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END OF SECTION

**Part 1 General****1.1 GENERAL**

- .1 Provide identified pricing to the prime contractor. Refer to division 1 specifications.

**1.2 RELATED SECTIONS**

- .1 This section must be read in association with the following: Division 1, mechanical and electrical divisions.

**1.3 IDENTIFIED PRICES (EXCLUDING HST)**

- .1 Provide a breakdown for the supply and installation of the fire alarm system to allow for proper accounting of the total cost of the fire alarm system demolition and installation of the fire alarm system within the shared building. The three separate areas are indicated on the drawings.
  - .1 Fire Alarm Work:
    - .1 For the demolition, supply of new, and installation of fire alarm devices within "Upper Grand District School Board Area"
    - .2 For the demolition, supply of new, and installation of fire alarm devices within "Shared Facility Area"
    - .3 For the demolition, supply of new, and installation of fire alarm devices within "Town of Erin Area"
  - .2 Generator Work:
    - .1 For the electrical work related to the generator installation including the provision of the generator.

**END OF SECTION**

**Part 1 General****1.1 GENERAL INSTRUCTIONS**

- .1 Comply with the General Conditions, Supplementary Conditions, and all of General Requirements, Mechanical and Electrical Divisions.

**1.2 FEES**

- .1 The contractor is to determine general inspection fees with Electrical Safety Authority and include as part of tender.
- .2 A submission has been made (if required by this scope of project) by the consultant to the Electrical Safety Authority for review of this project. The payment of the required review costs will be coordinated by the consultant. A copy of the Electrical Safety Authority review report will be forwarded to the successful contractor for information and action. Contractor will not be responsible for these review costs.

**1.3 EQUIPMENT ALLOWANCES**

- .1 The electrical contractor is to review all specification sections forming part of the electrical bid documents and include additional equipment or components, as well as all associated installation costs and testing costs as noted, in the electrical bid price.

**END OF SECTION**

**Part 1 General****1.1 GENERAL****.1 This Section covers items common to Electrical Divisions.**

.2 This section supplements requirements of Division 1.

.3 Furnish labour, materials, and equipment necessary for completion of work as described in contract documents.

**1.2 INTENT**

.1 Mention herein or indication on Drawings of articles, materials, operations, or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated: and, performance of each operation prescribed with furnishing of necessary labour, equipment, and incidentals for electrical work.

.2 Where used, words "Section" and "Division" shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.

.3 Where used, word "supply" shall mean furnishing to site in location required or directed complete with accessory parts.

.4 Where used, word "install" shall mean secured in place and connected up for operation as noted or directed.

.5 Where used, word "provide" shall mean supply and install as each is described above.

**1.3 LIABILITY INSURANCE**

.1 This contractor must maintain and produce at the request of the consultant proof of proper insurance to fully protect the Owner, the Consultant and the Contractor from any and all claims due to accidents, misfortunes, acts of God, etc.

**1.4 DRAWINGS**

.1 Electrical Drawings do not show structural and related details. Take information involving accurate measurement of building from building drawings, or at building. Make, without additional charge, any necessary changes or additions to runs of conduits and ducts to accommodate structural conditions. Location of conduits and other equipment may be altered by Consultant without extra charge provided change is made before installation and does not necessitate major additional material.

.2 As work progresses and before installing fixtures and other fittings and equipment which may interfere with interior treatment and use of building, provide detail drawings or obtain directions for exact location of such equipment and fitments.

- .3 Electrical drawings are diagrammatic. Where required work is not shown or only shown diagrammatically, install same at maximum height in space to conserve head room (minimum 2200 mm (88") clear) and interfere as little as possible with free use of space through which they can pass. Conceal wiring, conduits and ducts in furred spaces, ceilings and walls unless specifically shown otherwise. Install work close to structure so furring will be small as practical.
- .4 Before commencing work, check and verify all sizes, locations, grades, elevations, levels and dimensions to ensure proper and correct installation. Verify existing/municipal services.
- .5 Locate all electrical equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.
- .6 In every place where there is indicated space reserved for future or other equipment, leave such space clear, and install services so that necessary installation and connections can be made for any such apparatus. Obtain instructions whenever necessary for this purpose.
- .7 Relocate equipment and/or material installed but not co-ordinated with work of other Sections as directed, without extra charge.
- .8 Where drawings are done in metric and product not available in metric, the corresponding imperial trade size shall be utilized.

#### **1.5 INTERFERENCE AND CO-ORDINATION DRAWINGS**

- .1 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the constructed spaces provided.
- .2 Prepare drawings to indicate co-ordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are co-ordinated.
- .3 Ensure that clearances required by jurisdictional authorities and clearances for proper maintenance are indicated on drawings.
- .4 Upon consultant's request submit copies of interference drawings to consultant.

#### **1.6 QUALITY ASSURANCE**

- .1 The installations of the division must conform to the latest edition of the Electrical Safety Code as well as its supplemental bulletins and instructions. Provide materials and labour necessary to comply with rules, regulations, and ordinances.
- .2 Complete underground systems in accordance with CSA C22.3 No. 7-94 except where specified otherwise.
- .3 Abbreviations for electrical terms: to CSA Z85-1983.
- .4 In case of differences between building codes, provincial laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Consultant in writing of such differences.

**1.7 ALTERNATES AND SUBSTITUTIONS**

- .1 Throughout these sections are lists of "Alternate Equipment" manufacturers acceptable to Consultant if their product meets characteristics of specified described equipment.
- .2 Each bidder may elect to use "Alternate Equipment" from lists of Alternates where listed. Include for any additional costs to suit Alternated used. Prices are not required in Tender for Alternates listed except where specifically noted as "Separate Price". Complete the Supplementary Tender Form.
- .3 It is responsibility of this Division to ensure "Alternate Equipment" fits space allocated and gives performance specified. If an "Alternate Equipment" unit is proposed and does not fit space allotted nor equal specified product in Consultant's opinion, supply of specified described equipment will be required without change in Contract amount. Only manufacturers listed will be accepted for their product listing. All other manufacturers shall be quoted as substitution stating conditions and credit amount.
- .4 If item of material specified is unobtainable, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after Contract has been awarded.

**1.8 EXAMINATION**

- .1 Site Inspection
  - .1 Examine premises to understand conditions, which may affect performance of work of this Division before submitting proposals for this work.
  - .2 No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.
- .2 Drawings:
  - .1 Electrical Drawings show general arrangement of fixtures, power devices, equipment, etc. Follow as closely as actual building construction and work of other trades will permit.
  - .2 Consider Architectural, Mechanical, and Structural Drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over Electrical Drawings.
  - .3 Because of small scale of Drawings, it is not possible to indicate all offsets, fittings, and accessories, which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.
- .3 Ensure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. If approval is received by Addendum or Change Order to use other than originally specified items, be responsible for specified capacities and for ensuring that items to be furnished will fit space available.

**1.9 SEQUENCING AND SCHEDULING**

- .1 It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Consultant. Should conditions arise where certain changes would be advisable, secure Consultant's approval of these changes before proceeding with work.
- .2 Coordinate work of various trades in installing interrelated work. Before installation of electrical items, make proper provision to avoid interferences in a manner approved by Consultant. Changes required in work specified in these sections caused by neglect to do so shall be made at no cost to Owner.
- .3 Arrange fixtures, conduit, ducts, and equipment to permit ready access to junction boxes, starters, motors, control components, and to clear openings of doors and access panels.
- .4 Furnish and install inserts and supports required by these sections unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to Sections involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by the electrical trade.
- .5 Adjust locations of ducts, conduits, equipment, fixtures, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each conduit and duct prior to installation.
  - .1 Make offsets, transitions, and changes in direction of ducts, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.
  - .2 Supply and install pull boxes, etc, as required to effect these offsets, transitions, and changes in direction.

**1.10 DRAW BREAKDOWN**

- .1 This Contractor **MUST** submit a breakdown of the tender price into classifications to the satisfaction of the Consultant, with the aggregate of the breakdown totaling the total contract amount. **Each item must be broken out into material and labour costs.** Progress claims, when submitted are to be itemized against each item of the draw breakdown. This shall be done in table form showing contract amount, amount this draw, total to date, % complete and balance.
- .2 Breakdown shall be as follows:
  - .1 Permits and fees
  - .2 Mobilization (maximum 1%)
  - .3 Demolition
  - .4 Panelboards and miscellaneous distribution equipment
  - .5 Emergency generator
  - .6 Feeder conduits
  - .7 Branch conduits

- .8 Feeder cables
  - .9 Branch wiring
  - .10 Lighting fixtures (interior)
  - .11 Fire alarm system
  - .12 Starters, contactors and control devices
  - .13 Wiring for mechanical equipment
  - .14 Commissioning and Integrated System Testing**
  - .15 Commissioning (minimum 3%)
  - .16 Electrical contractor closeout requirements (minimum of 3% but not less than \$5,000.00)
- .3 The breakdown must be approved by the Consultant prior to submission of the first draw.
  - .4 Breakdowns not complying to the above will not be approved.
  - .5 Breakdown must indicate total contract amount.
  - .6 Mobilization amount may only be drawn when all required shop drawings have been reviewed by the consultant.**

#### **1.11 SHOP DRAWINGS AND PRODUCT DATA**

- .1 General
  - .1 Furnish complete catalog data for manufactured items of equipment to be used in the Work to Consultant for review within 30 days after award of Contract.
  - .2 Provide a complete list of shop drawings to be submitted prior to first submission.
  - .3 Before submitting to the Consultant, review all shop drawings to verify that the products illustrated therein conform to the Contract Documents. By this review, the Contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers, and similar data and that it has checked and coordinated each shop drawing with the requirements of the work and of the Contract Documents. The Contractor's review of each shop drawings shall be indicated by stamp, date and signature of a qualified and responsible person possessing by the appropriate authorization.
  - .4 If material or equipment is not as specified or submittal is not complete, it will be rejected by Consultant.
  - .5 Additional shop drawings required by the contractor for maintenance manuals, site copies etc., shall be photocopies of the "reviewed" shop drawings. All costs to provide additional copies of shop drawings shall be borne by the contractor.
  - .6 Submit all shop drawings for the project as a package. Partial submittals will not be accepted.**
  - .7 Catalog data or shop drawings for equipment, which are noted as being reviewed by Consultant or his Engineer shall not supersede Contract Documents.



- .8 Review comments of Consultant shall not relieve this Division from responsibility for deviations from Contract Documents unless Consultant's attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.
- .9 Check work described by catalog data with Contract Documents for deviations and errors.
- .10 Shop drawings and product data shall show:
  - .1 Mounting arrangements.
  - .2 Operating and maintenance clearances. e.g. access door swing spaces.
- .11 Shop drawings and product data shall be accompanied by:
  - .1 Detailed drawings of bases, supports, and anchor bolts.
  - .2 Manufacturer test data where requested.
  - .3 Manufacturer to certify as to current model production.
  - .4 Certification of compliance to applicable codes.
- .12 State sizes, capacities, brand names, motor HP, accessories, materials, gauges, dimensions, and other pertinent information. List on catalog covers page numbers of submitted items. Underline applicable data.
- .13 Once these shop drawings are returned "reviewed" or "reviewed as noted" fabrication, production, and installation may commence. **NOTE: If a shop drawing is returned "reviewed as noted" this Contractor must provide written indication that the comments have been complied with.**

A partial list of shop drawings includes:

  - .1 Panelboards
  - .2 Emergency generator
  - .3 Fire alarm system
  - .4 Luminaires
  - .5 Emergency battery units and fixtures
  - .6 Starters, contactors and control devices
  - .7 Firestopping materials
  - .8 Wiring devices
  - .9 Occupancy sensors
  - .10 Co-ordination study
  - .11 Roof cone
  - .12 Integrated Life Safety System Testing Plan (ITP)
- .2 Submissions shall be submitted electronically as per the following directions:
  - .1 Electronic Submissions:
    - .1 Electronically submitted shop drawings shall be prepared as follows:
      - .1 Use latest software to generate PDF files of submission sheets.
      - .2 Scanned legible PDF sheets are acceptable. Image files are not acceptable.

- .3 PDF format shall be of sufficient resolution to clearly show the finest detail.
- .4 PDF page size shall be standardized for printing to letter size (8.5"x11"), portrait with no additional formatting required by the consultant. Submissions requiring larger detail sheets shall not exceed 11"x17".
- .5 Submissions shall contain multiple files according to section names as they appear in Specification.
- .6 File names shall include consultant project number and description of shop drawing section submitted.
- .7 Each submission shall contain an index sheet listing the products submitted, indexed in the same order as they appear in the Specification. Include associated PDF file name for each section.
- .8 On the shop drawing use an "electronic mark" to indicate what is being provided.
- .9 **Each file shall bear an electronic representation of the "company stamp" of the contractor. If not stamped the file submission will not be reviewed.**
- .2 Email submissions shall include subject line to clearly identify the consultants' project number and the description of the shop drawings submitted.
- .3 Electronic attachments via email shall not exceed 10MB. For submissions larger than 10MB, multiple email messages shall be used. Denote related email messages by indicating "1 of 2" and "2 of 2" in email subject line for the case of two messages.
- .4 Electronic attachments via web links (URL) shall directly reference PDF files. Provide necessary access credentials within link or as username/password clearly identified within body of email message.
- .5 On site provide one copy of the "reviewed" shop drawings in a binder as noted above.
- .6 Contractor to print copies of "reviewed" shop drawings and compile into maintenance manuals in accordance with requirements detailed in this section.

#### 1.12 CARE, OPERATION AND START-UP

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

**1.13 VOLTAGE RATINGS**

- .1 Operating voltages: to CAN3-C235-83.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

**1.14 PERMITS, FEES AND INSPECTION**

- .1 A submission has been made (if required by this scope of project) by the consultant to the Electrical Safety Authority for review of this project. The payment of the required review costs will be co-ordinated by the consultant. A copy of the Electrical Safety Authority review report will be forwarded to the successful contractor for information and action.
- .2 The contractor is required to include in his tender all required inspection costs by the Electrical Safety Authority. Permit application is the responsibility of the contractor.
- .3 Reproduce drawings and specifications required by Electrical Safety Authority at no cost.
- .4 Notify Consultant of changes required by Electrical Safety Authority prior to making changes.
- .5 Furnish Certificates of Acceptance to Engineer from Electrical Safety Authority and other authorities having jurisdiction upon completion of work.
- .6 This contractor must furnish any certificates required to indicate that the work completed conforms with laws and regulations of authorities having jurisdiction.

**1.15 MATERIALS AND EQUIPMENT**

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

**1.16 ELECTRIC MOTORS, EQUIPMENT, AND CONTROLS**

- .1 Supplier and installer responsibility is indicated in the Equipment Wiring Schedule on electrical drawings.
- .2 Control wiring and conduit is specified in the Electrical specifications except for conduit, wiring and connections below 50 V, which are related to control systems specified in the Mechanical specifications.

**1.17 FINISHES**

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish.
  - .2 Paint indoor switchgear and distribution enclosures light grey.

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

### 1.18 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates as follows:
- .2 Nameplates:
  - .1 Lamicoid 3 mm (1/8") thick plastic engraving sheet, black face, white core, mechanically attached with self tapping screws.

#### NAMEPLATE SIZES

Size 1	9 mm x 50 mm (3/8" x 2")	1 line	3 mm (1/8") high letters
Size 2	12 mm x 70 mm (1/2" x 2 1/2")	1 line	5 mm (3/16") high letters
Size 3	12 mm x 70 mm (1/2" x 2 1/2")	2 lines	3 mm (1/8") high letters
Size 4	20 mm x 90 mm (3/4" x 3 1/2")	1 line	9 mm (3/8") high letters
Size 5	20 mm x 90 mm (3/4" x 3 1/2")	2 lines	5 mm (3/16") high letters
Size 6	25 mm x 100 mm (1" x 4")	1 line	12 mm (1/2") high letters
Size 7	25 mm x 100 mm (1" x 4")	2 lines	6 mm (1/4") high letters

- .3 Wording on nameplates labels to be approved by Consultant prior to manufacture.
- .4 Allow for average of twenty-five (25) letters per nameplate.
- .5 Identification to be English.
- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .7 Nameplates for disconnects, starters and contactors must indicate equipment being controlled and voltage.
- .8 Nameplates for transformers must indicate transformer label as indicated and capacity, primary, and secondary voltages.

### 1.19 WIRING IDENTIFICATION

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

### 1.20 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 (45') intervals.

- .3 Colour bands must be 25 mm (1") wide.

	<u>Prime</u>
up to 208 V	yellow
209 to 600 V	white
Voice system	green
Data System	orange
Security	brown
Public address	black
Cable TV	blue
Fire alarm	red
Emergency lighting	pink

- .4 This contractor must paint all system junction boxes and covers in conformance with the above schedule.

### 1.21 PROTECTION OF OPENINGS

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

### 1.22 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

### 1.23 MANUFACTURERS AND CSA LABELS

- .1 All labels must be visible and legible after equipment is installed.

### 1.24 WARNING SIGNS

- .1 To meet requirements of Electrical Safety Authority and Consultant.  
 .2 Provide porcelain enamel signs, with a minimum size of 175 mm x 250 mm (7" x 10").

### 1.25 LOCATION OF OUTLETS

- .1 Do not install outlets back-to-back in wall; allow minimum 150 mm (6") horizontal clearance between boxes.  
 .2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3 m (10'), and information is given before installation.  
 .3 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

### 1.26 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise. Coordinate with block coursing (if applicable).  
 .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: 1100 mm (43.3").

