Lube oil filter:
  - (iii) Lube oil filter: replaceable, full flow type, removable without disconnecting piping.
  - (iv) Lube oil cooler.
  - (v) Engine sump drain valve.
  - (vi) Oil level dipstick.
- (y) Starting system:
  - (i) A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.
  - (ii) Cranking limiter to provide 3 (three) cranking periods of 10s duration, each separated by 5s rest.
  - (iii) Lead acid, 24 V storage battery parallel connected with sufficient capacity to crank engine for 3 min at 32 deg. F without using more than 25% of ampere hour capacity, together with a low electrolyte level indicator and audible warning device.
- (z) Battery charger: 120 V, 60 Hz input, 10 A, 24 V DC output, heavy duty service, constant current, constant voltage with output regulation 1% for input variation of +/- 10% from no load to full load, SCR controlled output regulator, AC input and DC output circuit protection, 2% accuracy analog voltmeter and ammeter, on/off switch, indicator lights for AC ON, Current Limit, Float Charge and Equalize Charge, Manual equalize switch, Low battery Voltage Alarm with Time Delay, High Battery Voltage Alarm, AC Fail Alarm and No charge Alarm,. Type SCA 24/10 by Vulcan.
- (aa) Vibration isolated engine instrument panel with:
  - (i) Lube oil pressure gauge.
  - (ii) Lube oil temperature gauge.
  - (iii) Coolant temperature gauge.

- (iv) Running time meter: non-tamper type.
- (v) Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.
- (vi) Drip tray.
- (vii) 120V, 1ph, battery heater.

#### 2.4 ALTERNATOR

- (a) Alternator shall be manufactured to NEMA MG1.
- (b) Continuous 100% rated output: 100kW, 347/600V, 3-phase, 4-wire, 60 Hz, at 0.8 PF.
- (c) Output at 105 deg. F ambient:
- (d) 100% full load continuously.
- (e) 110% full load for 1 hr.
- (f) 150% full load for 1 min.
- (g) Revolving field, brushless, single bearing.
- (h) Drip proof.
- (i) Amortisseur windings.
- (j) Synchronous type.
- (k) Dynamically balanced rotor permanently aligned to engine by flexible disc coupling, or use 2 bearing type.
- (l) Exciter: rotating brushless.
- (m) EEMAC class H insulation on windings.
- (n) Thermocouples or RTDs embedded in stator winding and connected to alternator control circuitry.

#### 2.5 DIGITAL VOLTAGE REGULATOR

- (a) The digital voltage regulator shall be microprocessor based with fully programmable operating and protection characteristics. The regulator shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. The voltage regulator shall include a VAR/Pf control feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic in order to optimize voltage and frequency response for site conditions. The voltage regulator shall include standard the capability to provide generator paralleling with

reactive droop compensation and reactive differential compensation.

- (b) Stability: .25% maximum voltage variation at any constant load from no load to full load.
- (c) Transient as per CSA282-05
- (d) Transient: 35% maximum voltage dip in most severe Motor starting condition which is a 20 HP motor.
- (e) Transient: 25% maximum voltage dip when connecting a 15 KVA transformer.
- (f) The alternator shall be capable of sustaining 300% rated current for period not less than 10s permitting selective tripping of down line protective devices when short circuit occurs.

## 2.6 CONTROL PANEL

- (a) Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls.
- (b) Flexible conductors between door and fixed panel.
- (c) Functional Requirements: The following functionality shall be integral to the control panel.
  - (i) The control shall include a minimum 64 x 240 pixel, 28mm x 100mm, white backlight graphical display with text based alarm/event descriptions
  - (ii) The control shall include a minimum of 3-line data display
  - (iii) Audible horn for alarm and shutdown with horn silence switch
  - (iv) Standard ISO labeling
  - (v) Multiple language capability
  - (vi) Remote start/stop control
  - (vii) Local run/off/auto control integral to system microprocessor
  - (viii) Cooldown timer
  - (ix) Speed adjust
  - (x) Lamp test
  - (xi) Push button emergency stop button
  - (xii) Voltage adjust
  - (xiii) Voltage regulator V/Hz slope – adjustable
  - (xiv) Password protected system programming
  - (xv) Digital Monitoring Capability: The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units.

## 2.7 ENGINE

- (i) Engine oil pressure
- (ii) Engine oil temperature
- (iii) Engine coolant temperature
- (iv) Engine RPM
- (v) Battery volts
- (vi) Engine hours
- (vii) Engine crank attempt counter
- (viii) Engine successful start counter
- (ix) Service maintenance interval
- (x) Real time clock
- (xi) Oil filter differential pressure
- (xii) Fuel temperature
- (xiii) Fuel pressure
- (xiv) Fuel filter differential pressure
- (xv) Fuel consumption rate
- (xvi) Total fuel consumed
- (xvii) Engine intake manifold temperature
- (xviii) Engine intake manifold pressure
- (xix) Engine crankcase pressure
- (xx) Air filter differential pressure
- (xxi) Boost pressure
- (xxii) Oil filter differential pressure

## 2.8 GENERATOR

- (i) Generator AC volts (Line to Line, Line to Neutral and Average)
- (ii) Generator AC current (Avg and Per Phase)
- (iii) Generator AC Frequency
- (iv) Generator kW (Total and Per Phase)
- (v) Generator kVA (Total and Per Phase)
- (vi) Generator kVAR (Total and Per Phase)
- (vii) Power Factor (Avg and Per Phase)
- (viii) Total kW-hr
- (ix) Total kVAR-hr
- (x) % kW
- (xi) % kVA
- (xii) % Kvar

