
Part 1 General

1.1 GENERAL

- .1 This Section covers items common to Sections of Division 16.
- .2 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 CODES AND STANDARDS

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3No.1 except where specified otherwise.
- .3 Abbreviations for electrical terms: to CSA Z85.
- .4 The electrical installation shall comply with the requirements of the Electrical Supply Authority, the latest edition of the Canadian Electrical Code, with all Provincial and Municipal Laws, Rules and Ordinances, and to the satisfaction of those persons having jurisdiction over same.
- .5 Notify the Contract Administrator of any discrepancies or conflicts with any regulation seven (7) Working days before Bid Opportunity's close. Failing such notification, meet all such requirements without change to the Contract price.
- .6 In no instance shall the standard established by these Specifications and Drawings be reduced by any of the codes, rules or ordinances.

1.3 CARE, OPERATION AND START-UP

- .1 Upon completion of the project, demonstrate the operation of all equipment in the presence of The City, or their representative, and the Contract Administrator. Obtain signed certification from the City that such equipment was shown to be fully operational and that all necessary operating instructions have been provided.
- .2 Arrange and pay for services of manufacturer's factory service Contract Administrator to supervise start-up of installation, check, adjust, balance, calibrate, test and commission components as specified in subsequent sections.
- .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.
- .4 Carefully examine all plans and Specifications pertaining to this Contract and become familiar with all details. Visit the Site and determine all factors affecting this section of the Work and include all costs for same in Bid Opportunity.

1.4 VOLTAGE RATINGS

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

1.5 PERMITS, FEES AND INSPECTION

- .1 Submit to Electrical Inspection Department and Supply Authority necessary number of Drawings and Specifications for examination and approval prior to commencement of Work.
- .2 Pay all associated fees for inspection of the Work by authorities having jurisdiction.
- .3 Notify Contract Administrator of changes required by Electrical Inspection Department prior to making changes.
- .4 Furnish Certificates of Acceptance from authorities having jurisdiction on completion of Work to Contract Administrator. Copies to be included in Maintenance Manuals.

1.6 MATERIALS AND EQUIPMENT

- .1 Provide Materials and equipment in accordance with Div. 16.
- .2 Equipment and Material to be CSA certified or certified by an equivalent recognized certifying agency to meet Canadian Standards. Where there is no alternative to supplying equipment which is certified, obtain special approval from local Electrical Inspection Department or authority having jurisdiction.
- .3 Factory assemble control panels and component assemblies.
- .4 Submit for Contract Administrator's approval, a duplicate list of makes and types of all equipment and Materials for this project, prior to placing of orders for same. This shall be done within fourteen (14) days of the award of the project Contract to the Contractor in order to avoid delays in delivery and completion.
- .5 Any Material or equipment ordered or installed without the Contract Administrator's prior approval shall, if so directed by the Contract Administrator, be removed and replaced with approved Material or equipment without a change in the Contract price.

1.7 RESPONSIBILITY

- .1 Be responsible for any damage caused the City's, or their Subcontractors due to improperly carrying out this Work.
- .2 Install all components of this Work promptly and where applicable, in advance of concrete pouring, or similar construction. Provide and set in the proper sequence of construction, all sleeves, hangers, inserts, etc. and arrange for all necessary openings, where required to accommodate the electrical installation.

- .3 Work shall be arranged in co-operation with other divisions of this Specification in such a manner that it doesn't interfere with the progress of the project. In areas where ducts or pipes must be installed along with conduit or cable, co-operate with other divisions so that the finished job will represent the most efficient use of the space.
- .4 In no case proceed with any Work in uncertainty. Obtain, from the Contract Administrator, any clarification necessary and thoroughly understand all portions of the Work to be performed.

1.8 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Supplier and installer responsibility is indicated in Motor Schedule on electrical Drawings, or in this Specification and related mechanical responsibility is indicated in Mechanical Equipment Schedule on mechanical Drawings.
- .2 Control wiring and conduit is specified in Division 16 except for conduit, wiring and connections below 50V which are related to temperature control systems specified in Division 15 and/or shown on mechanical Drawings.