- .2 Wall receptacles:
  - .1 General: 400 mm (16").
  - .2 Above top of continuous baseboard heater: 200 mm (8").
  - .3 Above top of counters or counter splash backs: 100 mm (4").
  - .4 In mechanical rooms: 1200 mm (48").
- .3 Panelboards: as required by Code or 1400 mm (56").
- .4 Voice/Data outlets: At height of adjacent outlet or at 400 mm (16").
- .5 Fire alarm stations: 1200 mm (3' - 11").
- .6 Fire alarm visual and signal devices: 2250 mm (88 ½").
- .7 Television outlets: 400 mm (16").
- .8 Thermostat: 1200 mm (3'-11").
- .9 Clocks: 2100 mm (84").
- .10 Heaters: 200 mm (8" AFF) to bottom of heater.
- .11 Emergency call switches and/or pushbuttons: 900 mm (36").

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

#### **1.28 CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete shall be schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm (2") beyond either side.
- .2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

#### **1.29 FIELD QUALITY CONTROL**

- .1 Conduct and pay for following tests:
  - .1 Power 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, security.

- .2 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .3 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.
- .4 Carry out tests in presence of Consultant.
- .5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .6 Submit test results for Consultant's review.

### **1.30 CO-ORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as indicated on drawings or as determined from co-ordination study.

### **1.31 GUARANTEE AND WARRANTY**

- .1 At the substantial completion stage of this project this Contractor must provide a written guarantee indicating that any defects, not due to ordinary wear and tear or improper use which occur within the first year from the date of substantial completion will be corrected at the contractors expense.
- .2 **If the electrical sub-contractor's office is 50 kilometers (30 miles) or more from the project site, the sub-contractor is to provide a service/warranty work agreement for warranty period with a local electrical sub-contractor approved by Consultant. Include copy of service/warranty agreement in warranty section of operation and maintenance manual.**
- .3 Warranty period shall start from date of substantial completion.
- .4 Refer to individual specification sections for information on any special manufacturer's equipment warranties.

### **1.32 SYSTEM START UP**

- .1 Provide consultant with written notice verifying all equipment operation and installation is complete prior to scheduled start-up period.
- .2 Start up shall be in presence of the following: owner or representative, contractor, and manufacturer's representative. Each person shall witness and sign off each piece of equipment. Consultant's attendance will be determined by consultant.
- .3 Arrange with all parties and provide 72 hours notice for start up procedure.
- .4 Simulate system start up and shut down and verify operation of each piece of equipment.
- .5 These tests are to demonstrate that the systems and equipment installed are operational as specified.

- .6 The contractor must describe during the start up session the required maintenance for each piece of equipment according to the manufacturer.
- .7 The contractor must provide all necessary tools (including a digital multimeter) to successfully complete the start up procedure.

### **1.33 OPERATION AND MAINTENANCE MANUAL**

- .1 Provide operation and maintenance data for incorporation into manual as specified in other Sections of this Division.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, Consultant before final inspection. Make changes as requested and re-submit as directed by Consultant.
- .3 Submit one manual for approval. Two manuals will be required at project completion. Each of which shall be in a three ring binder (minimum 50 mm (2") ring) labelled:
  - .1 Operation and Maintenance Manual.
  - .2 Project Name.
  - .3 Location.
- .4 Each manual must include (in "tabbed" sections) the following:
  - .1 Index
  - .2 List of General, Mechanical, Electrical Contractors and all associated sub-contractor names, addresses and contact numbers.
  - .3 List of suppliers and equipment wholesalers local to the project.
  - .4 One year warranty letter for all parts, equipment and workmanship.
  - .5 List of manufacturers, spare parts list and source.
  - .6 Copy of typewritten schedules for all new and renovated panels.
  - .7 Receipt of spare lamps and fuses from owner's representative.
  - .8 Receipt of turned over keys for electrical panels.
  - .9 Final certificate from the Electrical Safety Authority.
  - .10 Final Fire alarm verification certificate including field technician device sheets and ULC monitoring certificate.
  - .11 Certificate of exit/emergency lighting testing as per the specification.
  - .12 Copy of electrical shop drawings which have been stamped and reviewed by Consultant.
  - .13 Electrical As-built drawings including contractor company's as built stamp.
  - .14 Coordination study/Arc flash hazard study shop drawings.
  - .15 Any special warranties on equipment required (i.e. LED lighting, digital lighting control, SPDs, power generation).
  - .16 Certificate of completion from all associated sub-contractors.
  - .17 Generator test results.
  - .18 System commissioning certificate and report.



- .5 Upon acceptance of Operation and Maintenance Manual by the consultant, a pdf file of the entire manual is to be provided on a USB stick. Only one USB stick is to be provided containing both the approved manuals and as-built drawings.

### **1.34 AS-BUILT DRAWINGS**

- .1 Site records:
  - .1 Contractor shall provide 2 sets of reproducible electrical drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur. This shall include field and contract changes to electrical systems.
  - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection at all times.
- .2 As-built drawings:
  - .1 Identify each drawing in lower right hand corner in letters at least 3 mm (1/8") high as follows: - "AS-BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW ELECTRICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
  - .2 Submit hard copy to Consultant for approval. When returned, make corrections (if any) as directed.
  - .3 Once approved, submit completed reproducible paper as-built drawings as well as a scanned pdf file copy on USB stick with Operating and Maintenance Manuals. Submit approved completed reproducible paper as-built drawings as well as a scan pdf of **each** drawing file on USB stick (note pdf's cannot be combined).

### **1.35 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS**

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Manufacturers or their representatives are to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, As-built drawings, audio visual aids, etc. as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Where deemed necessary, Consultants may record these demonstrations on video tape for future reference.

### **1.36 SUBSTANTIAL PERFORMANCE**

- .1 Complete the following to the satisfaction of the consultant prior to submission of substantial performance.
  - .1 As-built Drawings.
  - .2 Maintenance Manuals.
  - .3 System Start up.

- .4 Instructions to Owners.
- .5 Final Certificates (Electrical Safety Authority, Fire Alarm, Emergency Lighting, Integrated Life Safety Systems Commissioning).

**1.37 TRIAL USAGE**

- .1 Consultant or owner may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

**1.38 REVISION TO CONTRACT**

- .1 Provide the following for each item in a given change notice:
  - .1 Itemized list of material with associated costs.
  - .2 Labour rate and itemized list of labour for each item.
  - .3 Copy of manufacturers/suppliers invoice if requested.

**1.39 EQUIPMENT SUPPORTS**

- .1 Equipment supports supplied by equipment manufacturer: shall be installed by the electrical contractor.
- .2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of - Structural Steel Section. Submit structural calculations with shop drawings if necessary.
- .3 Mount base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around. This installation of this pad shall be the responsibility of the electrical contractor.
- .4 This contractor shall be responsible for providing all anchor bolts and associated formed concrete bases for lighting standards as detailed.

**1.40 SLEEVES**

- .1 Pipe sleeves: at points where pipes pass through masonry, concrete, or fire rated assemblies and as indicated.
- .2 Schedule 40 steel pipe.
- .3 Sleeves with annular fin continuously welded at midpoint:
  - .1 Through foundation walls.
  - .2 Where sleeve extends above finished floor.
- .4 Sizes: minimum 6 mm (1/4") clearance all around, between sleeve and conduit.
- .5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm (1") above other floors.
- .6 Through foundation walls PVC sleeves are acceptable.

- .7 Fill voids around pipes:
  - .1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
  - .2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
  - .3 Fill future-use sleeves with easily removable filler.

#### **1.41 FIRESTOPPING**

- .1 Firestopping material and installation within annular space between conduits, ducts, and adjacent fire separation.
- .2 Provide materials and systems capable of maintaining effective barrier against flame, smoke, and gases.
- .3 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.
- .4 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation.
- .5 Provide "firewrap" blanket around services penetrating firewalls. Extent of blanket must correspond to ULC recommendations. In general wrap individual conduits with approved firewrap materials on each side of firewall. Refer to architectural drawings for FT ratings. Provide 1 and/or 2 layers of firewrap with transverse and longitudinal seams overlapped and/or butted (second layer offset from first layer). Cut edges are to be sealed with aluminum foil tape. Provide 50 mm stainless steel banding at 200 mm intervals. Install firewrap to manufacturers' recommendations for proper FT rating. Acceptable manufacturers are 3M Firemaster ductwrap or approved equal.
- .6 The firestopping materials are not to shrink, slump or sag and be free of asbestos, halogens and volatile solvents.
- .7 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.
- .8 Firestop materials are to be capable of receiving finish materials in those areas, which are exposed and scheduled to receive finishes.
- .9 Firestopping shall be inspected and approved by local authority prior to concealment or enclosure.
- .10 Install material and components in accordance with ULC certification, manufacturers instructions and local authority.
- .11 **Submit product literature and installation material on firestopping in shop drawing and product data manual.**
- .12 Acceptable manufacturers:
  - .1 Fyresleeve Industries Inc.
  - .2 General Electric Pensil Firestop Systems
  - .3 International Protective Coatings Corp.
  - .4 Rectorseal Corporation (Metacaulk)

- .5 Proset Systems
- .6 3M
- .7 AD Systems
- .8 Hilti
- .9 Royal

**Note: Fire stop material must conform to requirements of local authorities having jurisdiction. Contractor to confirm prior to application and ensure material used is compatible with that used by other trades on site.**

- .13 Ensure firestop manufacturer representative performs on site inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

#### **1.42 PAINTING**

- .1 Refer to Section Interior Painting and specified elsewhere.
- .2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .3 Prime and touch up marred finished paintwork to match original.
- .4 Restore to new condition, or replace equipment at discretion of consultant, finishes which have been damaged too extensively to be merely primed and touched up.

#### **1.43 ACCESS DOORS**

- .1 Supply access doors to concealed electrical equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 mm x 600 mm (24" x 24") for body entry and 300 mm x 300 mm (12" x 12") for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
  - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Consultant.
  - .2 Remaining areas: use prime coated steel.
  - .3 Fire rated areas: provide ULC listed access doors
- .4 Installation:
  - .1 Locate so that concealed items are accessible.
  - .2 Locate so that hand or body entry (as applicable) is achieved.
  - .3 Installation is specified in applicable sections.
- .5 Acceptable materials:
  - .1 Le Hage
  - .2 Zurn
  - .3 Acudor
  - .4 Nailor Industries Inc.

**1.44 DELIVERY STORAGE & HANDLING**

- .1 Follow Manufacturer's directions in delivery, storage, and protection, of equipment and materials.
- .2 Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury, but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in dry, heated space.

**1.45 REPAIR, CUTTING, CORING AND RESTORATION**

- .1 Be responsible for required digging, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Consultant. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
- .2 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
- .3 Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
- .4 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.
- .5 Slots, cores and openings through floors, walls, ceilings, and roofs shall be provided by this contractor but performed by a trade specializing in this type of work. This Division shall see that they are properly located and do any cutting and patching caused by its neglect to do so.

**1.46 EXISTING SYSTEMS**

- .1 Connections into existing systems to be made at time approved by Consultant. Request written approval of time when connections can be made.
- .2 Be responsible for damage to existing plant by this work.

**1.47 CLEANING**

- .1 Clean interior and exterior of all electrical equipment provided including light fixture lenses.
- .2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition.

**1.48 ASBESTOS**

- .1 If asbestos is suspected or identified cease all work in the immediate area in accordance with OSHA and notify consultant.
- .2 Each contractor and on site employee of the contractor shall have "asbestos awareness training".

- .3 The Contractor shall ensure that employees who may come into contact with asbestos due to the nature of the work that they perform, have received training that enables them to recognize asbestos and that enables them to react in accordance with the Occupational Health and Safety Act and regulations thereto should contact with asbestos occur during the course of their work.
- .4 **It is the responsibility of the contractor to review the asbestos book in the building prior to starting any work.**
- .5 Existing occupied buildings (depending upon their age) may contain asbestos in thermal insulating materials and some manufactured products, such as vinyl asbestos floor tile. Any insulating materials, on pipes, fittings, boilers, tanks, ductwork, etc. may contain asbestos and shall not be disturbed.
- .6 **A survey of each building documenting the location and condition of asbestos-containing materials is available for your mandatory review prior to commencing any work on premises.**

#### **1.49 DISCONNECTION AND REMOVAL**

- .1 Disconnect and/or remove equipment as indicated.
- .2 Cap and conceal all redundant and obsolete connections.
- .3 Provide a list of equipment to be removed to the owner, for his acceptance of same. Remove all equipment from site, which the owner does not retain.
- .4 Store equipment to be retained by owner on site where directed by consultant.

#### **1.50 OWNER SUPPLIED EQUIPMENT**

- .1 Connect to equipment supplied by the owner and make operable.

#### **1.51 ENCLOSURES**

- .1 This contractor must ensure that all electrical equipment mounted in sprinklered areas is provided with an enclosure in conformance with the Electrical Safety Code.

#### **1.52 EXISTING CONCRETE SLAB X-RAY/SCANNING**

- .1 This contractor shall retain the services of a qualified company to provide and X-Ray and/or scan of the existing buried services in walls and/or floors prior to starting any work in the affected area.
- .2 Failure to locate existing piping, conduit, rebar etc., shall not relieve this contractor of repair of same prior to installing his service.
- .3 This contractor shall be responsible for all repairs and/or replacement of existing services caused by cutting the existing concrete slabs and/or walls.

**END OF SECTION**

**Part 1 General****1.1 GENERAL PROVISIONS**

- .1 Conform to the General Provisions of Division 1 and Electrical General Requirements Section.
- .2 This project is one of a retrofit nature in part, and which will require extensive demolition.
- .3 Allow for all remedial work in areas indicated on the drawings and as generally defined in the relevant sections of the specifications.

**1.2 SCOPE OF WORK**

- .1 The scope of work is essentially the selected disconnection and/or removal of services and/or equipment, devices etc. as indicated or required to complete the work.
- .2 The reference drawings indicate some of the services which shall remain and some may have to be retained through construction and a phased changeover to help construction i.e. electrical service, phone service, winter heat, and temporary construction services i.e. washroom facility. This co-ordination remains the responsibility of the contractors.

**Part 2 Products****2.1 GENERAL**

- .1 This Division is to liaise with the Owners or Consultant for equipment being removed that may be suitable for reuse to that specified or handed over to the owner.
- .2 This Division to take full responsibility for any special tools or equipment required to disassemble or remove material from building.

**Part 3 Execution****3.1 GENERAL**

- .1 The general requirements are indicated on the drawings and on the outline specification in Division 1.
- .2 The general execution of the demolition is to be carried out in a clean and efficient manner.
- .3 Demolition of existing ceiling, walls etc., to facilitate removal of existing services or equipment or installation of new to be kept to a minimum and then restored to match existing.
- .4 All openings or holes created by removal of existing electrical systems which are not being reused are to be patched with the same material surrounding surfaces.
- .5 All new holes and openings to facilitate electrical systems are to be patched to match surrounding surfaces.

- .6 Protect all existing furnishings materials and equipment. Any damage occurring as a result of the work of this Division shall be repaired or replaced at the expense of this Division.
- .7 Where work involves breaking into or connecting to existing services, carry out work at times directed by the Owners in an expedient manner with minimum disruption to the facility and systems downtime.
- .8 Where unknown services are encountered immediately advise Consultant and confirm findings in writing.
- .9 Where the location of any services has been shown on the plans, such information is not guaranteed. It is this Division's responsibility to verify locations, etc., immediately after moving on site. Should for any reason the information obtained necessitates changes in procedure or design, advise the Consultant at once. If verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.
- .10 Disconnect and/or remove equipment, devices, cabling, services, etc. as indicated.
- .11 Remove all redundant and obsolete systems, connections, and wiring.
- .12 Provide a list of equipment to be removed to the owner, for their acceptance of same. Remove all equipment from site that the owner does not retain.
- .13 Maintain equipment to be retained by owner on site where directed by consultant.
- .14 Demolition of all parts of the work must be completed within the confines of the work area and in such a way as the dust produced and risk to injury of will not adversely affect the building users.
- .15 Demolished areas of the existing building will remain in their current use in some cases. Demolition in these areas must be kept to the minimum required to complete the work.
- .16 Demolition shall take place within areas isolated from all other areas with appropriate hoarding, scaffolding, netting, fencing or other means of security between building users and the work.

**END OF SECTION**



**Part 1 General****1.1 INTENT**

- .1 Life safety and fire protection systems are to be installed to comply with the provisions of the current Ontario Building and Fire Codes. As a result, testing of these integrated systems must be performed as a whole to ensure the proper operation and inter-relationship between systems (functional testing).
- .2 The testing is to provide functional verification and documented confirmation that these building systems satisfy the intent of the Building Code.
- .3 These systems as applicable to any given project include but are not limited to fire alarm, smoke and carbon monoxide alarms, sprinkler system and associated valves, standpipe, smoke control, ventilation, and pressurization systems, door hold open devices, elevator recalls, smoke, fire shutters, and dampers, emergency power generator, fire pump assemblies, and emergency lighting.

**1.2 GENERAL**

- .1 This testing process is the responsibility of the Integrated Testing Firm as a sub-contractor to the electrical trade. Electrical trade to include all costs associated with the Integrated Testing Coordinator in contract.
- .2 This process must be co-ordinated with suppliers and sub-contractors associated with these systems (mechanical and/or electrical).
- .3 This process must be co-ordinated with the project construction schedule and be completed, including all associated documentation, prior to the consultant's certification of the project for occupancy.
- .4 All applicable contractors, sub-contractors, and suppliers are to include all required costs in their respective tender costs.
- .5 All work is to be performed in accordance with CAN/ULC S1001-2011. Special consideration is to be given to the Sample Integrated Testing Plan (ITP), the review of life safety system design documents, and the provision of test plans and reports.
- .6 The work to be performed by this contractor is also described in CAN/ULC S1001-2011.
- .7 Refer to CAN/ULC S1001-11 Rev1-2019 Informative Annex (C) for Sample Integrated Testing Plan (ITP).

**1.3 QUALITY ASSURANCE**

- .1 The following criteria must be met in order to be considered an acceptable Integrated Testing Coordinator for this project:
  - .1 Manufacturers: Firms regularly engaged in functional testing and implementation of life safety and fire protection systems for not less than five years.