## 2.9 VOLTAGE REGULATION

- (i) Excitation voltage
- (ii) Excitation current

2.10 LOCAL ANNUNCIATOR (NFPA 99/110, CSA 282)

- (a) Annunciator shall be networked directly to the generator set control.
- (b) Local Annunciator shall include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton.
- (c) Provide the following individual light indications for protection and diagnostic:
  - (i) Low coolant temperature
  - (ii) High coolant temperature warning
  - (iii) High coolant temperature shutdown
  - (iv) Low oil pressure warning
  - (v) Low oil pressure shutdown
  - (vi) Overspeed
  - (vii) Low coolant level
  - (viii) EPS supplying load
  - (ix) Control switch not in auto
  - (x) High battery voltage
  - (xi) Low battery voltage
  - (xii) Battery charger AC failure
  - (xiii) Emergency stop
  - (xiv) Spare
  - (xv) Spare
- (d) Remote Annunciator (NFPA 99/110, CSA 282)
- (e) Provide a remote annunciator to meet the requirements of NFPA 110, Level 1.
- (f) The annunciator shall provide remote annunciation of all points stated above and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn.
- (g) Ability to be located up to 800 ft from the generator set.
- (h) Circuit Breaker: Provide a generator mounted 100% circuit breaker, molded case, 400A amp trip, 3 pole, NEMA 1/IP22. Breaker shall utilize a solid state trip unit. The breaker shall be UL/CSA Listed and connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the generator set. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be supplied on the load side of breaker.
- (i) Operating lights, panel mounted:
- (j) "Normal power" pilot light.
- (k) "Emergency power" pilot light.
- (l) Green pilot lights for breaker on and red pilot lights for breaker off.

- (m) Push to test lamp button.
- (n) Local alarm with separate manually reset NO contacts wired to terminal block for "emergency power system trouble" FACP annunciation on:
  - (i) Low battery voltage.
  - (ii) Ventilation failure.
  - (iii) Low engine temperature.
  - (iv) Low water level.
  - (v) Engine overcrank.
  - (vi) Engine overspeed.
  - (vii) High engine temperature.
  - (viii) Engine low oil pressure.
  - (ix) Generator "running".
  - (x) Control switch not in "Automatic" position.

#### 2.11 STRUCTURAL STEEL MOUNTING BASE

- (a) The complete generating set shall be mounted on structural steel base of sufficient strength and rigidity to protect assembly from stress or strain during transportation, installation and under operating conditions on suitable level surface.
- (b) The assembly shall be fitted with vibration isolators and the control console shall be resiliently mounted. Provide vibration isolators recommended by engine manufacturer.
- (c) Use sound insulation pads for installation between isolators and concrete base.

#### 2.12 EQUIPMENT IDENTIFICATION

- (a) Provide equipment identification in accordance with Section 16010.

#### 2.13 FABRICATION

- (a) The complete unit is to be shop fabricated and assembled.

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2.14        **HOUSING**

- (a)        Provide weather-proof sound attenuated enclosure c/w double wall and roof construction with fiberglass insulation.
- (b)        Base shall be capable of supporting machinery and accessory and framing shall be to withstand wind up to 100 mph.
- (c)        Provide motor operated dampers, interlocked with engine, rain tight louvers and ice protection.
- (d)        Provide 2@ LED lighting WP fixtures to suit.
- (e)        Provide 3@120 volt, 20 amp, grounded receptacles.
- (f)        Provide 60A-3P feeder c/w associated conduit from main electrical room to generator panel.
- (g)        Lock shall be as per owner's requirement.
- (h)        Sound attenuation shall be minimum 71 db @ 7m from unit.

2.15        **FLEXIBLE CONNECTIONS**

- (a)        Provide bronze construction with bronze wire braid covering, similar to American Brass Co. type and pressure rating as required for each service.

2.16        **SPARE PARTS**

- (a)        Deliver 1 set of filter elements (air, fuel and oil), complete set of fuses, for each size used and one belt for every belt drive to owner at final acceptance.

Part 3 – EXECUTION

3.1 INSTALLATION

- (a) Locate generating unit and install as required.
- (b) Complete wiring and interconnections as required.
- (c) Completely fill main and day tanks with fuel.
- (d) Coordinate floor capabilities and space conditions for delivery and removal.

END OF SECTION

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Materials and installation for automatic load transfer equipment which can monitor voltage on all phases of normal power supply, initiate cranking of standby generator unit, transfer loads and shut down standby unit.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedure].
- .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.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN3-C13-M83(R1998), Instrument Transformers.
  - .2 CSA C22.2No.5-02, 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).
  - .3 CSA C22.2No.178-1978(R2001), Automatic Transfer Switches.
- .2 American National Standards Institute (ANSI)/National Electrical Manufacturers Association (NEMA)
  - .1 ANSI/NEMA ICS 2-2000 Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.

**1.4 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Detailed instructions to permit effective operation, maintenance and repair.
- .3 Technical data:
  - .1 Schematic diagram of components, controls and relays.
  - .2 Illustrated parts lists with parts catalogue numbers.
  - .3 Certified copy of factory test results.

**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 all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for recycling in accordance with Waste Management Plan.

- .4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by the Consultant.

## **Part 2 Products**

### **2.1 MATERIALS**

- 1.1. Comply with UL 1008 for the ratings and conditions required by this specification.

### **1.2. TRANSFER EQUIPMENT**

- 1.3. Two-Way 4 (four) pole double throw arrangement, mechanically and electrically interlocked, solenoid operation with CSA 1 enclosure, modified to be sprinkler proof.
- 1.4. 347/600 V, 3ph, 4W, with current rating as shown on drawings.
- 1.5. Fault withstand rating: 35 KA symmetrical.
- 1.6. Both Transfer switches are for Essential Loads and Non-Essential Loads as indicated on drawings.