1.9 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint indoor switchgear and distribution enclosures light grey to EEMAC 2Y-1-1958.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean and prime exposed non-galvanized hangers, racks, and fastenings to prevent rusting.

1.10 WORKMANSHIP AND MATERIALS

- .1 The installation shall consist of Material and equipment specified unless as provided herein. Electrical equipment provided under this Contract shall be built in accordance with EEMAC standards and shall be C.S.A. certified (or certified by an equivalent recognized certifying agency to meet Canadian Standards) and/or locally approved. All equipment supplied under this Contract shall be new and the best of its respective kind and of uniform pattern throughout.
- .2 Any Material or equipment ordered or installed without the Contract Administrator's prior approval shall, if so directed by the Contract Administrator, be removed and replaced with approved Material or equipment without a change to the Contract.
- .3 Replace inferior Work if so ordered by Contract Administrator without a change to the Contract.
- .4 Retain same foreman or superintendent on the job until completed, unless otherwise directed by the Contract Administrator.

- .5 All tradesmen shall carry all tools on their person at all times. Any tool not in use shall be under lock and key in an area authorized by the building supervisor.

1.11 CLEANLINESS AND CLEANING

- .1 This division shall maintain a clean tidy job Site. All boxes, crates, and construction debris due to this portion of the Work shall be neatly piled outside the construction area and shall be removed at least weekly during the construction period. All construction areas shall be kept clear of debris.
- .2 Before the project will be accepted by the City, all lighting fixtures, lamps, lens, panelboards, switches, receptacles, cover plates, and other electrical equipment shall be clean and free of dust, plaster, paint, etc. Any equipment which is scratched or damaged shall be refinished or replaced if so designated by the Contract Administrator.

1.12 MODIFICATIONS

- .1 Locations of all light fixtures, convenience receptacles, outlets, switches, telephone or similar outlets, fire alarm stations, bells, etc. are subject to modification by the Contract Administrator, who reserves the right to move these up to 3000 mm from the position shown, without change to the Contract price, provided notice is given before the related Work has commenced.

1.13 REQUEST FOR EQUAL

- .1 Applications for approval of equal, or alternate Materials, or methods, as substitutions for those specified or shown, shall be submitted in accordance with B6.
- .2 If an "Equal" has been granted, the choice between the Materials or methods specified and those approved as equal shall be optional with this Contractor.
- .3 If an "Alternate" has been approved, the difference in cost between this alternate and the specified Material or method shall be stated in the Bid Opportunity as an "add to" or "delete from" the Bid Opportunity price and the choice of Materials or methods shall rest with the Contract Administrator.
- .4 Costs for any required additional Material, wiring and labour due to the granted equal or approved alternate shall be included in the Bid Opportunity price or alternate price. This shall include costs which are incurred by other Divisions of this Specification.
- .5 Any request for equal shall include the following:
 - .1 Catalogue information, all technical data, full detail and size of the proposed equipment and all components.
 - .2 Any information requested in the related Specification section.
 - .3 Photometric Data for light fixtures.
 - .4 Provide block and riser diagram showing wiring and conduits required, power requirements, etc. with any requests. Maintain maximum allowable conduit sizes.
 - .5 Provide comply/non-comply list addressing each item of the Specifications and Drawings with each request for equal. This shall include a photocopy of all applicable Specification sections showing a complete compliance / non-

compliance listing. Refer to spec detail sheet "Shop Drawing Compliance List Sample", for example, (this detail sheet applies to Requests for Equal as well).

1.14 SITE OBSERVATIONS

- .1 Contractor's Work will be observed periodically by The Contract Administrator, solely for purpose of determining general quality of Work, and not for any other purpose. Guidance will be offered to Contractor in interpretation of plans and Specifications to assist him to carry out Work. Observation and directives given to Contractor does not relieve Contractor and his agents, servants and employees of their responsibility to erect and install Work in all its parts in a safe and Workmanlike manner, and in accordance with plans and Specifications, nor impose upon City, and/or Contract Administrator or their representatives, any responsibility to supervise or oversee erection or installation of any Work.
- .2 Contractor shall notify Contract Administrator for a final distribution inspection prior to energizing distribution system. All distribution equipment shall be left with covers removed to allow a thorough inspection.