- .2 Qualifications: Firms with at least five years of successful experience in facility construction, inspection, acceptance testing or commissioning as it relates to fire protection and life safety and equipment similar to that required for this project.
  - .3 The Contractor shall be an established commissioning contractor that has had and currently maintains a locally run and operated business for at least five years.
  - .4 The Contractor shall show satisfactory evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the systems.
- .2 Pre-qualified Life Safety Systems Testing Firms include these listed below or local branches of the companies noted in the vicinity of this project:
- .1 Georgian Bay Fire and Safety Ltd.  
1700 20th Street East  
Owen Sound, Ontario
  - .2 Vintage Fire and Life Safety Ltd.  
25 Coverdale Cres.  
Kitchener, Ontario N2M 4X1
  - .3 Troy Life and Fire Safety  
805 Boxwood Dr., Unit #201  
Cambridge, Ontario N3E 1A4
  - .4 Control Tech Systems  
31 Regal Road  
Guelph, Ontario N1K 1B6
  - .5 Lonergan Engineering  
4 Industrial Parkway South  
Aurora, Ontario L4G 3W1

**NOTE: This agent must be a third party firm NOT associated with this project in any way and be under contract with the electrical sub-contractor not the fire alarm supplier.**

- .3 Other firms to these listed above, who feel they are capable, must submit in writing, to the Consultant's office confirmation of the items listed in the criteria above, a minimum of one week prior to tender close in order to be considered as a bidder.

#### **1.4 GENERAL REQUIREMENTS**

- .1 The Commissioning Process shall generally encompass and co-ordinate the following key areas:
  - .1 Integrated systems testing planning.
  - .2 Integrated systems testing implementation (functional testing).
  - .3 Integrated systems testing documentation

**1.5 RESPONSIBILITIES**

- .1 General Contractor:
  - .1 The general contractor shall verify completeness of the building envelope, perimeter and interior items which affect proper operation of the noted systems.
  - .2 The general contractor will assure participation and co-operation of Sub-Contractors and Specialty Contractors (mechanical, electrical, building management, etc.) under the General Contractor's jurisdiction as required for the commissioning process.
- .2 Mechanical Contractor:
  - .1 Verify Functional performance of associated mechanical systems for compliance with design intent as specified in the appropriate Specification sections.
  - .2 Provide the documentation with standard Functional performance reports on completion of the testing.
  - .3 Verify submissions for system operation and maintenance manuals, as-built documents, spare parts listing, special tools listing, and other items as may be specified.
- .3 Electrical Contractor:
  - .1 The Integrated Life Safety Systems Testing Coordinator (ITC) is being retained by the electrical contractor, however; this contractor's work to satisfy the ITC requirements shall be included in the tender price.
  - .2 Verify Functional performance of electrical systems for compliance with design intent as specified in the appropriate Specification sections.
  - .3 Provide the documentation with standard Functional performance reports on completion of the testing.
  - .4 Verify submissions for electrical system operation and maintenance manuals, as-built documents, spare parts listing, special tools listing, and other items as may be specified.
  - .5 As a minimum this contractor must include for:
    - .1 Providing the ITC with documentation of design and shop drawings.
    - .2 Provide documents for sequence of operation and maintenance of system.
    - .3 Testing of all components and accessories to confirm Alarm/Supervisory/Trouble at the fire panel.
    - .4 Testing and operation of any generator (s) as applicable to the project.
    - .5 Other items that may be requested by the ITC.
    - .6 Re-commissioning of any items that may have failed.
    - .7 Re-setting of the system to proper operation after tests are completed.
    - .8 Provide written confirmation that life safety systems are installed in accordance with applicable codes and standards, as well as the scope of the project engineering documents.

.9

.4 Equipment Manufacturers:

- .1 The equipment manufacturers shall be responsible for providing labour, material, equipment, etc., required within the scope of the respective equipment to facilitate the commissioning process.
- .2 The equipment manufacturers will perform Pre-Functional and Functional Performance Tests required by the commissioning process.

.5 Design Engineer:

- .1 The design engineer shall review and provide written confirmation of acceptance of the Integrated Testing Plan (ITP).
- .2 The design engineer shall observe Functional Performance Testing, at his discretion.
- .3 The design engineer shall provide technical capabilities for resolution of deficiencies, where required.
- .4 The design engineer shall provide necessary information to assist Integrated Test Coordinator including written confirmation of life safety systems installation in accordance with project engineering documents and are ready for integrated testing.

**Part 2 Commissioning Process**

**2.1 OPERATIONS AND MAINTENANCE MANUALS**

- .1 Furnish Final, reviewed Operation and Maintenance Manuals to the Consultant fourteen (14) days prior to scheduled Functional Performance Tests.

**2.2 FUNCTIONAL PERFORMANCE TEST**

- .1 The contractor shall be responsible for the Functional Performance Tests. These tests ensure that all equipment and systems are installed in accordance with the Specifications, Drawings, and manufacturers' requirements.
- .2 The contractor shall be responsible for co-ordinating schedule for Functional tests of various equipment and systems.
- .3 In the Functional Test, all noted systems and sub-systems shall be checked for the following:
  - .1 Verify that each element has been properly installed, properly identified, and that all connections have been made correctly.
  - .2 Verify that tests, meter readings, and specific mechanical/electrical performance characteristics agree with those required by equipment or system manufacturer.
  - .3 Re-commission any item(s) that may have failed.
  - .4 Notify the consultant in writing, at least fourteen (14) days prior to the date of Functional Performance Testing. Schedule the Functional performance tests over a period of consecutive business days.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 CSA C22.2 No.0.3-92, Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No.131-M89(R1994), Type TECK 90 Cable.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Electrical General Requirements Section.

**Part 2 Products****2.1 BUILDING WIRES**

- .1 Conductors: stranded for 10 AWG and larger.
- .2 Minimum size: 12 AWG.
- .3 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene material 90°C (194°F) rated T90 for indoor above grade installations and RW90 for below grade installations.

**2.2 TECK CABLE**

- .1 Cable: to CAN/CSA-C22.2 No.131.
- .2 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper, size as indicated.
- .3 Inner jacket: polyvinyl chloride material.
- .4 Armour: aluminum.
- .5 Overall covering: polyvinyl chloride material.
- .6 Fastenings:
  - .1 One hole steel zinc straps to secure surface cables 50 mm (2") and smaller. Two hole steel straps for cables larger than 50 mm (2").
  - .2 Channel type supports for two or more cables at 1500 mm (60") centres.
  - .3 Threaded rods: 6 mm (1/4") diameter to support suspended channels.
- .7 Connectors must be suitable for:
  - .1 Installed environment and approved for use with TECK cable.

**2.3 ARMoured CABLES**

- .1 Conductors: insulated, copper minimum size as indicated above.
- .2 Type: AC90 (minimum size 12 AWG).
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Connectors must be suitable for installed environment and approved for use with armoured cable.

**Part 3 Execution****3.1 INSTALLATION OF BUILDING WIRES**

- .1 Install wiring from source to load through raceways as specified.
- .2 Provide separate neutral conductors for all lighting circuits and circuits originating from surge protected panels. Size raceways accordingly.

**3.2 INSTALLATION OF TECK CABLE 0 - 1000 V**

- .1 Group cables wherever possible on channels.
- .2 Terminate cables in accordance with Wire and Box Connectors - 0 - 1000 V Section.

**3.3 INSTALLATION OF ARMoured CABLES**

- .1 Group cables wherever possible.
- .2 Terminate cables in accordance with Wire and Box Connectors - 0 - 1000 V Section.
- .3 These cables are to be installed in concealed locations only. These concealed locations are considered to be stud walls and "drops" to stud walls, lighting fixtures, and ceiling mounted devices.
- .4 **These "drops" shall not be permitted to exceed 2.4 m (8'-0"). To limit these "drops" to lengths noted above provide additional branch wiring in conduit.**

**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 Electrical General Requirements Section.

**Part 2 Products****2.1 MATERIALS**

- .1 Splitters must conform to CSA C22.2 No. 76 (latest edition).
- .2 Junction and pull boxes must conform to CSA C22.2 No. 40 (latest edition)

**2.2 SPLITTERS**

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

**2.3 JUNCTION AND PULL BOXES**

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

**Part 3 Execution****3.1 SPLITTER INSTALLATION**

- .1 Install splitters and mount plumb, true and square to the building lines on 19 mm (3/4") painted plywood backboards.

**3.2 JUNCTION AND PULL BOXES INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Install junction and pull boxes so as not to exceed 30 m (100') of conduit run between pull boxes and in conformance with the Electrical Safety Code.

**3.3 IDENTIFICATION**

- .1 Provide equipment identification in accordance with General Electrical Requirements Section.
- .2 Install size 2 identification labels indicating system name, voltage and phase.

**END OF SECTION**



**Part 1 General****1.1 REFERENCES**

- .1 Outlet boxes, conduit boxes, and fittings must conform to CSA C22.2 No. 18 (latest edition).

**Part 2 Products****2.1 OUTLET AND CONDUIT BOXES GENERAL**

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm (4") 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.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

**2.2 SHEET STEEL OUTLET BOXES**

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 mm x 50 mm x 64 mm (3" x 2" x 2½") or as indicated. 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required. Iberville 1104 Series.
- .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit **in utility rooms**, minimum size 102 mm x 57 mm x 38 mm (4" x 2¼" x 1½"). Iberville 1110 Series.
- .3 102 mm (4") square or octagonal outlet boxes for lighting fixture outlets.
- .4 102 mm (4") square outlet boxes with extension and plaster rings for flush mounting devices in finished tile walls.

**2.3 MASONRY BOXES**

- .1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.

**2.4 CONDUIT BOXES**

- .1 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle **in areas (other than utility rooms) where surface conduit is used.**

**2.5 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 (1- 1/4") 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 (1/4") of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.

**END OF SECTION**

**Part 1           General****1.1               REFERENCES**

- .1       CSA C22.2 No.65-1956(R1965) Wire Connectors.

**Part 2           Products****2.1               MATERIALS**

- .1       Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as indicated.
- .2       Fixture type splicing connectors: with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3       Clamps or connectors for armoured cable, mineral insulated cable, and flexible conduit, as required.

**Part 3           Execution****3.1               INSTALLATION**

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

**END OF SECTION**

**Part 1**            **General**  
**Not Applicable.**

**Part 2**            **Products**

**2.1**                **MATERIALS**

- .1            Grounding equipment must conform to CSA C22.2 No 41 (latest edition).

**2.2**                **EQUIPMENT**

- .1            Clamps for grounding of conductor: size as required to electrically conductive underground water pipe and electrically conductive metal gas piping.
- .2            Rod electrodes: copper clad steel 19 mm (3/4") diameter by 3 m (10') long.
- .3            Plate electrodes: galvanized steel, surface area 0.2 m<sup>2</sup>, minimum 1.6 mm thick.
- .4            Insulated grounding conductors: green with insulation type that matches specified phase conductors. Gauge shall be in conformance with the latest edition of the Electrical Safety Code to suit required installation conditions.
- .5            Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .6            Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
- .1            Grounding and bonding bushings.
  - .2            Protective type clamps.
  - .3            Bolted type conductor connectors.
  - .4            Thermit welded type conductor connectors.
  - .5            Bonding jumpers, straps.
  - .6            Pressure wire connectors.

**Part 3**            **Execution**

**3.1**                **INSTALLATION GENERAL**

- .1            Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. **Where 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            Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5            Soldered joints not permitted.
- .6            Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

**3.2 ELECTRODES**

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter. This shall apply to the installation or replacement of building water service.
- .2 Make ground connections to continuously conductive metal gas piping system. This shall apply to installation or replacement of gas appliances, as well as installation or modification of a building gas piping system.
- .3 Corrugated metal tubing shall not be used as a bonding means for the gas piping system.
- .4 Bond separate, multiple electrodes together.
- .5 Use #2/0 copper conductors for connections to electrodes. Size in conformance with the Electrical Safety Code.

**3.3 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, and outdoor lighting.

**3.4 COMMUNICATION SYSTEMS**

- .1 Install grounding connections for fire alarm systems as follows:
  - .1 Sound, fire alarm, computer network systems as indicated.

**3.5 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Electrical General Requirements Section.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of 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 REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CAN/CSA C22.2 No.18-92, Outlet Boxes, Conduit Boxes, and Fittings.
  - .2 CSA C22.2 No.45-M1981(R1992), Rigid Metal Conduit.
  - .3 CSA C22.2 No.56-1977(R1977), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CSA C22.2 No.83-M1985(R1992), Electrical Metallic Tubing.
  - .5 CSA C22.2 No.211.2-M1984(R1992), Rigid PVC (Unplasticized) Conduit.
  - .6 CAN/CSA C22.2 No.227.3-M91, Flexible Nonmetallic Tubing.

**Part 2 Products****2.1 CONDUITS**

- .1 Rigid metal conduit: to CSA C22.2 No.45, 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) with couplings: to CSA C22.2 No.83.
- .4 Rigid PVC conduit: to CSA C22.2 No.211.2.
- .5 Flexible metal conduit: to CSA C22.2 No.56, aluminum and liquid-tight flexible metal.
- .6 Flexible PVC conduit: to CAN/CSA C22.2 No.227.3, ENT.

**2.2 CONDUIT FASTENINGS**

- .1 One hole steel straps to secure surface conduits 53 mm (2") and smaller. Two hole steel straps for conduits larger than 53 mm (2").
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1.5 m (5'0") oc.
- .4 Threaded rods, 6 mm (1/4") diameter, to support suspended channels.

**2.3 CONDUIT FITTINGS**

- .1 EMT fittings shall be set screw style (zinc alloy).
- .2 Flexible metal conduit fittings shall be screw-in type.
- .3 Liquid type flexible metal conduit fittings shall be sealtite type.
- .4 PVC fittings shall be PVC type complete with PVC adaptors at all boxes.
- .5 Rigid conduit and mineral insulated conduit fittings shall be threaded type.
- .6 Coating: same as conduit.

- .7 Factory "ells" where 90° bends are required for 27 mm (1") and larger conduits.
- .8 Where bushings are noted to be provided they must be "screwed" type fastened to a conduit connector. Push-fit or glued in place bushings will NOT be accepted.

## 2.4 FISH CORD

- .1 Nylon twine.

## Part 3 Execution

### 3.1 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical/ electrical service rooms and in unfinished areas.
- .3 **Use electrical metallic tubing (EMT) for all branch circuits unless specified otherwise.**
- .4 Use rigid aluminum threaded conduit where specified and up to 2.1 m (7'0") above finish floor where exposed to mechanical injury.
- .5 Use flexible metal conduit for connection to motors in dry areas, connection to recessed fixtures without a prewired outlet box, connection to surface or recessed fixtures, work in movable metal partitions.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations and for connections to kitchen equipment.
- .7 Conduits terminating at electrical equipment in sprinklered areas are to be provided with insulated compression style connectors equal to Thomas & Betts Cat. #TC8XXSC or approved equal.
- .8 **Minimum conduit size for branch circuits shall be 21 mm (3/4").** Single drops from ceiling mounted junction boxes down to a light switch or duplex receptacle may be reduced to 16 mm (1/2").
- .9 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .10 Mechanically bend steel conduit over 27 mm (1") diameter.
- .11 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .12 Install fish cord in empty conduits.
- .13 Run 2- 27 mm (1") spare conduits up to accessible ceiling space from each flush panel. Terminate these conduits in 152 mm x 152 mm x 102 mm (6" x 6" x 4") junction boxes in ceiling space.
- .14 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .15 Dry conduits out before installing wire.

**3.2 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m (5') clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm (3") parallel to steam or hot water lines with minimum of 25 mm (1") at crossovers.
- .7 Do not fasten surface conduit larger than 25 mm (1") to roof deck. Provide standoffs or supports as manufactured by Caddy or use unistrut trapeze fastened to structure.**

**3.3 CONCEALED CONDUITS**

- .1 Do not install horizontal runs in masonry walls.
- .2 Do not install conduits in terrazzo or concrete toppings.

**3.4 CONDUITS UNDERGROUND**

- .1 Slope conduits to provide drainage.

**END OF SECTION**



**Part 1 General****Part 2 Products****2.1 MATERIALS**

- .1 Rigid PVC ducts must conform to CSA C22.2 No. 211.0, 211.1 and 211.2 (latest edition).
- .2 Ducts and/or cables must be excavated, bedded, reinforced, encased, and backfilled as per details on the drawings.

**2.2 DUCT**

- .1 Ducts indicated for encasement in concrete must be type DB-2. Ipex "Super Duct" or approved equal.
- .2 Ducts indicated for direct burial must be type SCEPTER. Ipex "Scepter" rigid PVC duct or approved equal.

**2.3 DUCT FITTINGS**

- .1 Fittings required to provide a complete continuous ductbank installation shall include but not be limited to, couplings, bell end fitting, caps, adapters, base and intermediate spacers.
- .2 Small or large angle couplings will be required where noted on the drawings.
- .3 Expansion joints are to be provided when running ducts in concrete across expansion joints and where exposed on roofs or exterior of buildings.

**Part 3 Execution****3.1 BASIC INSTALLATION**

- .1 Excavate trench along route as indicated and at a depth to suit cables and/or ducts as detailed.
- .2 If required, trench is to be pumped to maintain excavation free of water.
- .3 Import granular fill and place in bottom of trench. Compact to provide a firm level base.
- .4 Quantity and arrangement of ducts must be provided according to drawing details.
- .5 When ducts terminate at buildings or precast bases provide bell end fittings.
- .6 When terminating a ductbank for future extension terminate each duct with a coupling. If ducts are encased in concrete set coupling flush with end of concrete.
- .7 Attach ducts to spacers using non-metallic materials.
- .8 Provide concrete as detailed. Pour concrete down sides of ductbank to ensure spaces around and under ducts are filled first.
- .9 Concrete must obtain 50% of its specified strength prior to backfilling.
- .10 Backfilling must be imported granular 'A' material.**

- .11 Backfill must be placed as 150 mm (6") compacted lifts.
- .12 Excess excavated material must be removed from site by this contractor.
- .13 Ensure ducts indicated to be installed along a curb line are installed at least 600 mm (24") from that curb line.