### **5.4 BYPASS-ISOLATION SWITCHES**

- A. A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.
- B. Power interconnections shall be silver-plated copper bus bar. The only field installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control interwiring shall be provided with disconnect plugs.
- C. Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door. Designs requiring insertion of loose operating handles or opening of the enclosure door to operate are not acceptable.
- D. Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). Designs that disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.
- E. The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.
- F. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.

- G. Designs requiring operation of key interlocks for bypass isolation or ATs which cannot be completely withdrawn when isolated are not acceptable.

## 2. CONTROLS

- 2.1. Selector switch - four position "Test" "Auto" "Manual" "Engine start".
- 2.1.1. Test position - Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.
- 2.1.2. Auto position - Normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.
- 2.1.3. Manual position - Transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.
- 2.1.4. Engine start position - Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.
- 2.2. Control transformers: dry type with 120 V secondary to isolated control circuits from:
- 2.2.1. Normal power supply.
- 2.2.2. Emergency power supply.
- 2.3. Relays: continuous duty, industrial control type, with wiping action contacts rated 10A minimum:
- 2.3.1. Voltage sensing, one per phase, solid state type adjustable drop out and pick up, closed differential, 2V minimum, undervoltage, overvoltage protection.
- 2.3.2. Adjustable time delay, normal power to standby, for engine start 0 second to 6 seconds, set at 3 seconds.
- 2.3.3. Adjustable time delay 0-6 seconds, on transfer to emergency, air diaphragm type, set at 1 second.
- 2.3.4. Adjustable time delay on retransfers from standby to normal power. 0 to 30 minutes, set at 5 minutes.
- 2.3.5. Adjustable time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power. 0-300 seconds, set at 300 seconds.
- 2.3.6. Frequency, to prevent transfer from normal power supply until frequency of standby unit reaches preset values.

## 3. ACCESSORIES

- 3.1. Pilot lights to indicate switch position, green for normal, red for standby, mounted in panel.
- 3.2. Auxiliary relays to provide 4 N.O. and 4 N.C. contacts for remote alarms.
- 3.3. Solid state electronic monitors:
- 3.3.1. Voltage sensing, single three phase with adjustable time delay on circuit opening and closing arrangement.
- 3.3.2. Under and Over frequency sensing, with adjustable differential for nominal frequency of 60 Hz with adjustable time delay on trip of 60 Hz, with circuit closing arrangement, with 2 N.O. and 2

N.C. contacts, and a repetitive accuracy plus or minus 0.2 Hz.

- 3.4. Plant exerciser: 168 h timer to start standby unit once each week for selected interval but does not transfer load from normal supply. Timer adjustable 0-168 h in 15 min intervals.

#### **4. EQUIPMENT IDENTIFICATION**

- 4.1. Install nameplate.

#### **5. FABRICATION**

- 5.1. Shop assemble transfer equipment including:

- 5.1.1. Mounting base and enclosure.  
5.1.2. Transfer switch-operating mechanism.  
5.1.3. Control transformers and relays.  
5.1.4. Accessories.

#### **6. INSTALLATION**

- 6.1. Locate, install and connect transfer equipment, supplied under this Division.  
6.2. Check relays and adjust as required.  
6.3. Install and connect battery and remote alarms.  
6.4. Provide required control wiring from transfer switch (plus 2 spare conductors) to diesel generator control panel and ancillary electrical equipment, to initiate emergency operation, annunciation and controls.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

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

#### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results – 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 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .7 Repeat, at 1h intervals, several times, complete test with selector switch in each position, for each test.

**END OF SECTION**

**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 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
  - .1 ANSI/IEEE 837-[1989], Standard for Qualifying Permanent Connections Used in Substation Grounding.
  - .2 Canadian Standards Association (CSA International)
    - .1 CAN/CSA-B72-[M87(R1998)], Installation Code for Lightning Protection Systems.

**1.3 DESCRIPTION OF SYSTEM**

- .1 System to consist of metallic air terminals, lightning conductors connecting air terminals to ground and interconnected ground electrodes, and/or ground cables.
- .2 Sky wire cone, where sky line elevated at height to protected structure beneath, but having no direct connection to sky line which is connected to system of ground electrodes.

**1.4 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate materials and methods of attachment of conductors to air terminals and electrodes.

**1.5 REGULATORY REQUIREMENTS**

- .1 System subject to: approval by authority having jurisdiction.

**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 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal any 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 the Consultant.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Air terminals: copper or solid rod.
- .2 All conductors as specified on drawings.
- .3 Fastenings and attachment straps: copper.
- .4 Electrodes: As specified on drawings.
- .5 All down runs and cable clamps as indicated to form a complete sky-cone system.
- .6 Connections: copper connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install lightning protection to CAN/CSA-B72.
- .2 Bond discharge conductors to service mast or other non-current-carrying electrical parts.
- .3 Submit certificate of installation to the Consultant.

**3.2 INSPECTION**

- .1 Obtain inspection certificate from Consultant for discharge conductor passing through any fire supporting membrane.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED SECTIONS**

**1.2 REFERENCES**

- .1 National Association of Corrosion Engineers (NACE)
  - .1 NACE RP-01-69-latest edition, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 SYSTEM DESCRIPTION**

- .1 Design Responsibility: NACE certified specialist to select and design cathodic protection system to protect:
  - .1 Entire telethermics systems, sectionalized as indicated.
  - .2 Steel manholes.
  - .3 Other buried steel structures.