1.15 GUARANTEE

- .1 Guarantee the satisfactory operation of all Work and equipment supplied and installed as a part of this section of the Specifications.
- .2 Replace forthwith, at no additional Material or labour cost, any part which may fail, or prove defective within a period of twelve (12) calendar months after the final acceptance of the complete installation, provided that such failure is not due to improper usage, or ordinary wear and tear.
- .3 No certificate given, payment made, partial or entire use of the equipment by the City shall be construed as acceptance of defective Workmanship or Materials.
- .4 This general guarantee shall not act as a waiver of any specified guarantee or special equipment guarantees covering a greater length of time.

1.16 IDENTIFICATION OF EQUIPMENT

- .1 Identify electrical equipment with nameplates and labels as follows and as indicated in other Specification sections.
- .2 Nameplates:
 - .1 Lamacoid 3mm thick plastic engraving sheet, shall be white with black letters or as directed, mechanically attached with self tapping screws. Nameplates for equipment fed from emergency power or from emergency UPS power (increase nameplate size as required to suit wording) shall be white with red letters.

NAMEPLATE SIZES

Size 1	10 x 50mm	1 line	3mm high letters
Size 2	12 x 70mm	1 lines	5mm high letters
Size 3	12 x 70mm	2 lines	3mm high letters
Size 4	20 x 90mm	1 line	8mm high letters

Size 5	20 x 90mm	2 lines	5mm high letters
Size 6	25 x 100mm	1 line	12mm high letters
Size 7	25 x 100mm	2 lines	6mm high letters

- .3 Labels:
- .1 Embossed plastic labels with 6mm high letters unless specified otherwise.
- .4 Fabrication details of all nameplates labels and wording on nameplates and labels to be approved by Contract Administrator prior to manufacture.
- .5 Allow an average of twenty-five (25) letters per nameplate and label.
- .6 Room names and numbers used shall be actual room names and numbers that will be used on the project. Division 16 to co-ordinate and confirm with trades involved.
- .7 Identification to be English.
- .8 Co-ordinate names of equipment and systems with Division 15 to ensure that identical names are used.
- .9 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .10 Nameplates for disconnects, starters and contactors: Indicate equipment being controlled and voltage.
- .11 Nameplates for terminal cabinets and pull boxes: Indicate system and voltage.
- .12 Nameplates for transformers: Indicate capacity, primary and secondary voltages.
- .13 Nameplates for control devices: indicate equipment controlled.
- .14 Adjacent to each breaker in CDP type panelboards, provide and mount lamacoid nameplates identifying the respective load and location.
- .15 To match existing where applicable.
- .16 All convenience receptacles shall have a lamacoid size 1 plate on which the panel and circuit number from which it is fed, is indicated. The identification shall be mechanically secured to the coverplate on the appropriate outlet. Pressure indented adhesive strip nameplates are not acceptable and shall not be used.
- .17 All receptacles fed from a UPS shall have a "UPS" lamacoid near top of cover plate.

1.17 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings on both ends of phase conductors of feeders (coloured plastic tapes) and branch circuit wiring (numbered wire markers). Conductor marker identification shall correspond with panel or terminal board directory information.
- .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. Colour coding used shall be documented by individual systems in Maintenance Manuals.
- .5 Insulated grounding conductors shall have a green finish and shall be used only as a grounding conductor.

1.18 CONDUIT, OUTLET BOXES AND CABLE IDENTIFICATION

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

	<u>Prime</u>	<u>Auxiliary</u>
Up to 250V (normal power)	yellow	
Up to 600V (normal power)	yellow	green
Up to 250V (emergency power)	yellow & red	
Up to 600V (emergency power)	yellow & red	green
Fire alarm	red	
Control	blue	
- .4 Other conduit systems as directed on Site; all conduit systems shall be identified.
- .5 Color outlet box covers to color designated and show circuit numbers in black felt marker on inside of covers.