### **3.2 DIRECT BURIAL OF DUCTS**

- .1 After sand bed specified is in place, lay ducts maintaining 75 mm (3") clearance from each side of trench to nearest duct. Do not pull cable into trench.
- .2 Provide offsets for thermal action and minor earth movements. Offset ducts 150 mm (6") for each 60 m (200') run, maintaining minimum duct separation, and bending radius requirements.
- .3 Underground cable splices not acceptable.
- .4 Duct separation:
  - .1 Provide separation of ducts in conformance with the details in the Electrical Safety Code.

### **3.3 CABLE INSTALLATION IN DUCTS**

- .1 Install cables as indicated in ducts.
- .2 Do not pull spliced cables inside ducts.
- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .5 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables are properly terminated, seal ends of cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

**3.4 FIELD QUALITY CONTROL**

- .1 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .2 Check phase rotation and identify each phase conductor of each feeder.
- .3 Check each feeder for continuity, short circuits, and grounds. Ensure resistance to ground of circuits is not less than 50 mega ohms.
- .4 Pre-acceptance tests.
  - .1 After installing cable but before terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
- .5 Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.
- .6 Remove and replace entire length of cable if cable fails to meet any of test criteria.
- .7 The Consultant requires a minimum of 48 hours notice to inspect at his discretion the following; ductbank excavation, bedding and duct placement, pouring and/or placement of ductbank encasement.**

**END OF SECTION**

**Part 1           General****1.1           GENERAL REQUIREMENTS**

- .1       The studies must be submitted to the Consultant prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Consultant may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.
- .2       The studies shall include all portions of the electrical distribution system from the normal power source or sources down to and including the smallest adjustable trip circuit breaker in the distribution system. Normal system connections and those, which result in maximum fault conditions, shall be adequately covered in the study.
- .3       The firm should be currently involved in high- and low-voltage power system evaluation. The study must be performed, stamped and signed by a registered professional engineer in the Province of Ontario. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Consultant for approval prior to start of the work. A minimum of five (5) years experience in power system analysis is required for the individual in charge of the project.
- .4       The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.
- .5       The extent of the studies shall be limited to the new electrical distribution equipment shown on the distribution riser diagram.

**1.2           DATA COLLECTION FOR THE STUDY**

- .1       The Contractor shall provide the required data for preparation of the studies. The Consultant performing the system studies shall furnish the Contractor with a listing of the required data immediately after award of the contract.
- .2       The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacturing.
- .3       Data collected for the study, including correspondence with local utility, shall be included with study report.

**Part 2           Products****2.1           SHORT CIRCUIT AND PROTECTIVE DEVICE EVALUATION AND COORDINATION STUDY**

- .1       The short-circuit study shall be performed with the aid of a digital computer program and shall be in accordance with the latest applicable IEEE and ANSI standards.

- .2 In the short-circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short-circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low-voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant overcurrent protective device locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor fault contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.
- .3 In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
- .4 Include on the curve sheets power company relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. In addition, include all devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.  
  
Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical fault current to which the device is exposed.
- .5 Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.
- .6 Include complete fault calculations as specified herein based on contract documents.
- .7 Submit qualifications of individual(s) who will perform the work for approval prior to commencement of the studies. Provide studies in conjunction with equipment submittals to verify equipment ratings required. Submit the study to Consultant for review prior to delivery of the study to the Owner. Make all additions or changes as required by the reviewer.

- .8 Utilize equipment load data for the study obtained by the Contractor from contract documents, including contract addendum's issued prior to bid openings.
- .9 Include fault contribution of all motors in the study. Notify the Consultant in writing of circuit protective devices not properly rated for fault conditions.
- .10 When emergency generator is provided, include phase and ground coordination of the generator protective devices. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Contractor shall obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.
- .11 Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.
- .12 For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current and time to ensure protective devices will not trip during major or group start operation.

## 2.2

### ARC FLASH HAZARD ANALYSIS

- .1 The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E – Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D and CSA Z462-(latest edition).
- .2 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- .3 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.
- .4 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- .5 The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.
- .6 Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm<sup>2</sup>.
- .7 The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- .8 Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

- .9 Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-latest edition section B.1.2.

### **2.3 STUDY REPORT**

- .1 The results of the power system study shall be summarized in a final report. Submit report in accordance with Electrical General Requirements Section as a shop drawing.
- .2 The report shall include the following sections:
  - .1 Descriptions, purpose, basis, and scope of the study.
  - .2 Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
  - .3 Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
  - .4 Fault current calculations including a definition of terms and guide for interpretation of computer printout.
  - .5 Incident energy and flash protection boundary calculations
    - .1 Arcing fault magnitude
    - .2 Device clearing time
    - .3 Duration of arc
    - .4 Arc flash boundary
    - .5 Working distance
    - .6 Incident energy
    - .7 Hazard Risk Category
    - .8 Recommendations for arc flash energy reduction
    - .9 **Recommendations for Personal Protection Equipment (PPE) level.**

### **Part 3 Execution**

#### **3.1 POWER COMPANY APPROVAL**

- .1 Copies of the final report must be submitted to the power company for their review and approval. Approved copies of the report shall be submitted to the Consultant.

#### **3.2 FIELD SETTINGS**

- .1 The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study, and protective device coordination study.
- .2 Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved short-circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the Owner.

**3.3 ARC FLASH WARNING LABELS**

- .1 The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- .2 The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:
  - .1 Location designation
  - .2 Nominal voltage
  - .3 Flash protection boundary
  - .4 Hazard risk category
  - .5 Incident energy
  - .6 Working distance
  - .7 Personal Protection Equipment (PPE) level
  - .8 Engineering report number, revision number and issue date.
- .3 Labels shall be machine printed, with no field markings.
- .4 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings:
  - .1 For each 600, 480 and applicable 208 volt panelboards, one arc flash label shall be provided.
  - .2 For each motor control center, one arc flash label shall be provided.
  - .3 For each low voltage switchboard, one arc flash label shall be provided.
  - .4 For each switchgear, one flash label shall be provided.
  - .5 For medium voltage switches one arc flash label shall be provided
- .5 **Labels shall be field installed by the firm providing the Arc Flashing Hazard Analysis.**

**3.4 ACCEPTABLE TESTING FIRMS**

- .1 MVA Engineering (519) 668-4698
- .2 GT Woods (905) 272-1696
- .3 Brosz & Associates (905) 472-6660
- .4 K-Tek Electro-services Ltd. (905) 640-0660 ext. 228

**END OF SECTION**



**Part 1 General****1.1 SHOP DRAWINGS**

- .1 Submit shop drawings for each system in Conformance with The Electrical General Requirements Section.

**1.2 PRODUCT/MAINTENANCE DATA**

- .1 Submit product/maintenance data for each system for inclusion in maintenance manual conforming to The General Electrical Requirements Section.

**1.3 SCOPE**

- .1 The scope of this Section will include the following systems.
  - .1 Occupancy sensors.

**Part 2 Products****2.1 OCCUPANCY SENSORS**

- .1 Where noted on drawings the wall mounted (passive technology) occupancy sensor used in storage and service rooms shall be either:

- .1 Hubbell Cat. # AP1277XIN (colour by Architect).
- .2 Wattstopper Cat. #PW-100-VOLT-X (colour by Architect).
- .3 Leviton Cat. #ODS-15-ID-VOLT-X (colour by Architect).
- .4 Sensor switch Cat. #WSX-VOLT-X (colour by architect).
- .5 Cooper Controls (Greengate) Cat.#ONW-P-1001-VOLT-X (colour by architect).

- .2 Where noted on the drawings, the wall mounted switch style occupancy sensor used in Administrative Offices and Seminar/Meeting Rooms shall be a dual technology switch with either single or double relay (circuit) as noted on the drawings. Colour to suit architect.

Note: For dual relay switches, program the sensor for 15 minute off delay, enabled walk-thru, audible alert enabled, relay 1 on mode: auto on, relay 2 on mode: manual on.

- .1 Single relay (circuit): Wattstopper Cat. #DW-100
- .2 Dual relay (circuit): Wattstopper Cat. #DW-200
- .3 Approved equal:
  - .1 Hubbell.
  - .2 Leviton.
  - .3 Sensor switch.
  - .4 Cooper Controls (Greengate).
- .3 Provide other occupancy sensors to suit the detail on the drawings.
- .4 All sensors shall be set to 5 minutes "delay to off" unless otherwise directed.

**Part 3 Execution****3.1 OCCUPANCY SENSORS**

- .1 Install power packs in accessible maintenance areas.
- .2 Provide access doors if power packs are installed above drywall ceilings.
- .3 Install sensors in gym where noted on plan at mid height of wall.
- .4 It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper coverage within the range of coverage as per the manufacturer's recommendations. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective rooms.
- .5 It is the contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the facility, to verify placement to sensors and installation criteria.
- .6 The contractor shall also provide the on-site training necessary to familiarize the owner's personnel with the operation, use, adjustment and problem solving diagnosis of the occupancy sensing devices systems.
- .7 Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control. Submit commissioning report with closeout documents.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Dry type transformers must conform to CSA C22.2 No.47 and C9 (latest edition).
- .2 **Dry type transformers must conform to CSA C802 (latest edition).**
- .3 **Dry type transformers must be in accordance with Ontario Green Energy Act 2018 (NRCan 2018) DOE 2016.**

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Electrical General Requirements Section.

**Part 2 Products**

**2.1 TRANSFORMERS**

- .1 Transformers to be of one manufacturer throughout project.
- .2 Ratings and characteristics shall be as indicated on riser diagrams.
- .3 Aluminum winding.
- .4 Transformers are to be ventilated dry type style with 4-2½% taps (2 F.C.B.N. and 2 F.C.A.N.)
- .5 Maximum permissible sound levels shall be as follows:

Transformer Rating (KVA)	Sound Level (dBA)
≤50	45
51 to 150	50
151 to 300	55
301 to 500	60

- .6 **All transformers with a K factor of 4 or above must be electro-static shielded.**
- .7 **Transformers with a K-factor of 4 or above must include a secondary neutral bus that is sized at twice the rated secondary phase current.**
- .8 Transformer enclosure shall be EEMAC/NEMA 3R ventilated complete with removable front panel.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Electrical General Requirements Section.

- .2 Label must indicate:
  - .1 transformer "tag" as per riser diagram
  - .2 primary and secondary voltage and phase.

### 2.3 ACCEPTABLE MANUFACTURERS:

- .1 Acceptable manufacturers are as follows:
  - .1 Hammond
  - .2 Rex
  - .3 Delta
  - .4 Acme
  - .5 Bemag

## Part 3 Execution

### 3.1 INSTALLATION

- .1 Primary and secondary feeders are to be connected using flexible conduit.
- .2 Transformers with a rating up to and including 75 KVA are permitted to be wall mounted provided mounting method is a suitably sized angle iron frame secured to structure (i.e., masonry wall, steel columns, etc. NOT metal siding).
- .3 The above rating of transformers may also be suspended from **structure only** on a unistrut trapeze as detailed.
- .4 Transformers above 75 KVA must be floor mounted.
- .5 Floor mounted transformers are to be mounted/secured to a concrete pad suitably sized to suit the transformer. This pad is the responsibility of this contractor and must be provided in conformance with the standard of Division 1 specifications for poured in place concrete.
- .6 All transformers must be mounted on vibration isolators equal to Korfund RD2-grey or approved equal.
- .7 Ensure adequate clearance around transformer for ventilation as per the Electrical Safety Code.
- .8 Install transformers in level upright position.
- .9 Remove shipping supports only after transformer is installed and just before putting into service.
- .10 Loosen isolation pad bolts until no compression is visible.
- .11 Make primary and secondary connections in accordance with wiring diagram.
- .12 Energize transformers after installation is complete.

**END OF SECTION**

**Part 1           General****1.1               PRODUCT DATA**

- .1       Submit product data in accordance with Electrical General Requirements Section.
- .2       Drawings to include electrical detail of panel, branch breaker or switch type, quantity, ampacity and enclosure dimension.

**Part 2           Products****2.1               PANELBOARDS**

- .1       Panel boards must conform to CSA C22.2 No. 29 (latest edition).
- .2       Panelboards: product of one manufacturer.
- .3       Install circuit breakers in panelboards before shipment.
- .4       In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand. **Series rating is acceptable – submit information with shop drawings.**
- .5       Bus and breakers/switches must be rated for 10000 A (symmetrical) interrupting capacity or as indicated.
- .6       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.
- .7       Panelboard mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .8       Two keys for each panelboard and key panelboards alike.
- .9       Aluminum bus with neutral of same ampere rating as mains.
- .10      Mains must be suitable for bolt-on breakers. Provide main (if applicable) and branch breakers as bolt-on style.
- .11      Trim with concealed front bolts and hinges.
- .12      Trim and door finish must be baked grey enamel.
- .13      All panels regardless of voltage and amperage must be provided with a lockable door.
- .14      Fusible pull-outs or door-operated type switches are not acceptable.
- .15      Fuse clips must be suitable for type of fuse specified for each unit.
- .16      Fuses must conform to Section 26 28 13 with sizes as indicated on drawings.

- .17 Branch circuit panelboards (250 AMP or smaller) must be one of the following:
  - .1 Eaton Cat # POW-R-LINE-C PRL-1 or PRL-2,
  - .2 Schneider Electric Cat # NQ Series
  - .3 Siemens Cat #Sentron P1 Series
- .18 Branch circuit panelboards indicated to be complete with an external surge protective
- .19 Power distribution circuit breaker panelboards (400 AMP or larger) must be one of the following:
  - .1 Eaton CAT# POW-R-Line-C PRL-3A or PRL-4A
  - .2 Schneider Electric CAT# I-Line Series (Bolt-On)
  - .3 Siemens CAT# P2 Series (up to 600A mains and maximum 100A-3P branch breakers)
  - .4 Siemens CAT# S5 Series (up to 1200A mains with branch breakers above 100A-3P)
- .20 Panels ranging in width from 368 to 558 mm (14½" to 22"), depth from 100 to 150 mm (4" to 6") and height from 533 to 1143 mm (21" to 45") are to be retrofitted. Retrofit panels must allow for the installation of new panel interior and trim to suit the existing recessed panel tub. Note: Panel manufacturers bidding this project that do not carry a panel retrofit kit must allow in their price the cost to remove the existing panel tub and replace with new including all necessary wall repairs. Retrofit panelboards shall be: Cutler Hammer Cat. # PIR-X-3-A-X-X.

## 2.2 BREAKERS

- .1 Breakers: to Moulded Case Circuit Breakers Section.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker (as specified) must be separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for fire alarm, stairway, exit and night light circuits.

## 2.3 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Electrical General Requirements Section.
- .2 Nameplate for each panelboard size 4 engraved description as indicated. In finished areas install label on inside of panel, and in service areas install label on exterior of panel.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved "name of load" as indicated.
- .4 Complete circuit directory with typewritten legend showing location of each circuit.  
**Include a copy of the directories in the maintenance manuals.**

**Part 3 Execution****3.1 INSTALLATION**

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard. Plywood shall be 21mm (3/4") fire rated or painted with intumescent fire block paint having a minimum of 1h rating, unless noted otherwise.
- .3 Mount panelboards to height specified in Electrical General Requirements Section or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus.

**END OF SECTION**

**Part 1 General****1.1 PRODUCT DATA**

- .1 Submit product data in accordance with Electrical General Requirements Section.

**Part 2 Products****2.1 BREAKERS GENERAL**

- .1 Moulded case circuit breakers must conform to CSA C22.1 No.5.1-M91 (latest edition.)
- .2 Bolt-on moulded case circuit breaker quick-make, quick-break type, for manual and automatic operation.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Unless otherwise indicated 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.
- .5 Moulded case circuit breakers 250 Amps and above are to operate by means of a 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 and ground fault short circuit protection (if indicated or applicable by the Electrical Safety Code versus the breaker amperage). Unless otherwise specified, complete system selective co-ordination shall be provided by the individually adjustable time/current curve shaping elements as following:
  - .1 Breakers shall have fixed rating plug determining breaker continuous current rating.
  - .2 All breakers shall have adjustable long delay pickup and time, L.
  - .3 All breakers shall have individual adjustments for short delay pickup and time, S; including I<sup>2</sup>t settings in time adjustment.
  - .4 Breakers shall have adjustable instantaneous pickup, I; that if required by co-ordination study can be turned off, (I).
  - .5 If required by Electrical Safety Code breakers shall have individually adjustable ground fault current pick-up and time, G; including I<sup>2</sup>t settings in time adjustment.



- .6 Unless otherwise specified, for the low voltage systems provide an electronic trip unit as specified above for the following moulded case circuit breakers:
- .1 Mains or ties in main switchboard: LS trip unit with fixed instantaneous over-ride exceeding maximum value of fault at the point of installation.
  - .2 Transformer feeder for the units 225kVA and above: LSI or LS trip unit with fixed instantaneous over-ride, where instantaneous trip setting or instantaneous over-ride allows for transformer inrush of 12xFLA at 0.1s and exceeds maximum value of fault at the transformer secondary.
  - .3 Feeders exceeding 250A trip setting: LS trip unit with fixed instantaneous over-ride exceeding maximum value of fault at downstream panelboard.
  - .4 Branch circuits or feeders for MCCs with fusible combination starters: LSI trip unit where instantaneous trip setting allows for maximum size downstream fuse total clearing time.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install circuit breakers as indicated complete with all necessary mounting hardware and filler panels if necessary.