**1.4 DESIGN REQUIREMENTS**

- .1 General: sufficient anodes for 20 years of operation without replacement, based upon earth resistivity tests performed on site by manufacturer.
- .2 Impressed current systems: graphite or high silicon cast iron.
- .3 Sacrificial anode system:
  - .1 Base design on 3% of total conduit surface assumed to be bare and application of 2 mA/ft<sup>2</sup>, conduit-to-soil potential of 0.850 V or more, negative.
  - .2 Anodes: magnesium.

**1.5 SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 62 00.01 - Hazardous Materials.
- .3 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada, and include:
  - .1 Soil analysis, details affecting design, calculations, locations of anodes, test stations, routes of connecting cables, installation procedures, wire splicing details, hardware, accessories.
- .4 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
  - .1 Test reports: submit certified test reports for mobile shelving storage from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

- .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures and.
- .5 Manufacturer's Field Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.
- .6 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
  - .2 Data to include:
    - .1 Manual repeating and expanding upon oral operating and maintenance instructions.
    - .2 Record drawings showing locations of anodes, test stations, routes and cable routes.

## 1.6 QUALITY ASSURANCE

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with contractor's representative and Engineer in accordance with Section [01 32 16.06 - Construction Progress Schedule - Critical Path Method (CPM) Section 01 32 16.07 - Construction Progress Schedules - Bar (GANNT) Charts to:
  - .1 Verify project requirements.
  - .2 Review installation and substrate conditions.
  - .3 Co-ordination with other building subtrades.
  - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Site Meetings: as part of Manufacturer's Services described in PART 3 - FIELD QUALITY CONTROL, schedule site visits, to review Work, at stages listed.
  - .1 After delivery and storage of products, and when preparatory Work is complete, but before installation begins.
  - .2 Twice during progress of Work at 25% and 60% complete.
  - .3 Upon completion of Work, after cleaning is carried out.

## 1.7 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## 1.8 COMMISSIONING

- .1 Do commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Manufacturer to commission system and to certify in final written report to Engineer satisfactory installation and performance.

- .3 Provide testing and maintenance program.
- .4 Provide additional anodes as required to ensure adequate performance of cathodic protection system for 20 years.
- .5 Adjust current to impressed current systems to suit actual site conditions to ensure specified anode life as well as full protection.
- .6 Report to include latest estimated life expectancy of anodes.
- .7 Retest 6 months after completion of backfilling.
  - .1 Submit written report to Engineer.

## **Part 2 Products**

### **2.1 SUSTAINABLE REQUIREMENTS**

- .1 Materials and products in accordance with Section 01 47 15 - Sustainable Requirements: Construction.
- .2 Do verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification.

### **2.2 ANODES**

- .1 7.6 kg magnesium, having following composition: Aluminum: 5.3-6.7% Manganese: 0.15% min. Zinc: 2.5-3.5% Silicon: 0.13% max. Copper: 0.05% max. Nickel: 0.003% max. Iron: 0.003% max.
  - .1 Other: 0.3% max. Magnesium: remainder.
- .2 Cast with perforated steel strap core mechanically secured and silver soldered to anode lead wire.
- .3 Anode: completely surrounded by 12.7 mm minimum of packing firmly compacted by vibration in permeable cloth. Packing to pass 100 mesh screen and consist of:
  - .1 Ground hydrated lime: 75%.
  - .2 Powdered Wyoming bentonite: 20%.
  - .3 Anhydrous sodium sulfate: 5%.

### **2.3 CONDUCTOR AND LEAD WIRES**

- .1 #12 type THWN solid copper wire.

### **2.4 WIRES FOR TEST PURPOSES**

- .1 #12 type TWHN solid copper wire.

### **2.5 ELECTRICAL ISOLATION MATERIALS**

- .1 Include fittings, flanges, bolts, nuts, washers, gasket materials suitable for service, operating temperatures, pressures.

### **2.6 COATINGS**

- .1 Electrically resistant, highly resistant to mechanical damage.

### **2.7 LINK SEALS**

- .1 Modular mechanical type consisting of interlocking synthetic rubber links, high strength non-creep glass-reinforced pressure plates, corrosion resistant bolts and nuts.

- .2 Sizes, number of links, as recommended by manufacturer.

## **2.8 BURIED CABLE SPLICES**

- .1 Copper compression bolts, electrical putty, 19 mm wide rubber insulating tape, 19 mm wide plastic insulating tape.

## **2.9 CABLE CONNECTIONS**

- .1 Welded connections:
  - .1 Materials for welding copper cables to protected work suitable for thermit reaction welding process.
- .2 Pressure type:
  - .1 Clamp type.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 FIELD INVESTIGATIONS**

- .1 NACE certified specialist to survey entire route of piping and system at proposed installation depth.
- .2 Analyze soil samples for chemical constituents, electrical resistivity, water soluble salt content, calcium, sulphate, chloride, content and pH of soil.
- .3 Survey to include other details affecting design:
  - .1 Details of protected works.
  - .2 Protective coatings.
  - .3 Surrounding environment.
  - .4 Presence of neighbouring metal structures.
  - .5 Stray currents in vicinity.
  - .6 Number, locations of foreign utilities.
  - .7 Proximity of other cathodic protection systems which may affect or be affected by operation of this system.
- .4 Submit report to Engineer indicating soil analysis, type of cathodic protection system recommended.

### **3.3 ON-SITE SUPERVISION**

- .1 Cathodic protection system manufacturer's NACE certified corrosion specialist to provide instructions for, and supervision of, installation and commissioning.

### **3.4 BURIED CABLE SPLICES**

- .1 Use following procedures:
  - .1 Strip away 50 mm insulation : attach bolt.
  - .2 Cover connection with layer of putty.
  - .3 Wrap with 3 layers half lap rubber insulating tape.
  - .4 Finish with 3 layers half lap vinyl plastic tape.