1.19 WIRING TERMINATIONS

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

1.20 MANUFACTURERS AND CSA CERTIFICATION LABELS

- .1 Visible and legible after equipment is installed.

1.21 WARNING SIGNS

- .1 As specified and to meet requirements of Electrical Inspection Department and Contract Administrator.
- .2 Decal signs, minimum size 175 x 250mm.

1.22 SINGLE LINE ELECTRICAL DIAGRAMS

- .1 Provide single line electrical diagrams under plexiglass as follows:
 - .1 Electrical distribution system: Locate in basement main electrical room.
 - .2 Electrical power generation and distribution systems: Locate on 7th floor generator room.

- .2 Drawings: 600 x 900mm minimum size. Three required per room.

1.23 LOCATION OF OUTLETS

- .1 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.
- .2 Locate light switches on latch side of doors. Locate disconnect devices in mechanical rooms on latch side of door.

1.24 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 voltage 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. Provide copy of report in all maintenance manuals.

1.25 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: Schedule 40 steel pipe, sized for free passage of conduit, and protruding 50mm each side.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduit and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .4 Arrange for holes through exterior wall and roof to be flashed and made weatherproof.

1.26 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 Motors, heaters, and associated control equipment including sequenced operation of systems where applicable.
 - .4 Systems: Fire alarm system, security system, communication systems.
 - .5 Any other electrical systems.
- .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 All circuits shall be tested to ensure that the circuit numbers are correct and that the proper neutral conductors have been provided and installed.
- .4 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350V with a 500V instrument.
 - .2 Megger 350V - 600V circuits, feeders and equipment with a 1000V instrument.
 - .3 Check resistance to ground before energizing.
- .5 Advise Contract Administrator of dates and times for all testing with sufficient advance notice to allow Contract Administrator to make arrangements to attend.
- .6 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .7 Submit test results for Contract Administrator's review.
- .8 Insert test results and supplier's certifications in Maintenance Manuals.

1.27 CO-ORDINATION STUDY

- .1 Submit a complete Short Circuit and Time-Current Coordination Study for the breakers and fuses provided under this Contract as well as for the existing upstream breakers and fuses affecting the distributions in this Contract. If any existing breakers must be adjusted for proper coordination, other breakers affected must be included in the study and adjusted as required for proper coordination. Hydro protective devices to be included in the study.
 - .1 For the new distributions include all existing upstream overcurrent protection up to and including the (eg. main breaker in the normal main distributions and up to and including the main breaker in the emergency main distributions).
 - .2 Drawings of existing distributions are included in the Bid Opportunity documents, visit Site for additional information as required.
 - .3 Curves shall be plotted on a standard log-log scale as time versus current values on a common 600 Volt base. It shall be the responsibility of the Division 16 Contractor to provide time-current curves of all breakers, fuses, etc.
 - .4 The study shall:
 - .1 Select settings and characteristics for the protective devices in order to achieve maximum selectivity between devices during fault conditions (ie. the device nearest the fault will operate first, thus minimizing the interruption) and to provide proper protection for all distribution equipment, transformers, cable, etc.
 - .2 Determine the fault currents at critical points in the power system under the worst case conditions in order to ensure the adequacy of the electrical equipment and protective devices. Motor contribution is to be taken into account.
 - .3 Include all breakers in CDP type panelboards. Breaker settings shall be listed in the study for all breakers with adjustable trips.
 - .5 In addition to the curves for the protective devices, each Drawing shall show and include proper protection and coordination for:

- .1 Transformer inrush points.
- .2 Transformer full load currents.
- .3 Transformer damage curves (single phase and three phase).
- .4 Cable damage curves.
- .5 The largest motor or motors likely to present coordination problems.
- .6 All required breaker settings shall be listed in table form including breaker details such as breaker type, trip rating, etc. All breakers with adjustable trips shall be included in this list.
- .7 Maximum available short circuit currents shall be listed for each bus. This listing shall also include the interrupting rating of the protective devices actually supplied in the Contract.
- .8 In all cases use actual values for transformer impedance, cable types, cable sizes, cable lengths, available utility fault current, etc.
- .9 Identification names and numbers for breakers and distribution in the study shall match the identification shown on the Contract documents.
- .10 The short circuit and coordination study shall be done by a Professional Engineer licensed in the Province of Manitoba and the study shall be signed and sealed by the Professional Engineer.
- .11 Ground fault curves shall be plotted on the same Drawings as overcurrent curves to ensure proper coordination.
- .12 The study shall include the generator breakers.
- .13 Where there is equipment such as power factor correction panels with incoming breakers include these breakers in the study.
- .14 As a minimum, the study shall be bound in a 3-ring loose leaf binder and shall include:
 - .1 A title sheet listing the study name, project name, project number, date, engineering company that prepared the study (including address and phone number), the engineers seal and signature, etc.
 - .2 Table of Contents.
 - .3 Purpose of the study.
 - .4 The criteria for determining proper selective coordination, protection, adequacy, etc. (eg. describe when coordination is achieved, minimum/maximum tripping times and current values, separation between curves, safety margins, damage curves, etc.).
 - .5 Summary stating that proper selective coordination, proper protection, adequacy of the equipment for the maximum available short circuit currents, etc. was achieved and listing any areas of compromise, potential problems, marginal adequacies, etc.
 - .6 Drawings of the breaker curves showing proper selective coordination, protection, adequacies, etc. On each Drawing, include a single line diagram of the distribution for the curves shown on the Drawing, breaker settings, etc.
 - .7 Maximum available short circuit currents at each bus.
- .15 The study shall be started immediately on award of Contract and shall be submitted as a Shop Drawing for review in advance of distribution Shop Drawings. A minimum of 6 copies shall be submitted.

- .16 In cases such as primary breaker protection for transformers provide breakers with fully adjustable solid state trips (fully adjustable LSIG setting) for transformers 45 kVa and larger in order to allow proper coordination. Costs for this shall be included in the Bid Opportunity price.
- .17 All breakers shall be set per the curves in the coordination study.
- .18 The Short Circuit and Time-Current Coordination Study (revised to as-built conditions) shall be included in the Operating and Maintenance Manuals.
- .2 A certified testing agency normally engaged in field service equipment testing shall be engaged and shall test all the circuit breaker settings for coordination verification as follows (to include new and existing breakers that require adjustment of settings):
 - .1 Verification of coordination testing shall consist of:
 - .1 Testing of all circuit breaker solid state relays with the breaker manufacturer's test kit to verify at least 3 points on each time-current characteristic. One point shall be tested at the breakpoint of the characteristic at the high end and another point shall be tested at the breakpoint of the characteristic at the low end. The other points shall be tested along the straight line of the characteristic.
 - .2 Ductor (contact resistance) testing and meggar (insulation) testing of all breakers including moulded case breakers in CDP type panels, air circuit breakers, other breakers with solid state trips, high voltage breakers, etc.
 - .2 The report shall be bound in a 3-ring loose leaf binder, similar to the Short Circuit and Time-Coordination Study, with title sheet, table of contents, purpose, test criteria, test equipment used, summary and test data. The test data shall list all devices in table form with both the actual tested values and the required values listed. All test values shall fall within +/- 10% of the required values. Necessary corrective action shall be taken to correct any problems and then re-tested until the equipment passes all required tests. Compare test results to the time current coordination study and confirm that the curves as actually tested provide the required coordination. After all tests and analysis has been completed successfully, the summary in the final report shall clearly state that all equipment has successfully passed all tests and is in good operating condition. The test report shall be certified by the testing agency and shall be signed and sealed by a Professional Engineer responsible for the testing. A minimum of 6 copies shall be submitted.
 - .3 The breaker co-ordination test report shall be included in the Operating and Maintenance Manuals.
- .3 Acceptable Supplier of Service:
 - .1 Meg-A-Ron Engineering
 - .2 J.R. Stephenson Mfg. Ltd.
 - .3 Siemens
 - .4 Schneider