**END OF SECTION**

**Part 1 General****1.1 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Electrical General Requirements Section.

**Part 2 Products****2.1 SWITCHES**

- .1 General purpose AC switches must conform to CSA C22.2 No. 111 (latest edition).
- .2 15 or 20 A, 120 V, single pole, double pole, three-way, four-way, keyed, or motor rated switches complete with pilot light.
- .3 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 molding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 Toggle style (Rocker style) (architect to select colour).
- .4 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .5 Switches of one manufacturer throughout project.
- .6 Acceptable materials:
  - single pole: Hubbell Cat # HBL1201 [HBL2101 (decora)] Series
  - three way: Hubbell Cat # HBL1203 [HBL2103 (decora)] Series
  - four way: Hubbell Cat # HBL1204 [HBL2124 (decora)] Series
  - Keyed: Hubbell Cat. #HBL1221 Series complete with 2 keys per switch
  - (Keys): Hubbell Cat. #HBL1209
  - Motor rated: Hubbell Cat. #HBL1221PL [HBL2121 PL (decora)] c/w pilot light (20 A):
- .7 Acceptable alternate manufacturers include:
  - .1 Pass & Seymour
  - .2 Leviton.

**2.2 RECEPTACLES**

- .1 Receptacles, plugs, and other similar wiring devices must conform to CSA 22.2 No 42 (latest edition).
- .2 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, with following features (20A where noted):
  - .1 Urea molded housing (Colour by architect).
  - .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.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.
- .5 Acceptable materials:

Standard duplex receptacle	Hubbell Cat # HBL5252CN
Ground fault protected T-slot receptacles	Hubbell Cat. # GF20L A complete with Decora style coverplate to suit specification below
T-slot receptacles	Hubbell Cat. #HBL5352
Dryer receptacle	Hubbell Cat # HBL9430A
Range receptacle	Hubbell Cat # HBL9450A

- .6 Acceptable alternate manufacturers include:
  - .1 Pass & Seymour
  - .2 Leviton

**2.3 COVER PLATES**

- .1 Cover plates from one manufacturer throughout project.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Stainless steel, brushed, 1 mm (1/32") thick cover plates for wiring devices mounted in flush-mounted outlet box.  
 Thermoplastic construction, colour to match wiring device, thickness 2.5 mm (3/32") for wiring devices mounted in flush-mounted outlet box.
- .4 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .5 Weatherproof cover plates complete with gaskets and "heavy-duty in use" covers in conformance with the Electrical Safety Authority. Provide product equal to Intermatic Cat. #WP5100C.
- .6 Where noted on plans for exterior weatherproof GFPC receptacles at grade, provide extra-duty single gang horizontal die cast receptacle covers. NEMA 3R rated complete with lockable hasp and reinforced hinge. Suitable for use with 12-gauge cord sets. Intermatic Cat. # WP1010HMXD or equal.

**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 specified in Electrical General Requirements Section or 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 specified in Electrical General Requirements Section or as indicated.
  - .3 Where split receptacle has one portion switched mount vertically and switch upper portion.
- .3 Cover plates:
  - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
  - .2 Install suitable common cover plates where wiring devices are grouped.
  - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CSA C22.2 No.248.12/94, Low Voltage Fuses Part 12: Class R (Bi-National Standard with, UL 248-12 (1st Edition).
  - .2 CSA C22.2 No. 106-M92 (latest edition).

**1.2 MAINTENANCE MATERIAL**

- .1 Three spare fuses of each type and size installed.

**1.3 DELIVERY AND STORAGE**

- .1 Ship fuses in original containers.
- .2 Store fuses in original containers in moisture free location.

**Part 2 Products****2.1 FUSES GENERAL**

- .1 Fuses: product of one manufacturer for entire project.
- .2 Fuses specified below must conform to CSA C22.2 No. 106 (latest edition). Fuses conforming to standard C22.2 No. 106-1953 will be rejected.
- .3 Fuses must provide a fully co-ordinated system for both overload and fault conditions.

**2.2 FUSE TYPES**

- .1 Class L fuses (formerly HRC-L ) for ratings 601-6000 A..
  - .1 Time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Fast acting as noted.
- .2 Class J fuses (formerly HRCI- J).
  - .1 Time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .2 Fast acting as noted.
- .3 Class R fuses (formerly HRCI- R). For UL Class RK1 fuses, peak let-through current and  $I^2t$  values not to exceed limits of UL 198E-1982, table 10.2.

**2.3 ACCEPTABLE PRODUCTS**

- .1 Service Entrance:
  - 1-600 A: Mersen Type CJ
  - 601-6000 A: Mersen Type CL

- .2 Motor Protection:
  - 1-600 A: Mersen Type AJT
  - 601-2000 A: Mersen Type A4BT
- .3 Other acceptable manufacturers:
  - .1 GEC
  - .2 Little Fuse

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
  - .1 Install Class R rejection clips for HRCI-R fuses.
- .3 Ensure correct fuses fitted to assigned electrical circuit.

**END OF SECTION**

**Part 1 General**

**1.1 PRODUCT DATA**

- .1 Submit product data in accordance with Electrical General Requirements Section.

**Part 2 Products**

**2.1 DISCONNECT SWITCHES**

- .1 Enclosed manual air break switches must conform to CSA C22.1 No.4 (latest edition).
- .2 Fuseholder assemblies must conform to CSA C22.2 No.39 (latest edition).
- .3 Fusible, and/or non-fusible, horsepower rated disconnect switches, size as indicated.
- .4 Provision for padlocking in off switch position by three locks.
- .5 Mechanically interlocked door to prevent opening when handle in ON position.
- .6 Fuses: size as indicated, to Fuses - Low Voltage Section.
- .7 Fuseholders: relocatable and suitable without adaptors, for type and size of fuse indicated.
- .8 Quick-make, quick-break action.
- .9 ON-OFF switch position indication on switch enclosure cover.
- .10 Disconnects feeding elevator controllers must be equipped with two auxiliary contacts approved by the elevator supplier.
- .11 Service entrance rated with fault bracing and fusing as required.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Electrical General Requirements Section.
- .2 Indicate name of load controlled on size 4 nameplate.

**2.3 ACCEPTABLE MANUFACTURERS**

<u>Manufacturer</u>	<u>General Purpose</u>	<u>Weather Proof</u>
Eaton	IHD Series	3HD Series
Schneider Electric	Type A Series	Type R Series
Siemens	ID Series	NFR/FR Series

**Part 3 Execution**

**3.1 INSTALLATION**

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

**END OF SECTION**



**Part 1 General****1.1 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Electrical General Requirements Section.
- .2 Indicate:
  - .1 Mounting method and dimensions.
  - .2 Starter/contactor 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.

**1.2 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for incorporation into manual specified in Electrical General Requirements Section.
- .2 Include operation and maintenance data for each type and style of starter/contactor.

**1.3 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with Electrical General Requirements Section.
- .2 Provide listed spare parts for each different size and type of starter:
  - .1 1 operating coil.
  - .2 3 fuses.
  - .3 10% indicating lamp bulbs used.

**Part 2 Products****2.1 MATERIALS**

- .1 Starters: must conform to CSAC22.2 No. 14 (latest edition) and EEMAC E14-1.
- .2 Control transformers must conform to CSAC22.2 No. 66 (latest edition).
- .3 Auto-transformers must conform to CSAC22.2 No 47 (latest edition).
- .4 Contactors must conform to CSA C22.2 No. 14 (latest edition).
- .5 Half size starters will not be accepted. NEMA and IEC rated starters are acceptable.

**2.2 MANUAL MOTOR STARTERS**

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

**2.3 FULL VOLTAGE MAGNETIC STARTERS**

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
  - .1 Contactor solenoid operated, rapid action type.
  - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
  - .3 Wiring and schematic diagram inside starter enclosure in visible location.
  - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include fused disconnect switch with operating lever on outside of enclosure to control disconnect, and provision for:
  - .1 Locking in "OFF" position with up to 3 padlocks.
  - .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 duty labeled as indicated.
  - .2 Indicating lights: standard duty type and color as indicated.
  - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.
  - .4 1 red pilot light for "stop" or "off" and 1 green light for "start" or "on".

**2.4 CONTROL TRANSFORMER**

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

**2.5 CONTACTORS**

- .1 Electrically held and controlled by pilot devices as indicated and rated for type of load controlled.
- .2 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.
- .3 Mount in CSA Enclosure 1 unless otherwise indicated.
- .4 Include following options in cover:
  - .1 Red indicating lamp.
  - .2 Hand - Off - Auto selector switch.
- .5 Control transformer: mounted in contactor enclosure.
- .6 Contactors must be definite purpose.

**2.6 FINISHES**

- .1 Apply finishes to enclosure in accordance with Electrical General Requirements Section.

**2.7 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Electrical General Requirements Section.
- .2 Manual starter designation label: black plate, white letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label: black plate, white letters, size 2, engraved as indicated.
- .4 Contactor designation label:  
black plate, white letters, size 4, indicating name of load controlled.

**2.8 ACCEPTABLE MANUFACTURERS**

- .1 The acceptable manufacturers are as follows:
  - .1 Allen Bradley
  - .2 Eaton
  - .3 Siemens
  - .4 Group Schneider
  - .5 Klockner Moeller

**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 Electrical General Requirements Section.
- .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.
- .5 Install contactors and connect auxiliary control devices.

**END OF SECTION**

**Part 1 General****1.1 CODES AND STANDARDS**

- .1 The generator set and its installation and on-site testing shall conform to the requirements of the following codes and standards:
  - .1 Latest edition of the Electrical Safety Code.
  - .2 CSA C22.2, No. 14 – (latest edition) Industrial Control Equipment.
  - .3 CSA 282, (latest edition) Emergency Electrical Power Supply for Buildings
  - .4 EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
  - .5 FCC Part 15, Subpart B.
  - .6 IEC8528 part 4. Control Systems for Generator Sets
  - .7 IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
  - .8 IEEE587 for voltage surge resistance.
  - .9 NEMA ICS10-1993 – AC Generator sets.
  - .10 NFPA99 – Essential Electrical Systems for Health Care Facilities
  - .11 NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
  - .12 UL508. The entire control system of the generator set shall be UL508 listed and labeled.
  - .13 UL2200. The genset shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.
- .2 The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

**1.2 DESCRIPTION OF SYSTEM**

- .1 Generating system consisting of factory assembled generator set equipment with digital electronic controls.
- .2 The system components shall consist of:
  - .1 Natural gas engine.
  - .2 Alternator.
  - .3 Alternator control panel.
  - .4 Automatic transfer equipment.
  - .5 Battery charger and battery.
  - .6 Fuel supply system.
  - .7 Exhaust system.
  - .8 Steel mounting base.

- .9 120V convenience outlet.
- .10 Remote annunciator.
- .11 Sound attenuated weather enclosure, c/w emergency battery unit and motorized dampers as required.
- .12 Load bank testing breaker.
- .3 The system is designed to operate as standby.

### **1.3 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Electrical General Requirements Section.
- .2 Include the following in the shop drawing submitted:
  - .1 Engine: make and model, with performance curves.
  - .2 Alternator: make and model.
  - .3 Voltage regulator: make, model and type.
  - .4 Automatic transfer switch: make, model and type.
  - .5 Battery: make, type and capacity.
  - .6 Battery charger: make, type and model.
  - .7 Alternator control panel: make and type of meters and controls.
  - .8 Governor type and model.
  - .9 Cooling air requirements in m/s.
  - .10 British standard or DIN rating of engine.
  - .11 Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, and total weight.
  - .12 Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
  - .13 Manufacturer's certification of prototype testing.
  - .14 Manufacturer's published warranty documents.
  - .15 Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
  - .16 Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
  - .17 Manufacturer's installation instructions.

### **1.4 OPERATION AND MAINTENANCE DATA**

- .1 Provide 3 sets of operation and maintenance data for diesel generator for incorporation into manual specified in the Electrical General Requirements Section.
- .2 Include in Operation and Maintenance Manual instructions for particular unit supplied and not general description of units manufactured by supplier and:
  - .1 Operation and maintenance instructions for engine, alternator, control panel, automatic transfer switch, battery charger, battery, fuel system, exhaust system and accessories, to permit effective operation, maintenance and repair.

- .2 Technical data:
  - .1 Illustrated parts lists with parts catalogue numbers.
  - .2 Schematic diagram of electrical controls.
  - .3 Flow diagrams for:
    - .1 Fuel system.
    - .2 Lubricating oil.
    - .3 Cooling system.
  - .4 Certified copy of factory test results.
  - .5 Maintenance and overhaul instructions and schedules.
  - .6 Precise details for adjustment and setting of time delay relays or sensing controls which require on site adjustment.

### **1.5 MAINTENANCE MATERIALS**

- .1 Include:
  - .1 2 fuel filter replacement elements.
  - .2 2 lube oil filter replacement elements.
  - .3 2 air cleaner filter elements.
  - .4 2 sets of fuses for control panel.
  - .5 Special tools for unit servicing.

### **1.6 SOURCE QUALITY CONTROL**

- .1 Factory Testing:
  - .1 The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.
  - .2 Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.
- .2 Test procedure:
  - .1 Prepare blank forms and check sheet with spaces to record data. At top of first sheet record:
    - .1 Date.
    - .2 Generator set serial no.
    - .3 Engine, make, model, serial no.
    - .4 Alternator, make, model, serial no.
    - .5 Voltage regulator, make and model.
    - .6 Rating of generator set, kW, kV.A, V, A, r/min, Hz.

- .2 Mark check sheet and record data on forms in duplicate as test proceeds.
- .3 Provide testing technician's signature on completed forms to indicate concurrence in results of test and submit to Consultant.

## **1.7 WARRANTY**

- .1 The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.
- .2 Provide a written guarantee from the date of substantial completion, signed and issued in the name of the owner, stating that the generating set is guaranteed against defects in material and workmanship for a period of 5 years or 1500 operating hours, whichever comes first for the generator set. Warranty for automatic transfer switches shall be 2 years.
- .3 The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

## **Part 2 Products**

### **2.1 GENERATOR SET**

- .1 Ratings
  - .1 The generator set shall operate at 1800 rpm and at a voltage of: 347/600 Volts AC, Three phase, Four-wire, 60 hertz.
  - .2 The generator set shall be rated at 400kW, 500 kVA at 0.8 PF, standby rating, based on site conditions of: Altitude 1000 ft. (300 meters), ambient temperatures up to **104 degrees F (40 degrees C)**.
- .2 Performance
  - .1 Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
  - .2 Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
  - .3 The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
  - .4 The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.



- .5 The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.
- .3 Construction
  - .1 The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails
  - .2 All switches, lamps, and meters in the control system shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.
- .4 Connections
  - .1 The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
  - .2 Power connections to auxiliary devices shall be made at the devices, with required protection located at a local branch circuit panel.
  - .3 Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

## 2.2

### ENGINE AND ENGINE EQUIPMENT

- .1 The engine shall be natural gas, 4 cycle, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:
  - .1 An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.
  - .2 Skid mounted radiator and cooling system rated for full load operation in 104 degrees F (40 degrees C) ambient as measured at the generator air inlet, based on 0.5 in H<sub>2</sub>O external static head. Radiator shall be sized based on a core temperature which is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture by the equipment manufacturer. Rotating parts shall be guarded against accidental contact.
  - .3 Electric starter(s) capable of three complete cranking cycles without overheating.

- .4 Positive displacement, mechanical, full pressure, lubrication oil pump.
- .5 Full flow lubrication oil filters with replaceable spin on canister elements and dipstick oil level indicator.
- .6 An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
- .7 Replaceable dry element air cleaner with restriction indicator.
- .8 Engine mounted battery charging alternator, 40-ampere minimum, and solid state voltage regulator.
- .9 Coolant heater with the following features:
  - .1 Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
  - .2 The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches
  - .3 The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.
- .10 Provide vibration isolators, spring type, quantity as recommended by the generator set manufacturer.
- .11 Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors.
- .12 Provide exhaust silencer of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall as a minimum be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards. The silencer shall be provided complete with drain, plug, and flanged couplings. A heavy duty flexible exhaust pipe with flanged couplings is to be provided from the generator set. Unless noted otherwise, silencers are to be factory installed.
- .13 A UL listed/CSA certified 10 amp voltage regulated battery charger shall be provided for the engine generator set. The charger is to be mounted within enclosure unless noted otherwise on the drawings. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:
  - .1 Loss of AC power red light
  - .2 Low battery voltage red light
  - .3 High battery voltage red light

.4 Power ON green light (no relay contact)

Note: Charger shall include an Analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses.

### 2.3 AC GENERATOR

- .1 The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 150 degrees Centigrade.
- .2 The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- .3 A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
- .4 The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

### 2.4 GENERATOR SET CONTROL

- .1 The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- .2 The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- .3 The generator set mounted control shall include the following features and functions:
  - .1 Control Switches
    - .1 Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or Manual position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
    - .2 EMERGENCY STOP switch. Switch shall be Red "mushroom head" push button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.