### **3.5 CONNECTION OF WIRES**

- .1 Use thermal reaction welding process.
- .2 Clean to bare metal.
- .3 After welding, remove slag, cover with bitumastic coating or other material compatible with original coating.

### **3.6 COATINGS**

- .1 Before and after installation:
  - .1 Inspect for complete coverage.
  - .2 Patch damaged coating using same material as original coatings.
- .2 Engineer to certify satisfactory installation.

### **3.7 TEST STATIONS**

- .1 Locate at 100 m intervals.
- .2 Arrange to permit periodic evaluation and overall effectiveness of cathodic protection system, as follows:
  - .1 At buildings: house test leads in electrical conduit terminated in waterproof cast iron housing affixed to structure.
  - .2 At every manhole where distance between manholes exceeds 300 m: terminate leads at test station with 450 mm of slack material at ground surface in waterproof cast iron housing encased in concrete.
- .3 Test leads terminating in test stations to have at least 500 mm slack lead below grade.

### **3.8 ELECTRICAL ISOLATION**

- .1 Isolate protected work into sections using electrically isolated flanges, bolts, nuts and washers.
- .2 Isolate protected work from other buried metallic systems and/or structures, steel reinforced concrete, buildings, piping systems inside buildings.
- .3 Provide everything necessary for stray current control.
- .4 Select size of wall opening and link seal to ensure complete electrical isolation and watertight joints.

### **3.9 WIRING**

- .1 Install to manufacturer's instructions.
- .2 Weld anode wire directly to protected work using welding procedures approved by manufacturer and run to test stations.
- .3 Splice anode wire to common gathering wire laid parallel to protected work and run to test station.
- .4 Weld cathode wire to protected work and run to test station.

### **3.10 WELDING**

- .1 Welds at protected work: moisture-proofed, covered with coatings compatible with original protective coatings.

### **3.11 CONTINUITY**

- .1 Provide joint bonds or other means to ensure that cathodic protection system is installed as designed.

- .2 Before backfilling, test for electrical continuity of piping systems.

**3.12 BACKFILLING**

- .1 Supervise backfilling of protected work and cathodic protection systems to ensure that neither is damaged or that cathodic protection systems are not compromised.
- .2 Anodes: backfill in neutral earth firmly packed around anodes to eliminate air pockets.
  - .1 Drench anodes thoroughly in water so that anode packing is saturated.
  - .2 Immediately, install backfill to 300 mm above anode to prevent drying out.
- .3 Backfilling: to Section 31 23 33.01 - Excavating, Trenching and Backfilling.

**3.13 ELECTRICAL SUPPLY**

- .1 Locations as indicated.
- .2 Ensure electrical supply is fully and permanently supervised.

**3.14 FIELD QUALITY CONTROL**

- .1 Site Tests and Inspections:
  - .1 Test systems to NACE RP-01-69 recommendations.
    - .1 Include pipe-to-soil potential and anode current output under all soil conditions.
    - .2 Test for full supervision of circuitry.
- .2 After backfilling, manufacturer's NACE certified corrosion specialist to conduct final inspection.
- .3 On completion, submit final report to Engineer.
- .4 Indicate in final report latest estimated life expectancy of anodes.
- .5 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

**3.15 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**3.16 DEMONSTRATION AND TRAINING**

- .1 Arrange for installer to demonstrate to owner's personnel on aspects of system design, and in operation and maintenance of equipment in accordance with Section 01 79 00 - Demonstration and Training.

**END OF SECTION**

## **PART 1 – GENERAL**

- 1.1 GENERAL REQUIREMENTS
  - 1.1.1 Conform to sections of Division 1 as applicable.
- 1.2 SHOP DRAWINGS
  - 1.2.1 Submit shop drawings and product data in accordance with Section 260501.
- 1.3 LAMP DATA
  - 1.3.1 Refer to LUMINAIRES FOR EACH lamp data.
- 1.4 BALLAST DATA
  - 1.4.1 Refer to LUMINAIRES FOR EACH ballast data.
- 1.5 LENSES DATA
  - 1.5.1 Refer to LUMINAIRES for lenses and louvre data.
- 1.6 LUMINAIRE CONSTRUCTION AND INSTALLATION
  - 1.6.1 Refer to LUMINAIRES for luminaire construction and installation.

## **PART 2 – PRODUCTS**

- 2.1 GENERAL
  - 2.1.1 All luminaries have been assigned a type designation as follows:
    - 2.1.1.1 The letter >A= followed by an additional letter denotes incandescent type fixture.
    - 2.1.1.2 The letter >F= followed by an additional letter or digit denotes fluorescent fixture (i.e. FA, FA1, FB etc.)
    - 2.1.1.3 The letter >H= followed by an additional letter or digit denotes H.I.D. fixture.
    - 2.1.1.4 The letters >LT= followed by an additional letter denotes light track.
    - 2.1.1.5 The letter >X= followed by an addIT. digit denotes Exit lights.

**END OF SECTION**

PART 1 - GENERAL

1.1 REFERENCE

1.1.1 Read and be governed by Section 16010.

1.2 RELATED WORK

1.2.1 Comply with relevant Sections of this and other Divisions of this Specification.

1.2.2 This specification covers the general requirements for the design and installation of a snow and ice melting system.

1.2.3 The electrical contractor shall supply and install a complete snow and ice melting system which shall consist of the following:

1.2.3.1 Electric heating cables.

1.2.3.2 Temperature controllers and auxiliary sensors.

1.2.3.3 Accessory materials such as contactors, prepunched strapping, junction boxes, etc.

1.2.3.4 Heating panel and feeders

1.2.4 References

1.2.4.1 The extent of the snow and ice melting system is as shown on specification sheets and architectural drawings.

1.2.4.1.1 Codes and Standards

1.2.4.1.1.1 The entire design and installation of the system shall comply with the Electrical Code (current edition) and the requirements of the "Authority Having Jurisdiction". All heaters shall be CSA approved and/or UL listed for this application.

1.2.4.1.1.2 The manufacturer shall have a minimum of 25 years experience manufacturing the heating cables herein specified.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

2.1.1 Snow melting slab heating cables shall be manufactured to CSA C22.2 No. 130.

#### 2.1.2 Heating Cable

2.1.3 Type M.I. heating cable shall be manufactured by Tyco Thermal Controls/ Pyrotenax, magnesium oxide insulated, with copper or resistance alloy conductor and a seamless copper or Alloy 825 sheath. The heating cable shall be constructed in such a manner that no combustible materials are allowed between the resistance alloy conductor and outer metal sheath. All heater core materials shall be inorganic and will not deteriorate with age.

2.1.4 The cable shall be jacketed with high density polyethylene (HDPE) to resist corrosion.

2.1.5 Each heater shall be factory-fabricated to the length required and shall not be altered on site. The heated section shall be joined to a PVC jacketed copper sheath cold lead section by a factory-made joint. Cold lead shall be seven feet long unless otherwise specified.

### 2.2 Controls

2.2.1 All heating circuits shall be controlled by one of the following methods:

2.2.1.1 a high limit slab sensing thermostat and/or timer.

2.2.1.2 an automatic snow/ice sensor (preferred) which detects precipitation occurring at temperatures below 38°F (4°C).

2.2.2 Where the rating of the controller would be exceeded, it shall be used in conjunction with a relay or contactor.

### 2.3 Power Distribution and Control Panel

The panel shall be cUL Listed to UL Standard 508A and CSA Standard C22.2 No. 14.

2.2.2 The panel shall be available with a NEMA 1 enclosure (for indoor installations), or NEMA 3R/4 enclosure (for outdoor installations) with space heater and thermostat.

2.2.3 The panel shall incorporate a microprocessor based snow melting controller with adjustable hold-on timer and a temperature sensor.

2.2.4 The panel shall incorporate 3-pole shunt trip circuit breakers with external ground fault sensors.

2.2.5 Panels shall be designed for operation on 600 volts to allow for Delta or Wye connected 3-phase heating cable circuits.

2.2.6 Main circuit breaker shall be provided upstream for protection outside the snow melting power distribution and control panel.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Cable manufacturer to be present before and during cable installation.

3.1.2 The current revision of the manufacturer's Installation Recommendation for Heating Cable in Heat Conducting Concrete Slabs, Engineering Information Sheet #H1 shall be considered part of this specification.

3.1.3 Cable sheaths shall not touch or cross one another nor shall cables cross expansion joints. Special procedures are required for crossing control and construction joints.

3.1.4 Heating cables are laid out at the specified spacing. Spacing should not be greater than 9 inches to ensure reasonably uniform distribution of heat.

3.1.5 All junction boxes shall be located in accessible areas. Junction boxes shall not be located in the heated slab, but shall be located above grade level. Covers shall be kept on boxes at all times when not working therein.

3.1.6 All terminations shall be protected from the weather and from physical damage and bonded to the system ground.

3.1.7 Any field alternations or deviations shall proceed only after authorization has been issued by engineer. All changes shall be accurately recorded by the contractor and shall be turned over to the engineer upon completion of that phase of the work.

3.2 Testing

3.2.1 Field testing of insulation resistance and continuity of the units shall be carried out with a 500 volt insulation tester and recorded by the Electrical Contractor. Testing shall be done when received on the job site, during installation, and after installation, by the Electrical Contractor.

3.2.2 Insulation resistance shall be consistently not less than 5 megohms.

3.2.3 Conduct a complete system test of controls to verify cable operation.

3.2.4 Copies of all such testing shall be delivered to the Engineer.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCE

1.1.1 Read and be governed by Section 16010.

### 1.2 RELATED WORK

1.2.1 Comply with relevant Sections of this and other Divisions of this Specification.

1.2.2 This specification covers the general requirements for the design and installation of a snow and ice melting system.

1.2.3 The electrical contractor shall supply and install a complete trace freezing protection system.

1.2.4 Furnish and Install a complete UL Listed, CSA Certified, or FM Approved system of heating cables, components, and controls to (choose one: prevent pipes from freezing, provide freeze protection of sprinkler system piping, provide flow maintenance of grease lines, provide flow maintenance for fuel oil).

## PART 2 - PRODUCTS

### 2.1 MATERIALS

2.1.1 The self-regulating heating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of (select: modified polyolefin (-CR) or fluoropolymer (-CT)), as required per section 427-23 of the NEC-1996. For installation on plastic piping, the heating cable shall be applied using aluminum tape (AT-180).

2.1.2 In order to conserve energy and to prevent overheating, the heating cable shall have a selfregulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 40° F pipe temperature operation to 150° F pipe temperature operation.

2.1.3 The heating cable shall operate on line voltages of (select: 120 or 208) volts without the use of transformers.

2.1.4 The heating cable for metal-pipe freeze protection shall be sized according to the table below. The required heating cable output rating is in watts per foot at 50° F. (Heating cable selection based on 1 inch fiberglass insulation on metal piping.)