- .3 RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
- .4 PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
- .2 Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:
  - .1 Digital voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases.
  - .2 Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW hours, and power factor. Generator output voltage shall be available in line to line and line to neutral voltages, and shall display all three phase voltages (line to neutral or line to line) simultaneously.
  - .3 The digital metering equipment shall be driven by a single microprocessor, to provide consistent readings and performance.
- .3 Generator Set Alarm and Status Display.
  - .1 The generator set shall be provided with alarm and status indicating lamps to indicate non automatic generator status, and existing warning and shutdown conditions. The lamps shall be high intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel:
    - .1 low oil pressure (alarm)
    - .2 low oil pressure (shutdown)
    - .3 oil pressure sender failure (alarm)
    - .4 low coolant temperature (alarm)
    - .5 high coolant temperature (alarm)
    - .6 high coolant temperature (shutdown)
    - .7 engine temperature sender failure (alarm)
    - .8 low coolant level (alarm or shutdown selectable)
    - .9 fail to crank (shutdown)
    - .10 fail to start/overcrank (shutdown)
    - .11 overspeed (shutdown)
    - .12 low DC voltage (alarm)
    - .13 high DC voltage (alarm)
    - .14 weak battery (alarm)
    - .15 fuel supply valve shutoff (alarm)
    - .16 high AC voltage (shutdown)
    - .17 low AC voltage (shutdown)
    - .18 under frequency (shutdown)

- .19 over current (warning)
- .20 over current (shutdown)
- .21 short circuit (shutdown)
- .22 over load (alarm)
- .23 emergency stop (shutdown)
- .2 Provisions shall be made for indication of three customer specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
- .4 Engine Status Monitoring.
  - .1 The following information shall be available from a digital status panel on the generator set control :
    - .1 engine oil pressure (psi or kPA)
    - .2 engine coolant temperature (degrees F or C)
    - .3 engine oil temperature (degrees F or C)
    - .4 engine speed (rpm)
    - .5 number of hours of operation (hours)
    - .6 number of start attempts
    - .7 battery voltage (DC volts)
  - .2 The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.
- .5 Engine Control Functions.
  - .1 The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
  - .2 The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
  - .3 The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
  - .4 The control system shall include time delay start (adjustable 0 - 300 seconds) and time delay stop (adjustable 0 - 600 seconds) functions.
  - .5 The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature, which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

- .6 Provide and install a 20-light LED type remote alarm annunciator with horn, located as shown on the drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for high battery voltage, low battery voltage, loss of normal power to the charger. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2. Control interface relays shall be included within annunciator panel for remote monitoring. Relays shall be configurable to indicate generator conditions and fault such as gas fuel supply valve closed, motorized damper fail to open, etc.
- .7 The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set on a continuous basis. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions. Settings per coordination study. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided. The breaker must have a minimum interrupting rating of 10 kA.
- .8 Control Interfaces for Remote Monitoring:
  - .1 All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:
  - .2 Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
  - .3 One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
  - .4 A fused 5 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
  - .5 A fused 10 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

**2.5 OUTDOOR WEATHER-PROTECTIVE SOUND ATTENUATING HOUSING**

- .1 The generator set shall be provided with a sound-attenuated level 2 housing which allows the generator set to operate at full rated load in the ambient conditions previously specified. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.
- .2 The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and padlockable door latches shall be provided for all doors. Door hinges shall be stainless steel.
- .3 The enclosure shall be provided with an exhaust silencer which is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust shall include a raincap and rainshield.
- .4 All sheetmetal shall be primed for corrosion protection. All surfaces of all metal parts shall be primed for corrosion protection. **The housing is to be painted a colour to a standard offering.**
- .5 Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
- .6 Within the generator enclosure, the generator supplier is to provide a panel that will feed the generator battery charger and block heater as well as the enclosure normal lighting, emergency lighting and space heater designed to maintain the enclosure at 40°F. All of these components are to be supplied, installed, and connected in the factory. The panel is to be CSA approved and bear the stamp of the Electrical Safety Authority.

**2.6 FUEL SYSTEM**

- .1 Fuel system shall be natural gas.

**2.7 COOLING AIR SYSTEM**

- .1 Unless noted otherwise, the engine ventilating system will be factory supplied and installed.

**2.8 AUTOMATIC LOAD TRANSFER EQUIPMENT**

- .1 Furnish and install automatic transfer switches (ATS) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All automatic transfer isolation switches and controllers shall be the products of the same manufacturer.

- .2 The automatic transfer switches and controls shall conform to the requirements of:
  - .1 UL 1008 - Standard for Transfer Switch Equipment
  - .2 IEC 947-6-1 Low-voltage Switchgear and Controlgear; Multifunction equipment; Automatic Transfer Switching Equipment
  - .3 NFPA 70 - National Electrical Code
  - .4 NFPA 99 - Essential Electrical Systems for Health Care Facilities
  - .5 NFPA 110 - Emergency and Standby Power Systems
  - .6 IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
  - .7 NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
  - .8 UL 508 Industrial Control Equipment
  - .9 CSA C22.2 No. 178 (latest edition)
  - .10 Latest edition of the Electrical Safety Code.
- .3 The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.
- .4 All transfer switch sizes shall use only one type of main operator for ease of maintenance and commality of parts.
- .5 The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- .6 All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
- .7 Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- .8 Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- .9 Neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.
- .10 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 switch. All control interwiring shall be provided with disconnect plugs.
- .11 The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.



- .12 A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to +/- 1% of nominal voltage. Frequency sensing shall be accurate to +/- 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
- .13 The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.
- .14 All customer connections shall be wired to a common terminal block to simplify field-wiring connections.
- .15 The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
  - .1 IEEE472 (ANSI C37.90A) Ring Wave Test.
  - .2 ENC55011 1991 Class A Conducted and Radiated Emission.
  - .3 EN61000-4-2 Electrostatic Discharge Immunity, Direct Contact & Air Discharge.
  - .4 EN61000-4-3 Radiated Electromagnetic Field Immunity.
  - .5 EN61000-4-4 Electrical Fast Transient Immunity.
  - .6 EN61000-4-5 Surge Immunity.
  - .7 ENV50141 HF Conducted Disturbances Immunity.
- .16 The ATS shall be furnished in a NEMA type 1 enclosure unless otherwise shown on the plans. Provide Sprinkler hood for sprinklered locations.
- .17 All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.
- .18 The ATS shall be rated to close on and withstand an RMS symmetrical short circuit current of 35 kA at the ATS terminals with the type of overcurrent protection shown on the plans.
- .19 A three position momentary-type test switch shall be provided for the **test / automatic / reset** modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.
- .20 A set of DPDT gold-flashed contacts rated 10 amps, 32 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

- .21 Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.
- .22 Provide a pre-signal relay on all automatic transfer switches to indicate to an elevator controller or controllers that a transfer or re-transfer is about to occur. Provide additional functions to suit generator testing and elevator signal requirements during testing.
- .23 LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).
- .24 LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

**The following features shall be built-in to the controller, but capable of being activated through keypad programming or the serial port only when required by the user:**

- .25 Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.
- .26 Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.
- .27 An Inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer.
- .28 The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.
- .29 **Engine Exerciser** - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:
  - .1 Enable or disable the routine.
  - .2 Enable or disable transfer of the load during routine.
  - .3 Set the start time,
    - .1 time of day
    - .2 day of week
    - .3 week of month (1st, 2nd, 3rd, 4th, alternate or every)
  - .4 Set the duration of the run. At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

.30 **System Status** - The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,

- .1 Normal Failed
- .2 Load on Normal
- .3 TD Normal to Emerg
- .4 2min15s

Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.

.31 **Self Diagnostics** - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

.32 **Data Logging** – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:

- .1 Event Logging
  - .1 Data and time and reason for transfer normal to emergency.
  - .2 Data and time and reason for transfer emergency to normal.
  - .3 Data and time and reason for engine start.
  - .4 Data and time engine stopped.
  - .5 Data and time emergency source available.
  - .6 Data and time emergency source not available.
- .2 Statistical Data
  - .1 Total number of transfers.
  - .2 Total number of transfers due to source failure.
  - .3 Total number of days controller is energized.
  - .4 Total number of hours both normal and emergency sources are available.

.33 Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):

<u>Parameter</u>	<u>Sources</u>	<u>Dropout / Trip</u>	<u>Pickup / Reset</u>
Undervoltage	N&E,3φ	70 to 98%	85 to 100%
Overvoltage	N&E,3φ	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

.34 Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.

- .35 Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- .36 The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
- .37 Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.
- .38 An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.
- .39 A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
- .40 Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
- .41 A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.
- .42 All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.
- .43 All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.
- .44 The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- .45 The manufacturer **must** provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- .46 The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.
- .47 The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout southwestern Ontario. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
- .48 The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

- .49 The controller shall be complete with a four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:
- .1 Nominal line voltage and frequency
  - .2 Single or three phase sensing
  - .3 Operating parameter protection
  - .4 Transfer operating mode configuration (Open transition, closed transition or delayed transition)
- Note: All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.
- .50 The transfer switch must be covered by a two (2) year warranty.
- .51 For ATS which feed elevators, provide a separate factory installed relay for each elevator served as part of the pre-transfer signal system. Relays shall not be shared between elevators. Refer to electrical distribution riser diagram for quantity of elevators served and information on connection of elevator pre-transfer signals from ATS system.**

## 2.9 FINISHES

- .1 Unless specified otherwise the generator set finish shall be the manufacturer's standard colour.
- .2 Supply 1 can of touch-up enamel.

## 2.10 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Electrical General Requirements Section.
- .2 Control panel:
  - .1 Size 4 nameplates for controls such as alternator breakers and program selector switch.
  - .2 Size 2 nameplates for meters, alarms, indicating lights and minor controls.

## 2.11 MANUFACTURERS

- .1 Approved generator set manufacturers shall include:
  - .1 Generac
  - .2 Kohler
  - .3 Cummins/Onan
  - .4 Toromont

- .2 Approved transfer switch manufacturers shall include:
  - .1 Asco
  - .2 Eaton
  - .3 Cummins/Onan

### **Part 3 Execution**

#### **3.1 SEQUENCE OF OPERATION**

- .1 Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control and a redundant signal over the required network connection.
- .2 The generator set shall complete a time delay start period as programmed into the control.
- .3 The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
  - .1 The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate "fail to crank" shutdown.
  - .2 The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate "fail to start".
  - .3 The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
- .4 On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.
- .5 When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.
- .6 On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
  - .1 Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

- .7 Demonstrate:
  - .1 Automatic starting of set and automatic transfer of load on failure of normal power.
  - .2 Automatic shut down of engine on resumption of normal power.
  - .3 That battery charger reverts to high rate charge after cranking.
- .8 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.

### **3.2 INSTALLATION**

- .1 Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable provincial and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- .2 Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections under the supervision of the equipment supplier.
- .3 Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and requirements of the site.
- .4 Equipment shall be initially started and operated by representatives of the manufacturer.
- .5 All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

### **3.3 FIELD QUALITY CONTROL**

- .1 On site acceptance test.
  - .1 The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified a minimum of 7 days in advance and shall have the option to witness the tests.
  - .2 Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.
  - .3 Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system. Coordinate timing and obtain approval for start of test with site personnel.

- .4 In conformance with CAN-CSA C282 (latest edition) the supplier is to perform an on site load test for:
  - 4 hours @ 100% load
  - Submit test results for review and include in maintenance manual.
- .5 At end of test run, check battery voltage to demonstrate battery charger has returned battery to fully charged state.

### **3.4 TRAINING**

- .1 The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 2 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

### **3.5 SERVICE AND SUPPORT**

- .1 The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.
- .2 The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
- .3 The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

### **3.6 MOE APPROVAL**

- .1 As part of contract, the following pre-qualified environmental consultant shall be employed:

Pinchin Environmental Ltd.  
2470 Milltower Court  
Mississauga, Ontario L5N 7W5  
Contact: Roslyn Miller  
Ph: 905-363-1361
- .2 Environmental consultant shall be included in electrical tender price.
- .3 MOE approval shall consist of a report documenting the approval requirements, generator equipment review and MOE registration for the project. Registration fee shall be included in tender price.
- .4 Other qualified Environmental Consultants are invited to bid once approved by engineer. Provide documentation and references that the environmental consultant has been in business at least 5 years providing approval and registration services. Documentation must be submitted to consultant a minimum of one week prior to tender close for consideration.

**END OF SECTION**



**Part 1 General****1.1 REFERENCES**

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1 ANSI/IEEE C62.41- 1991, Recommended Practices for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 American Society for Testing and Materials (ASTM)
  - .1 ASTM F1137- 88 (1993), Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .3 United States of America, Federal Communications Commission (FCC)
  - .1 FCC (CFR47) EM and RF Interference Suppression.
- .4 IESNA LM-79-08, IES Electrical Method for the Electrical and Photometric Measurements of Solid State Lighting Products.

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Electrical General Requirements Section for all light fixtures supplied under this contract.
- .2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Consultant.
- .3 Photometric data to include: VCP Table spacing criterion.

**1.3 SCOPE**

- .1 This contractor is responsible to supply and install all lighting fixtures as scheduled and/or indicated including lamp and those accessories required for a complete lighting system. This contractor must coordinate lighting installations with all other Divisions of this project.
- .2 All fixtures must be CSA approved or approved at this contractor's expense by the Special Inspection Division of the Electrical Safety Authority.

**1.4 GUARANTEE**

- .1 Guarantees for materials replacement shall be as follows from date of substantial completion.
  - .1 LED lamps: 3 months
  - .2 LED fixtures, and driver: 5 years.
- .2 The labour required to replace these ballasts, lamps or drivers must be included in the above guarantee, however only for the extent of the contract guarantee and warranty period as noted in Electrical General Requirements.

**1.5 EXISTING FIXTURE BALLAST REMOVAL AND DESTRUCTION****.1 Scope**

.1 This Contractor is responsible for contracting with an approved company for the dismantling, disposal and removal of all existing fluorescent ballasts and lamps from this project. This process must include but is not limited to the following:

- .1 Removal of existing ballasts from fixtures by this contractor.
- .2 This contractor is to compare the ballast number to the PCB ballast identification booklet provided by the disposal company.
- .3 If the ballast is not contaminated it is to be disposed of by normal means.
- .4 If the ballast is contaminated provide:
  - .1 Approved interm on site storage area.
  - .2 Approved interm on site storage containers.
  - .3 Any and all necessary on site inspections.
  - .4 All necessary approval certificates (include copies in maintenance manuals).
  - .5 Full dismantling, complete destruction and disposal of all ballasts components.

**.2 Approved Disposal Companies**

- .1 PCB Containment Technology Inc.  
75 Wanless Court  
Ayr, Ontario  
NOB 1E0  
Phone: (519) 740-1333  
Fax: (519) 740-2320

**Part 2 Products****2.1 FIXTURE CONSTRUCTION**

- .1 Fixtures must be constructed of 20 gauge (minimum) cold rolled steel. All metal edges require smooth finish.
- .2 Light leaks must be prevented by providing gasketting, stops, and barriers.
- .3 Fixtures must be finished in high reflective baked white enamel. This surface must have a reflectance of not less than 85%.
- .4 **All fixtures operating on 347 Volts must be provided with an integral disconnecting means conforming to Rule #30-308(4) of the Electrical Safety Code.**

**2.2 FIXTURE LENS**

- .1 Unless otherwise noted fixture lenses shall be as follows:
  - .1 Lens thickness: 3.2 mm (1/8")
  - .2 Material: injection moulded clear prismatic virgin acrylic
  - .3 Frame: hinged, latched, steel.

**2.3 LED FIXTURES**

- .1 Fixture LED's must be tested in conformance with IESNA LM80 standard.
- .2 LED's must be selected using a binning algorithm to ensure colour and lumen output of a given fixture are consistent, as well as meet or surpass ANSI C78.377 specification for the rated lifetime of the fixture. Colour accuracy between products must be within a 2-step MacAdam ellipse.
- .3 Luminaires must be tested to IESNA LM79 by an independent approved laboratory.
- .4 Luminaires must be tested prior to shipping.
- .5 Luminaires must be ULC certified and approved for use in Canada.
- .6 Fixtures must maintain a minimum of 90% of their initial light output for 60,000 hours. Submit test results upon request.
- .7 Lumen values indicated for fixtures in the project documents are to be considered as "absolute" or "delivered" values.
- .8 Other than for specialty fixtures, and unless otherwise indicated, the maximum driver current is to be 750 mA.

**2.4 STANDARD EXIT LIGHTING UNITS**

- .1 Exit lighting units must conform to CSA C860, CSA 22.2 No. 141 (latest edition).
- .2 Housing: extruded aluminum housing, white finish.
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: 2W LED.
- .5 Operation: 25 year.
- .6 Units are to be provided with three (3) pictogram legends indicating "left from here", "straight from here", and "right from here".
- .7 Face plate to remain captive for relamping.

**2.5 EMERGENCY LIGHTING UNITS**

- .1 Emergency lighting units must conform to CSA C22.2 No 141 (latest edition).
- .2 Supply voltage: as noted on drawings.
- .3 Output voltage: 12 V DC.
- .4 Battery: sealed, maintenance free, 10 year life.

Note: Battery units must be capable of supplying the wattage indicated for a minimum of 30 minutes.

- .5 Charger: solid state, multi rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.
- .6 Solid state transfer circuit.
- .7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .8 Signal lights: "AC Power ON" condition and "charging" condition.
- .9 Lamp heads: integral on unit, 345° horizontal and 180° vertical adjustment. Lamp type: minimum 4 watt LED.
- .10 Cabinet suitable for direct or shelf mounting to wall and complete with knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .11 Auxiliary equipment:
  - .1 Test switch.
  - .2 Ac input and DC output terminal blocks inside cabinet.
  - .3 Shelf.
  - .4 Cord and plug connection for AC. (**Not applicable on 347 V units**).

## **2.6 REMOTE EMERGENCY LIGHTING FIXTURES**

- .1 Remote emergency lighting fixtures must conform to CSA C22.2 No141 (latest edition).
- .2 Fixtures shall be small "micro" size or recessed style as indicated in the Light Fixture Schedule.
- .3 Fixtures must be adjustable type heads with canopy.
- .4 Fixtures are to be provided with protective lexan cube when specified in the Light Fixture Schedule.
- .5 Unless otherwise indicated surface mounted fixtures in washrooms, locker rooms, changerooms, and gymnasiums must be provided with wire guard.

## **2.7 ACCEPTABLE LIGHTING MANUFACTURERS**

- .1 Refer to the light fixture schedule as indicated on drawings.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated. Luminaires are not to be supported from the roof deck. Provide additional unistrut support channel and/or support from structure. Co-ordinate with consultant on site.
- .2 Ball align hangers must be provided for rod suspended fixtures.
- .3 Fixtures surface mounted to suspended ceilings must be secured through ceiling assembly to cross member supports. These supports are to be steel channels or angles independently secured **to structure** using # 12 "jack" chain. Each chain must be secured so no fixture weight is added to the ceiling assembly.

- .4 Plaster frames/flange kits must be provided by this Division for fixtures recessed in plaster and/or drywall ceilings.
- .5 Where specified, fixtures to be chain hung shall be hung using "jack" chain with a capacity to suit the fixture weight. Branch circuit wiring feeding these fixtures shall be AC90 cable "ty-wrapped" at 900mm (36") intervals along length of drop. Final appearance must be neat and professional.
- .6 Install exit lighting units with illuminated faces and chevrons/arrows indicating path(s) of exit as indicated. Unless otherwise noted install exit fixtures at 2400 mm (8' 0") above finished floor.
- .7 Install emergency lighting units and associated remote mounted fixtures as indicated.
- .8 Direct "heads" on units and remote mounted fixtures to illuminate path(s) of exit.
- .9 Install emergency lighting units and remote fixtures at 300mm (12") below finished ceiling, unless indicated otherwise.
- .10 Provide a 15 A 120 V duplex receptacle (connected to circuit indicated) adjacent to unit. **Not applicable on 347 V units. This receptacle connection is to be no lower than 8' 0" (2400 mm) AFF.**
- .11 **Special installation: Secure fixtures to structure to conform to the Electrical Safety Code using "jack chain" NOT ceiling suspension wire. Where coreslab is used, suspension point must be independent of the one used for suspension of the ceiling assembly. As an alternate to jack chain the contractor may use a pre-manufactured aircraft cable suspension and fastening system as manufactured by Gripple (Gripple Cat. #HF02-10F2). Provide minimum 2 per fixture.**
- .12 All battery units are to be provided with a visible lamicoid label indicating the unit number as per drawings.

### 3.2 WIRING

- .1 Connect luminaires to lighting circuits as indicated.
- .2 Connect exit fixtures to exit lighting circuits and unit equipment (if applicable).
- .3 Connect unit equipment to circuits as indicated.
- .4 All wiring of remote emergency fixtures shall be minimum #10 T90 for each circuit and run in conduit. Wiring must be sized in conformance with manufacturer's recommendations for distances required.

### 3.3 LUMINAIRE ALIGNMENT

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

### 3.4 DELIVERIES

- .1 Fixtures are to be completely assembled at the manufacturer's plant and delivered to the project site in original unitized containers. Ensure that a dry, protected and secure space is available for proper storage before scheduling delivery of fixtures.

**3.5 TESTING/CERTIFICATION**

.1 At the completion of the project and in the presence of the consultant, test all exit and emergency fixtures. On company letterhead, the contractor is to prepare a chart indicating:

- .1 project
- .2 date
- .3 equipment type
- .4 certification of correct connection
- .5 certification of correct operation
- .6 duration of test in minutes (minimum 30)
- .7 actual period of testing (time of day)

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 CAN/ULC-S524 (latest edition), Installation of Fire Alarm Systems.
- .2 ULC-S525 (latest edition), Audible Signal Appliances for Fire Alarm Systems.
- .3 CAN/ULC-S526 (latest edition), Visual Signal Appliances, Fire Alarm.
- .4 CAN/ULC-S527 (latest edition), Control Units, Fire Alarm.
- .5 CAN/ULC-S528 (latest edition), Manual Pull Stations.
- .6 CAN/ULC-S529 (latest edition), Smoke Detectors.
- .7 CAN/ULC-S530 (latest edition), Heat Actuated Fire Detectors, Fire Alarm.
- .8 CAN/ULC-S531 (latest edition), Smoke Alarms.
- .9 CAN/ULC-S536 (latest edition), Inspection and Testing of Fire Alarm Systems.
- .10 CAN/ULC-S537 (latest edition), Verification of Fire Alarm Systems.
- .11 CAN/ULC-S552 (latest edition), Inspection, Testing and Maintenance of Smoke Alarms.
- .12 CAN/ULC-S553 (latest edition), Installation of Smoke Alarms.
- .13 OBC-2012, Ontario Building Code.

**1.2 DESCRIPTION OF SYSTEM**

- .1 System includes:
  - .1 Control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating general alarm, supervising system continuously, actuating zone annunciators, and initiating trouble signals.
  - .2 Trouble signal devices.
  - .3 Power supply facilities.
  - .4 Addressable manual alarm stations.
  - .5 Addressable and conventional automatic alarm initiating devices.
  - .6 Audible and visual signal devices.
  - .7 End-of-line devices.
  - .8 Annunciators.
  - .9 Ancillary devices.
  - .10 Interface and zone modules.
  - .11 Remote trouble indicator.

**1.3 REQUIREMENTS OF REGULATORY AGENCIES**

- .1 This system is subject to review by local building department officials, local fire department officials. **Therefore, submission of verification certificate and field technician device verification sheets is required prior to inspection by these officials. Schedule accordingly.**

**1.4 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Electrical General Requirements Section.
- .2 Include:
  - .1 Layout of equipment.
  - .2 Zoning.
  - .3 Complete wiring diagram.

**1.5 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual specified in Electrical General Requirements Section.
- .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.

**1.6 MAINTENANCE MATERIALS**

- .1 Include:
  - .1 10% spare glass rods for total number of manual pull box stations if applicable.

**1.7 TRAINING**

- .1 Arrange and pay for on-site demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system. **Obtain written receipt of training session and include in maintenance manual.**

**1.8 SYSTEM OPERATION**

- .1 Operation of any alarm initiating device to:
  - .1 Cause audible and visual signal devices to sound throughout building.
  - .2 Transmit signal to fire department via monitoring station.
  - .3 Cause zone of alarm device to be indicated on control panel and remote annunciator(s).
  - .4 Cause air conditioning and ventilating fans to shut down and to function so as to provide required control of smoke movement.
  - .5 Cause fire doors and smoke control doors if normally held open, to close automatically.
  - .6 Log the alarm in the historical alarm log file.



- .2 System Reset
  - .1 It shall not be possible to reset the fire alarm system until all the alarm zones have been properly reset or cleared.
  
- .3 System Trouble Operation
  - .1 A trouble initiated by the actuation of a sprinkler system supervisory trouble switch shall cause the following to occur:
    - .1 An audible and visual trouble signal shall sound at the main control panel Only until acknowledged by an operator.
    - .2 Annunciate the Supervisory Trouble Alarm at the main control panel LCD Display and all remote annunciator(s).
    - .3 Log the Supervisory Trouble Alarm in the Historical Trouble Log File.
    - .4 Cause the remote trouble indicator to activate
  - .2 Any system trouble shall cause the following to occur:
    - .1 An audible and visual trouble signal shall sound at the main control panel LCD Display Only until acknowledged by an operator.
    - .2 Log the trouble condition in the separate Historical Trouble Log File.

#### **1.9 PERFORMANCE CRITERIA**

- .1 These specifications describe the minimum functional requirements for an electronically supervised, microprocessor based, fully integrated system. The initial installation shall include all the necessary electronic hardware, software and memory for a completely operable system in accordance with these specifications.

#### **1.10 QUALITY ASSURANCE**

- .1 Each and all items of the fire alarm system shall be listed as the products of a single manufacturer under the appropriate category by the Underwriter's Laboratories of Canada and shall bear the "U.L.C." label.
- .2 Each and all items of the fire alarm system shall be covered by a one year parts and labour warranty covering defects resulting from faulty workmanship and materials. The warranty shall be deemed to begin on the date the system is accepted by the Project Manager on issuance of the substantial performance certificate for the project.
- .3 All control equipment must have Transient Protection Devices to comply with U.L.C. requirements.

### **Part 2 Products**

#### **2.1 GENERAL**

- .1 The fire alarm system shall be an addressable, single stage, zoned, non-coded, indicating, fully integrated fire alarm.
- .2 The fire alarm control panel shall allow for loading or editing of special instructions and operating sequences as required. The system shall be capable of on site programming to accommodate expansion, and changes required by local codes. All software operations

shall be stored in a non-volatile programmable memory within the fire alarm control panel. Loss of primary and secondary power shall not erase the instructions stored in memory.

- .3 The ability to selectively program input/output control functions based on ANDing, ORing, NOTing, Timing and Special Coded Operations is also to be incorporated in the resident software programming of the system.
- .4 The system shall have the ability to manually disable and enable any device/circuit individually for maintenance or testing purposes.
- .5 It shall be possible to reprogram selected or all smoke detector initiating zones for alarm verification.
- .6 It shall be possible to program an adjustable time delay circuit for each waterflow initiating circuit to prevent false alarms that may be caused by erroneous pressure surges in the sprinkler system.
- .7 All on site programming changes to the fire alarm system shall be password protected.
- .8 Wiring to any remote annunciator shall be supervised for open and ground conditions. A separate annunciator trouble indicator must be provided at the control panel, which shall illuminate and an audible trouble signal shall sound at the control panel upon the detection of an open or ground condition.
- .9 All Control Panels and Remote Annunciator Cabinets are to be properly grounded to building ground. Conduit ground will not be acceptable. The green coloured grounding loop shall be a minimum #14 AWG insulated copper conductor run in conduit. The ground loop shall be connected to building water supply to the line side of the water meter. Ground wire must not be run in the same conduit as the Fire Alarm wiring.

## 2.2 POWER REQUIREMENTS

- .1 The control panels shall receive 120 VAC power via a dedicated overcurrent protected circuit. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the control panel and the remote annunciator. A green 'Power On' LED shall be displayed continuously while incoming power is present.
- .2 Control Panel output power supply shall have the following operating characteristics:
  - .1 Rated for five Amps continuous duty
  - .2 24 VDC filtered and regulated
  - .3 Power limited with a range of 20.4 VDC to 32 VDC.
  - .4 Automatic "Brownout" transfer to standby batteries when supply voltage falls to 102 VAC
- .3 Standby power for the system shall be produced by dual-sealed, lead acid, gelled cell batteries, series connected with sufficient Amp. Hour capacity to operate the system under supervisory conditions with AC power disconnected for 24 hours and at the end of this period operate the alarm devices for thirty consecutive minutes. The batteries shall be dual-sealed, maintenance free type.

- .4 The system batteries shall be supervised so that a low battery condition or disconnection of the batteries shall be audibly and visually annunciated at the control panel.
- .5 Battery charger shall have the following operating characteristics:
  - .1 Ability to charge a range up to 33 AH to 70% of their capacity within 12 hours.
  - .2 Compatible with either lead acid or nicad batteries.
- .6 All circuits requiring system operating power shall be individually fused at the control panel.
- .7 The system shall be modular in design to allow future expansion with a minimum of hardware additions and system interruptions.

### **2.3 FIRE ALARM CONTROL PANEL**

- .1 The fire alarm control panel construction shall be modular in design with solid state microprocessor based electronics. An 80 character Liquid Crystal Display shall indicate alarms, supervisory service conditions and any troubles. The panel shall include but not be limited to the following:
  - .1 80 character LCD display
  - .2 Local Energy, Shunt Master Box, or Reverse Polarity Remote Station Connection
  - .3 Form C Trouble Contact
  - .4 Earth Ground Supervision Circuit
  - .5 Basic 8 A power supply
  - .6 Automatic Battery Charger
  - .7 Standby Batteries
  - .8 Resident non-volatile programmable operating system memory for all operating requirements.
  - .9 Five Programmable Multi-Function keys with status LED's
  - .10 Red Alarm LED and Acknowledge Button
  - .11 Yellow Supervisory Service LED and Acknowledge Button
  - .12 Yellow Trouble LED and Acknowledge Button
  - .13 Green Power on LED
  - .14 Alarm/Signal Silence Button
  - .15 System Reset Button
  - .16 Operator Interface Keypad for Manual Control and System Information Access
  - .17 Addressable Interface Control Card
  - .18 Supervised Annunciator Circuit
- .2 The control Panel shall be capable of chronologically logging and storing 300 events in an alarm log and 300 events in a trouble log. The historical logs shall be stored in the CPU's memory and shall be protected by a lithium battery that is supervised for a low battery condition. Each recorded event shall include the time and date of that event's occurrence. The alarm log file must be separate from the trouble log file. It shall be possible for the user to generate a report of both logs upon request.

- .3 All auxiliary manual controls shall be supervised so that all switches must be returned to the normal automatic position to clear system trouble.
- .4 Signal Circuits shall be independently supervised and fused such that a fault on one circuit shall not affect the operation of any of the other circuits. All signal circuits shall be configured as follows:
  - .1 Class "B" wiring, current limited.
  - .2 Rated at two Amps of continuous power.
  - .3 Capable of powering polarised 24 VDC audible and visual signalling appliances.
- .5 Provide dry contact auxiliary control circuits as follows:
  - .1 Central Station alarm output.
  - .2 Central Station trouble output.
  - .3 SPDT Form C relays fused at 2 A @ 24 VDC.
- .6 System Expansion Modules connected by ribbon cables shall be supervised for module placement. Should a module become disconnected the system trouble indicator must illuminate and audible trouble signal must sound.
- .7 The Fire Alarm Control Panel shall be capable of supporting RS-232-C I/O ports. CPU data output to the I/O ports shall be in a parallel ASCII format at field adjustable baud rates of 220, 300, 1200, 2400 and 4800.
- .8 A walk test feature must be provided.
- .9 All system controls shall be housed in a surface wall mounted steel cabinets. Finish shall be according to the manufacturer's standards.
- .10 All modules shall be secured behind hinged locked door with a full viewing tempered plastic window. The hinged locked doors shall give access to all the operating controls but shall not expose live connections.
- .11 All internal wiring, control circuits, connections and terminals shall only be accessible behind a removable metal retainer plate.
- .12 All Cabinets are to be properly grounded to building ground. Conduit ground will not be acceptable.
- .13 The system must provide communication with addressable initiating devices. All of these devices will be annunciated on the control panel's main LCD display. Annunciation shall include the following conditions for each point:
  - .1 40 Character Zone/Device Location
  - .2 Type of Device
  - .3 Detector Status (Normal/Alarm/Trouble)
  - .4 Device Missing/Failed
- .14 The communication format must be a completely digital poll/response protocol to allow tapping of the circuit wiring. A high degree of communication reliability must be obtained by using parity data bit error checking routines for address codes and check sum routines for the data transmission portion of the protocol.

- .15 Each addressable device must be uniquely identified by an address code entered on each device base at time of installation. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact.
- .16 It shall be possible for the owner's representative to change a smoke detector without any special tools or programming.
- .17 The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions. Systems, which cannot support 100% of their point capacity in alarm simultaneously, cannot assure appropriate system response and are not acceptable.
- .18 **The appropriate quantity of isolator modules shall be installed so that a wiring fault (short, open or ground) within one floor area shall not prevent the normal operation of other addressable devices on other floor areas.**
- .19 The system shall maintain the sensitivity level set, for each sensor, over time by automatically compensating for environmental factors such as dust and dirt accumulations in a smoke sensor's chamber. The smoke sensor shall be a smoke density measuring device having no self-contained set-point. **The control panel shall determine the alarm decision for each sensor.**
- .20 The system shall automatically indicate when an individual sensor needs cleaning. When a sensor's average value reaches a predetermined value a 'Dirty Sensor' trouble condition shall be audibly and visually indicated at the control panel for the individual sensor.
- .21 All data transmissions, **including the analogue value**, between the smoke sensors and the control panel shall be digitally transmitted and incorporate parity and checksum digital data checks of each transmission.
- .22 An operator from the control panel, having a proper access level, shall have the ability to:
  - .1 Manually access and print the following information for each sensor in a report format that can be easily understood by the user:
    - .1 Primary Status
    - .2 Device Type
    - .3 Present Average Value
    - .4 Present Sensitivity Selected
    - .5 Highest Peak Detection Values
    - .6 Sensor Chamber Status (Normal, Almost Dirty, Dirty, Excessively Dirty)
  - .2 Manually control the following of each sensor:
    - .1 Clear Peak Detection Values
    - .2 Enable or Disable the Point
    - .3 Clear Verification Tally
    - .4 Control a Sensor's Relay Driver Output
- .23 It shall be possible to program the control panel to **automatically** change the sensitivity settings of each sensor based on **time-of-day** and **day-of-week**.

**2.4 ADDRESSABLE MANUAL ALARM STATIONS**

- .1 Manual alarm stations shall be addressable, single action, non-coded, semi-flush mounted type. Pull stations shall be break-glass style. Contacts are to activate when the handle is pulled down.
- .2 Addressable pull station electronics shall be mounted to the back plate of the station. The station's address will be set at the time of installation. Device addressing shall be accomplished by either an electrical or mechanical means.
- .3 Where noted on drawings, stations are to be equipped with tamperproof guard equal to Stopper II Cat. # STI-1100.

**2.5 INTELLIGENT DETECTORS-GENERAL OPERATION**

- .1 Addressable devices shall use simple to install and maintain decade, numbered 0 to 9, address switches. Detectors that have expanded addressing will have decade switch numbered from 0 to 15 for the most significant digit to allow detector addressing from 1 to 250.
- .2 Device addressing shall be accomplished by either an electrical or mechanical means.
- .3 Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel signalling line circuits.
- .4 Addressable smoke detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
- .5 The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity shall be automatically adjusted by the panel on a time-of-day basis.
- .6 Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance.
- .7 The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature.
- .8 The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
- .9 Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (PHOTO, THERMAL).

- .10 Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
- .11 Detectors shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
- .12 Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
- .13 The sensors shall be of a low profile design and ULC listed for both ceiling and wall mount applications.
- .14 Automatic smoke sensors shall be equipped with a dust cover, which shall be removed at the time of verification to prevent dust and dirt entering the smoke chamber during construction.
- .15 A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

## **2.6 INTELLIGENT MULTI-DETECTOR**

- .1 The intelligent multi-detector shall be an addressable device, which is designed to monitor photoelectric, ionization, and thermal technologies in a single sensing device. This detector shall utilize advanced electronics which react to smaller products of combustion found in fast flaming fires (ionization), slow smouldering fires (photoelectric), and heat (thermal) all within a single sensing device.
- .2 The multi-detector shall include two bicolor LEDs, which flash green in normal operation and turn on steady red in alarm.
- .3 Detectors are to be provided with relay base where noted on the drawings.
- .4 Separately mounted photoelectric ionization and heat detectors in the same location are not acceptable alternatives.