Pipe size (inches)	Minimum Ambient Temperature	
	0°F	-20°F
3 or less	5 watts	5 watts
4	5 watts	8 watts
6	8 watts	8 watts
8	8 watts	2 strips-5 watts
10	2 strips-5 watts	2 strips-8 watts

2.1.5 The heating cable shall be XL-Trace cable as manufactured by Raychem Corporation

2.1.6 Power connection, end seal, splice, and tee kit components shall be applied in the field.

2.1.7 Heating cable circuit shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC-1996.

## 2.2 COMPONENTS

2.2.1 All heating-cable components shall be UL Listed, CSA Certified, or FM Approved for use as part of the system to provide (choose one: pipe freeze protection, flow maintenance). Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bus wires or that use crimps or terminal blocks, shall not be acceptable. All components that make an electrical connection shall be reenterable for servicing. No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

## 2.3 SYSTEM CONTROL

2.3.1 Option 1: Manual Control

2.3.1.1 The system shall be controlled by a switch, either directly or through an appropriate contactor.

2.3.2 Option 2: Thermostatic Control-Ambient Sensing

2.3.2.1 The system shall be controlled by an ambient sensing thermostat (choose: AMC-1A or AMC-F5) set at 40°F either directly or through an appropriate contactor.

2.3.3 Option 3: Thermostatic Control-Line Sensing

2.3.3.1 The system shall be controlled by a line sensing thermostat (choose: AMC-F5 fixed at 40°F or AMC-1B variable set point) set at 40° F either directly or through an appropriate contactor.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- 3.1.1 Cable manufacturer to be present before and during cable installation.
- 3.1.2 System must be installed per manufacturer's recommendations.
- 3.1.3 Apply the heating cable linearly on the pipe after piping has been successfully pressure-tested. Secure the heating cable to piping with cable ties or fiberglass tape.
- 3.1.4 Apply "Electric Traced" labels to the outside of the thermal insulation.
- 3.1.5 All terminations shall be protected from the weather and from physical damage and bonded to the system ground.
- 3.1.6 Any field alternations or deviations shall proceed only after authorization has been issued by engineer. All changes shall be accurately recorded by the contractor and shall be turned over to the engineer upon completion of that phase of the work.

#### 3.2 Testing

- 3.3 After installation and before and after installing the thermal insulation, subject heating cable to testing using a 2500-Vdc Megger, Minimum insulation resistance shall be 20 megohms or greater.
  - 3.3.1 Conduct a complete system test of controls to verify cable operation.
  - 3.3.2 Copies of all such testing shall be delivered to the Engineer.

END OF SECTION

**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 26 05 01 - Common Work Results – Electrical.

**1.2 REFERENCES**

- .1 Ontario Building Code of Canada.
- .2 Government of Canada
  - .1 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.
  - .2 TB OSH Chapter 3-04, 1994-12-22, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-04, Standard for Fire Alarm Systems.
- .3 Underwriter=s Laboratories of Canada (ULC)
  - .1 CAN/ULC-S524-[1991], Installation of Fire Alarm Systems.
  - .2 ULC-S525-[1978], Audible Signal Appliances.
  - .3 CAN/ULC-S526-[1987(R1995)], Visual Signal Appliances, Fire Alarm.
  - .4 CAN/ULC-S527-[1987(R1995)], Control Units.
  - .5 CAN/ULC-S528-[1991], Manual Pull Stations.
  - .6 CAN/ULC-S529-[1987(R1995)], Smoke Detectors.
  - .7 CAN/ULC-S530-[1991], Heat Actuated Fire Detectors.
  - .8 CAN/ULC-S531-[1987(R1995)], Smoke Alarms.
  - .9 CAN/ULC-S536-[1997], Inspection and Testing of Fire Alarm Systems.
  - .10 CAN/ULC-S537-[1997], Verification of Fire Alarm Systems.

**1.3 DESCRIPTION OF SYSTEM**

- .1 System includes:
  - .1 Control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating general **two-stage (2)** alarm, supervising system continuously, actuating zone annunciator, and initiating trouble signals.
  - .2 Trouble signal devices.
  - .3 Power supply facilities.
  - .4 Manual alarm stations.
  - .5 Automatic alarm initiating devices.
  - .6 Audible signal devices.
  - .7 End-of-line devices.
  - .8 Visual alarm signal devices.
  - .9 Ancillary devices.

#### **1.4 REQUIREMENTS OF REGULATORY AGENCIES**

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

#### **1.5 SHOP DRAWINGS**

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

#### **1.6 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include:
  - .1 Operation and maintenance 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.
  - .4 List of recommended spare parts for system.

#### **1.7 EXTRA MATERIALS**

- .1 Provide maintenance materials in accordance with Section [01 78 00 - Closeout Submittals].
- .2 Include:
  - .1 Ten (10) spare glass rods for manual pull box stations if applicable.

#### **1.8 MAINTENANCE**

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

**1.9 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 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-S525.
- .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.
- .9 Smoke alarms: to CAN/ULC-S531.

**2.2 SYSTEM OPERATION**

- .1 Two-stage operation. Operation of any manual pull station or fire alarm detector device to:
  - .1 Cause an alert signal to sound throughout building.
  - .2 Cause an alarm to sound if the alert signal is not acknowledged within 5 mins of its initiation.
  - .3 Transmit signal to fire department via fire alarm transmitter and/or monitoring station.
  - .4 Cause zone of alarm device to be indicated on control panel and remote annunciator.
  - .5 Cause air conditioning and ventilating fans to shut down or to function so as to provide required control of smoke movement.
  - .6 Cause fire doors and smoke control doors if normally held open, to close automatically.
- .2 Capability to program smoke detector status change confirmation on any or all zones in accordance with CAN/ULC-S527.

## 2.3 CONTROL PANEL

- .1 Class A.
- .2 Two-Stage operation.
- .3 Zoned.
- .4 Coded.
- .5 Enclosure: CSA Enclosure 1, c/w lockable concealed hinged door, full viewing window, flush lock and 2 keys.
- .6 Supervised, modular design with plug-in modules:
  - .1 Alarm receiver with trouble and alarm indications c/w remote supervised annunciation for class A initiating circuit.
  - .2 Spare zones: compatible with smoke detectors and open circuit devices.
  - .3 Space for future modules.
  - .4 Latching type supervisory receiver circuits. Discrete indication for both off-normal and trouble.
- .7 Components:
  - .1 Coded alarm receiver panel with trouble and alarm indications for class A initiating circuit.
  - .2 Single stage alarm pulse rate panels:
    - .1 Single stroke control type for output to signal control panel continuously.
  - .3 Audible signal control panel with all control circuits complete with terminals for wiring and all plug-in modules for dc signals up to 2.0A load with trouble indication with class A connections.
  - .4 Common control and power units:
    - .1 Control panel containing following indications and controls:
      - .1 "Power on" LED (green) to monitor primary source of power to system.
      - .2 "Power trouble" indication.
      - .3 "Ground trouble" indication.
      - .4 "Remote annunciator trouble" indication.
      - .5 "System trouble" indication.
      - .6 "System trouble" buzzer and silence switch c/w trouble resound feature.
      - .7 System reset switch.
      - .8 "LED test" switch if applicable.
      - .9 "Alarm silence" switch to silence signals manually. If new alarm occurs after signals have been silenced, signals to resound.
      - .10 "Signals silenced" indication.
    - .2 Master power supply panel to provide 24Vdc to system from 120Vac, 60Hz input.
    - .3 Fire department connections:
      - .1 Plug-in module for [tripper] [shunt] type municipal box.
      - .2 Fire department bypass switch c/w indicator for trouble at panel.

- .5 Auxiliary relays: plug-in type, dust cover, supervised against unauthorized removal by common trouble circuit and c/w individual bypass switch.
  - .1 Contacts: 2.0A, 120Vac, for functions such as release of door holders or initiation of fan shut down.
  - .2 Contact terminal size: capable of accepting 22-12AWG wire.

## **2.4 POWER SUPPLY**

- .1 120V, ac, 60Hz input, 24Vdc output from rectifier to operate alarm and signal circuits, with standby power of gell cell batteries minimum expected life of 5 years, sized in accordance with OBC.

## **2.5 MANUAL ALARM STATIONS**

- .1 Manual alarm stations: pull lever, glass rod wall mounted or semi-flush, surface mounted type where required, non-coded single pole normally open contact for two (2) stage English signage.

## **2.6 AUTOMATIC ALARM INITIATING DEVICES**

- .1 Heat detectors, fixed temperature, non-restorable, rated 57 deg.C
- .2 Thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 deg. C rate of rise 8.3 Deg. C per minute.
- .3 Smoke detector: photo-electric type and air duct type with sampling tubes with protective housing.
  - .1 Twistlock type with fixed base.
  - .2 Wire-in base assembly with integral red alarm LED and terminals for remote alarm LED.

## **2.7 AUDIBLE SIGNAL DEVICES**

- .1 Horns: 78db at 10 feet, flush mounting as indicated (weatherproof where indicated), 24Vdc.
- .2 Horns/Strobe: 78db at 10 feet, 3.0 Candela, flush mounting as indicated, red colour, 24Vdc.

## **2.8 END-OF-LINE DEVICES**

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

## **2.9 REMOTE ANNUNCIATOR PANELS**

- .1 LED type with designation cards to indicate zone.
- .2 LEDs to annunciate alarm and trouble.
- .3 Wired in multiple with main control panel.

.4 Supervised, including trouble signal for open circuit.

.5 LED test button.

**2.10 GRAPHIC DISPLAY**

.1 As Required.

**2.11 VISUAL ALARM SIGNAL DEVICES**

.1 Strobe type: flashing red, 24Vdc.

.2 Designed for surface mounting on ceilings or walls as indicated.

**2.12 AS-BUILT RISER DIAGRAM**

.1 Fire alarm system riser diagram: in glazed frame on black lamicoïd sheet with bevelled edges, white lettering and designations minimum size 600 x 600 mm.

**2.13 ANCILLARY DEVICES**

.1 Remote relay unit to initiate fan shutdown.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install systems in accordance with CAN/ULC-S524.
- .2 Install main control panel and connect to ac power supply and dc standby power.
- .3 Locate and install manual alarm stations and connect to alarm circuit wiring.
- .4 Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.
- .5 Connect alarm circuits to main control panel.
- .6 Locate and install signal horns and visual signal devices and connect to signalling circuits.
- .7 Connect signalling circuits to main control panel.
- .8 Install end-of-line devices at end of alarm and signalling circuits.
- .9 Install remote annunciator panels and connect to annunciator circuit wiring.
- .10 Locate and install door releasing devices.
- .11 Locate and install remote relay units to control fan shut down.
- .12 Sprinkler system: wire alarm and supervisory switches and connect to control panel.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical and CAN/ULC-S537.
- .2 Fire alarm system:
  - .1 Test each device and alarm circuit to ensure manual stations, thermal and smoke detectors, sprinkler system transmit alarm to control panel and actuate first stage alarm and ancillary devices.
  - .2 Check annunciator panel to ensure zones are shown correctly.
  - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.
  - .4 Class A circuits.
    - .1 Test each conductor on all circuits for capability of providing alarm signal on each side of single open-circuit fault condition imposed near midmost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
    - .2 Test each conductor on all circuits for capability of providing alarm signal during ground-fault condition imposed near midmost point of circuit.

Reset control unit after each alarm function and correct imposed fault after completion of each test.

**3.3 TRAINING**

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

**END OF SECTION**