## **2.7 FIXED TEMPERATURE HEAT DETECTOR**

- .1 These heat detectors shall have a low mass thermistor heat sensor and operate at a fixed temperature. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the/ time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. The heat detector shall have a nominal alarm point rating of 57°C (1 35°F). The heat detector shall be rated for ceiling installation at a minimum of 21.3m (70') centres and be suitable for wall mount applications.

**2.8 FIXED TEMPERATURE / RATE OF RISE HEAT DETECTOR**

- .1 These heat detectors shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm, The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of 57°C (135°F) and a rate-of-rise alarm point of 9°C (15°F) per minute. The heat detector shall be rated for ceiling installation at a minimum of 21.3m (70') centres and be suitable for wall mount applications.

**2.9 PHOTOELECTRIC SMOKE DETECTOR**

- .1 The intelligent photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, aging, and humidity. The photo detector shall be rated for ceiling installation at a minimum of Soft (Olin) centres and be suitable for wall mount applications.
- .2 The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photo detector shall be suitable for operation in the following environment:
  - .1 Temperature: 0°C to 49°C (32°F to 120°F)
  - .2 Humidity: 0-93% RH, non-condensing
  - .3 Elevation: no limit
- .3 Detectors are to be provided with relay base where noted on the drawings.

**2.10 STANDARD DETECTOR MOUNTING BASES**

- .1 Provide standard detector mounting bases suitable for mounting on North American 1-gang, 85mm (3 ½ ") or 100 mm (4") octagon box and 100 mm (4") square box. The base shall, contain no electronics, support all detector types and have the following minimum requirements:
  - .1 Removal of the respective detector shall not affect communications with other detectors.
  - .2 Terminal connections shall be made on the room side of the base. Bases which must be removed to gain access to the terminals shall not be acceptable.

**2.11 INTELLIGENT DUCT SMOKE DETECTOR**

- .1 The smoke detector housing shall accommodate an intelligent photoelectric detector (as noted above) that provides continuous analog monitoring and alarm verification from the panel.



- .2 When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
- .3 Duct smoke detector sensor assemblies shall be complete with duct housing, photoelectric smoke detector, and sampling tubes as required. The duct-housing base shall come complete with an auxiliary set of form C dry contacts rated at 120 VAC, 3 Amps.
- .4 The system shall automatically indicate when an individual duct sensor needs cleaning.

## **2.12 AUDIBLE/VISUAL SIGNAL DEVICES**

- .1 Mini Horns: flush mounted temporal mini horn, 24Vdc operation, selectable HIGH/LOW setting 94.5 dBA (high)/89.8 dBA (low) at 3 m (10'), white or red coverplate, FM and ULC listed. Suitable for mounting on a single gang box.
- .2 Strobe: semi-recessed, 24Vdc operation, complete with selectable 15/30/75/110 candela output (unless otherwise noted set at 75 cd), synchronized strobe, red finish, FM and ULC listed. Suitable for mounting on a single gang box.
- .3 Mini Horn/Strobe: flush mounted temporal combination mini horn/strobe, 24 Vdc operation, selectable HIGH/LOW setting 94.5 dBA (high)/89.8 dBA (low) at 3 m (10') selectable 15/30/75/110 candela output (unless otherwise noted set at 75 cd), synchronized strobe white or red coverplate, FM and ULC listed. Suitable for mounting on a single gang box.

### **NOTES:**

- .1 **Signal devices with integral strobe lights in high abuse areas (i.e. gymnasium, change rooms, etc.) must be provided with protective wireguards.**
- .2 **Any surface mounted signal devices must be provided with suitable backboxes supplied by the manufacturer.**
- .3 **Provide synchronization modules to suit signal devices (if required by manufacturer).**
- .4 **Set signal devices in classrooms to LOW setting.**

## **2.13 END OF LINE RESISTORS**

- .1 End-of-line resistors for signalling circuits shall be sized to ensure the correct supervisory current flows in each circuit.
- .2 End-of-line resistors shall be mounted on a stainless steel plate for mounting on a standard single gang box and bear the ULC label.

## **2.14 REMOTE ANNUNCIATOR PANELS**

- .1 Each remote panel in the installed system shall include remote control display annunciators. These annunciators shall have integral membrane style, tactile push-button control switches for the control of system functions, and LED-s with programmable (software-controlled) flash rates and slide-in labels for annunciation of system events.

- .2 The remote control display annunciators shall provide the system with individual zone and device annunciation.
- .3 Annunciator must be keyed similar to control panel.

#### **2.15 GRAPHIC DISPLAY (PASSIVE)**

- .1 Black and white layout of facility showing all zones as specified/indicated.
- .2 Display is to be found behind Plexiglas, approximate size: 500 mm x 500 mm (20" x 20").
- .3 Finish frame to architects direction.

#### **2.16 ANCILLARY DEVICES**

- .1 Relay unit to initiate fan shutdown on alarm condition.
- .2 Relay unit to facilitate elevator recall functions as indicated.
- .3 Relay unit to release door hold devices.

#### **2.17 INTELLIGENT MODULES – GENERAL OPERATION**

- .1 The modules shall have a minimum of 2 diagnostic LED's mounted behind a finished coverplate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes, which can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment:
  - .1 Temperature: 0°C to 49°C (32°F to 120°F).
  - .2 Humidity: 0-93% RH, non-condensing.

#### **2.18 MONITOR MODULE**

- .1 The monitor modules shall have the following operating characteristics:

A flashing LED indicates that the module is in communication with the control panel. The LED latches steady on alarm (subject to current limitations on the loop).
- .2 The monitor modules shall have the following features:

Nominal operating voltage: 15 to 32 VDC.  
Maximum current draw: 5.1 mA (LED on)  
Average operating current: 400 uA (LED flashing)  
EOL resistance: 47K ohms.  
Temperature range: 0°C to 49°C (32°F to 120°F)  
Humidity range: 10% to 93% noncondensing  
Dimensions: 114.3mm (4.5") high x 101.6 mm (4") wide x 31.75 mm (1.25") deep. Mounts to a 101.6 mm (4") square x 53.975 mm (2.1/8") deep box.

**2.19 ISOLATOR MODULE**

- .1 Fault isolator modules shall be provide to automatically isolate wire-to-wire short circuits on an SLC loop. The fault isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop. If a wire-to wire short occurs, the fault isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the fault isolator module shall automatically reconnect the isolated section of the SLC loop. The fault isolator module shall not require any address-setting, and its' operations shall be totally automatic. It shall not be necessary to replace or reset a fault isolator module after its normal operation. The fault isolator module shall mount in a standard 10.16 cm (4") deep electrical box, in a surface-mounted backbox, or in the fire alarm control panel. It shall provide a single LED which shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

**2.20 CONTROL MODULE**

- .1 Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contact relay.
- .2 The control module NACs may be wired for Style Z or Style Y (Class A/B) with up to 1 Amp of inductive A/V signal, or 2 Amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% or all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
- .3 The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 Amps at 30 VDC.

**2.21 DOOR HOLD OPEN DEVICES**

- .1 Units to be complete with the following features:
  - .1 Wall mounted style.
  - .2 Long life electromagnet.
  - .3 Low current operation.
  - .4 Completely silent operation.
  - .5 25 lbf (111N) minimum holding force.
  - .6 Adjustable swivel contact plate.
  - .7 Brushed zinc finish.
  - .8 Maintenance free operation.
  - .9 Water resistant design.
  - .10 ULC, CSA, and FM approved.

**2.22 SPRINKLER AND SUPERVISED VALVE CONNECTIONS**

- .1 Sprinkler and standpipe system contacts shall be provided by the mechanical/sprinkler contractor but connected into the fire alarm system by this Division.

**2.23 REMOTE TROUBLE INDICATOR**

- .1 A system remote trouble indicator where noted on the drawings shall be provided complete with the following features:
  - .1 Flush mounted in a double gang box.
  - .2 Trouble LED.
  - .3 Trouble buzzer.

**2.24 SYSTEM WIRING**

- .1 The system wiring must be FSA rated in conformance with the Electrical Safety Code to suit the type of installation.
- .2 Wiring shall be minimum #18 AWG twisted shielded pair in conduit. "Securex 2" armoured cable will be permitted to be used for "drops" to devices on accessible ceilings.
- .3 As indicated on system riser diagram initiating device wiring shall be run in a loop with a home run from the last device to the control panel (Class 'A' configuration). Wiring from the "loop" module to conventional devices must be supervised, run in conduit, and conform to the standards of the Electrical Safety Code.
- .4 Signal wiring is to be cross connected in a class 'B' configuration.
- .5 Install isolator modules and end of line resistors in service rooms no higher than 2.4 M AFF. Provide location of these devices at the time of shop drawing submission.
- .6 **These are the basic wiring requirements for system operation. Prior to tender close manufacturer and contractor are to confirm all necessary wiring specifications and requirements.**

**2.25 APPROVED EQUIPMENT**

<u>DEVICE</u>	<u>NOTIFIER</u>	<u>EDWARDS</u>	<u>SIMPLEX</u>	<u>SIEMENS</u>	<u>MIRCOM</u>
<b><u>Control Panel</u></b>					
	NFS2-3030 1-10 loops 318 add/loop	EST 4 or EST 3X	4010-ES -2 loop -250 add	Cerberus Pro or Desigo	FX-4000 Series
<b><u>Intelligent Devices</u></b>					
Manual Alarm Stations 1-Stage	NBG 12LX	SIGA-270	4099-9001	HMS-SA	MS-401AD
Addressable Multi-Sensor	FSP-851TA	SIGA2-PS		FDOT421	MIX-2251TB

Addressable Base	B710LPA	SIGA-SB	4098-9792	DB-11	B210LPA
Addressable Base c/w Relay	B224RBA	SIGA-RB	4098-9791 c/w 2098-9737	DB-HR	B224RBA
Heat Sensor	FST-851RA	SIGA2-HRS or SIGA2-HFS	4098-9733	FDT421	MIX-5251RBA Series
Smoke Detectors	FSI-851A	SIGA-PS	4098-9714	FDO421	MIX-2251BA
Duct Type Smoke Detector (c/w Air Sampling Tubes)	FSD-751PA + ST-X	SIGA-SD c/w SIGA-PS	4098-9755 and 4098-9714	FDO421 (detector) ST Series (tubes) FDBZ (housing)	DNRA (Housing) MIX-2251BRA (Detector) DST (Tubes)
Monitor Module	FMM-1A	SIGA-CT Series	ZAM-Monitor 4090-9001	HTRI-S	MIX-M500MA
Control Module	FCM-1 or FRM-1	SIGA-CR	ZAM-Control 4090-9002	HTRI-R	MIX-M500RA
Isolator Module	ISO-XA	SIGA-IM	4090-9116	HLIM-1	M500XA
Annunciator	ACM-32 AEM-32 ACM-32AY	EST3-6ANN	4603-9101 (GEO-7000 Series flush enclosure)	FT-Series Rembox (XLS)	RAX-LCD RAM- 1032TZ/RAM- 1016TZ RAX-1048
<b><u>Conventional and Auxiliary Devices</u></b>					
Mini Horn	MHRA (System Sensor)	Genesis G1R- HD	4901-9858	ZH-R	FH-340R
Door Holder	FMM Series	1500 Series	2088 Series	DH Series	DH Series
Mini Horn complete with strobe	P2RA (System Sensor)	Genesis G1R- HDVM	4906-9127	ZH-MC-R-B	FHS-340R
Strobe	SRA (System Sensor)	G1R-VM	4906-9101	ZR-MC-R-B	FS-340R

Remote Trouble Indicator	RTB	RTU	RT1-1C	RT1-1	RTI-1
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**Part 3 Execution**

**3.1 INSTALLATION**

- .1 The entire system shall be installed in accordance with CAN/ULC-S524 (latest edition) and approved manufacturers manuals and wiring diagrams. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation, All wiring shall be of the type recommended by the Electrical Safety Code, approved by local authorities having jurisdiction for the purpose, and shall be installed in dedicated conduit throughout.
- .2 Install main control panel and connect to ac power supply.
- .3 Locate and install manual alarm stations and connect to alarm circuit wiring.
- .4 Locate and install detectors and connect to alarm circuit wiring. **Do not mount detectors within 1 m (39") of air outlets.** Maintain at least 600 mm (24") radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.
- .5 Connect alarm circuits to main control panel.
- .6 Locate and install signal devices and connect to signalling circuits.
- .7 Connect signalling circuits to main control panel.
- .8 Install end-of-line devices at end of applicable alarm and signalling circuits.
- .9 Install remote annunciator panels and connect to annunciator circuit wiring.
- .10 Locate and install door releasing devices.  
**Note: Door holders must release by way of local smoke detector and signal from main control panel. Provide additional relays to suit.**
- .11 Locate and install remote relay units to control fan shut down.
- .12 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- .13 Connect fire suppression systems to control panel.
- .14 Elevator controllers are to be connected with 4 #14 conductors in conduit from fire alarm control panel to signal elevator recall in the event of a general alarm.
- .15 **Connect smoke damper integral detector outputs to monitor modules and include dual voltage relay for monitoring of AC power to smoke damper as trouble condition at fire alarm panel based on module address.**

**3.2 FIELD QUALITY CONTROL**

- .1 The system shall be installed and fully tested under the supervision of trained manufacturer's representative. The system shall be demonstrated to perform all the functions as specified.

**3.3 ACCEPTABLE INSTALLER**

- .1 The fire alarm / life safety system specified herein shall be installed by an Authorized Electrical Contractor who is CFAA certified.

**3.4 EXAMINATION**

- .1 Prior to the commencement of any of the work detailed herein, an examination and analysis of the area(s) where the Fire Alarm / Life Safety System and all associated components are to be installed shall be made.
- .2 Any of these area(s) which are found to be outside the manufacturers' recommended environments for the particular specified products shall be noted on a Site Examination Report which shall be given to the Building Owners Representative, and the Consultant.
- .3 Any shorts, opens, or grounds found on existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.

**3.5 DEMONSTRATION**

- .1 Each of the intended operations of the installed Fire Alarm / Life Safety System shall be demonstrated to the Building Owners' Representative and the Consultant.

**3.6 SYSTEM TEST**

- .1 Perform tests in accordance with General Electrical Requirements Section and CAN/ULC-S537-(latest edition) Standard for the Verification of Fire Alarm Systems.
- .2 Fire alarm system:
  - .1 Test each device and alarm circuit to ensure noted devices transmit alarm to control panel and actuate general alarm and ancillary devices.
  - .2 Check annunciator panels to ensure zones are shown correctly.
  - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.
  - .4 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 middlemost 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 signals during ground-fault condition imposed near middlemost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
  - .5 Class B circuits
    - .1 Test each conductor on all circuits for capability of providing alarm signal on line side of single open-circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
- .3 The control panel shall continuously perform as automatic self-test routine on each sensor, which will functionally check the sensor electronics and ensure the accuracy of the valves being transmitted to the control panel.

- .4 Automatic testing will occur at a rate of one sensor every four minutes.
- .5 The sensor's average analogue value is the average of the last 2000 recorded analogue entries of its chamber.
- .6 Any sensor that fails this test shall indicate a '**SELF-TEST ABNORMAL**' trouble condition with the sensor's address at the control panel.
- .7 The system shall automatically indicate when an individual sensor needs cleaning. When the sensor's average value reaches a predetermined value, a '**DIRTY SENSOR**' trouble condition shall be audibly and visually indicated at the local control panel for that sensor. IF a '**DIRTY SENSOR**' indication is left unattended and its average value increases to a second predetermined value, an '**EXCESSIVELY DIRTY SENSOR**' trouble condition shall be indicated at the local control panel for that sensor. To prevent false alarms, these '**DIRTY**' conditions shall in no way decrease the amount of smoke obscuration necessary to generate an alarm condition.
- .8 An operator having a proper access level, shall have the capability to manually access the following information from the control panel:
  - .1 Primary Status
  - .2 Device Type
  - .3 Present Average Value
  - .4 Present Sensitivity Selected\*
  - .5 Highest Peak Detection Values (HVP)\*
  - .6 Sensor Range (Normal, Dirty, Excessively Dirty)

\* Values shall be in 'percent of smoke obscuration' format so that no interpretation is required by the operator.
- .9 **Provide "Integrated Testing" of this life safety system in conformance with the noted specification section. Include all associated costs in tender.**

### 3.7 AUDIBILITY TESTING

- .1 Audibility Testing:
  - .1 The contractor is to coordinate an audibility test prior to occupancy of the facility. The test is to be performed by the representatives of the fire alarm manufacturer in the presence of the consultant. The test report is to be in chart form indicating:
    - .1 Project
    - .2 Date of test
    - .3 Room name and number
    - .4 Ambient dB level
    - .5 Alarm dB level
    - .6 Name of testing technician
  - .2 The test results are to be submitted to the consultant for review prior to issuing to owner's representatives and/or authorities having jurisdiction.



**3.8 EQUIPMENT ALLOWANCES**

- .1 The manufacturer and electrical contractor are to include in their bid the cost to add five (5) additional signaling devices to be installed and verified in locations as directed by the consultant. Note: This installation and verification and subsequent audibility test will be occurring after the initial audibility testing is complete.
- .2 The manufacturer and electrical contractor are to include in their bid the cost to add three (3) additional fire detection devices (heat or smoke detectors) to be installed and verified in locations as directed by the consultant.
- .3 The manufacturer and electrical contractor are to include in their bid the cost to add three (3) additional fire alarm zones with associated zone modules and including six (6) additional isolation modules to be installed and verified as directed by the consultant.

**END OF SECTION**