1.28 ARC FLASH HAZARD ANALYSIS

- .1 Scope

- .1 The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this Contract, and existing panels or distributions which are modified/added to.
- .2 References
 - .1 Institute of Electrical and Electronics Engineers, Inc. (IEEE)
 - .1 IEEE 141 - Recommended Practice for Electrical Power Distribution and Coordination of Industrial and Commercial Power Systems.
 - .2 IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - .3 IEEE 399 - Recommended Practice for Industrial and Commercial Power System Analysis.
 - .4 IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings.
 - .5 IEEE 1015 - Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
 - .6 IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.
 - .2 The National Fire Protection Association (NFPA)
 - .1 NFPA 70 - National Electrical Code, latest edition.
 - .2 NFPA 70E - Standard for Electrical Safety in the Workplace.
- .3 Submittals For Construction
 - .1 Arc flash labels shall be provided in hard copy only and affixed to the relevant switchgear.
- .4 Qualifications
 - .1 The equipment manufacturer or approved Contract Administratoring firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.
- .5 Studies
 - .1 The Contractor shall furnish an Arc Flash Hazard Analysis Study report and schematics (including calculations) per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.
- .6 Arc Flash Hazard Analysis
 - .1 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
 - .2 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where Work could be performed on energized parts.
 - .3 The Arc-Flash Hazard Analysis shall include all significant locations in 600 volt systems fed from transformers equal to or greater than 125kVA where Work could be performed on energized parts.
 - .4 Safe Working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².

- .5 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- .6 The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment locations. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculations will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- .7 The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculation on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
 - .1 Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 - .2 Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- .8 For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the Work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- .9 When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculations.
- .10 Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to computer the incident energy for the corresponding location.
- .11 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 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arch flash event, a maximum clearing time based on the specific location shall be utilized.
- .12 Incident energy and flash protection boundary calculations
 - .1 Arcing fault magnitude
 - .2 Protective device clearing time
 - .3 Duration of arc

- .4 Arc flash boundary
- .5 Working distance
- .6 Incident energy
- .7 Hazard Risk Category
- .8 Recommendations for arc flash energy reduction
- .7 Field Adjustment
 - .1 Arc Flash Warning Labels
 - .1 The Contractor of the Arc Flash Hazard Analysis shall provide a 3.5in. x 3.5in. thermal transfer type label of high adhesion polyester for each Work location analyzed.
 - .2 All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to Contract Administrator and after any system changes, upgrades or modifications have been incorporated in the system.
 - .3 The label shall include the following information, at a minimum:
 - .1 Location designation
 - .2 Nominal voltage
 - .3 Flash protection boundary
 - .4 Hazard risk category
 - .5 Incident energy
 - .6 Working distance
 - .7 Contract Administrator's report number, revision number and issue date
 - .4 Labels shall be machine printed, with no field markings.
 - .5 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - .1 For each 600 volt panelboard, one arc flash label shall be provided.
 - .2 For each motor control centre, one arc flash label shall be provided.
 - .3 For each low voltage switchboard, one arc flash label shall be provided.
 - .4 For each switchgear, one flash label shall be provided.
 - .5 For medium voltage switches one arc flash label shall be provided.
 - .6 Labels shall be field installed by Electrical Contractor.
 - .8 Arc Flash Training
 - .1 The Contractor of the Arc Flash Hazard Analysis shall train the City's qualified electrical personnel of the potential arc flash hazards associated with Working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.
 - .9 Acceptable Supplier of Service

- .1 Meg-A-Ron Engineering
- .2 JR Stephenson Mfg. Ltd.
- .3 Siemens
- .4 Schneider
- .5 Cutler Hammer

1.29 DRAWINGS

- .1 Carefully examine all Drawings and Specifications relating to all Work, and all electrical Work indicated thereon shall be considered as a part of the Work by this section unless indicated otherwise. Prior to the date of the last addendum report at once to the Contract Administrator, any defect, discrepancy, omission or interference affecting the Work of this section, or the guarantee of same.
- .2 Install all equipment as shown or as specified and in accordance with manufacturer's approved Shop Drawings.
- .3 The Drawings accompanying these Specifications are intended to show the general arrangement and extent of the Work to be carried out, but the exact location and arrangement of all parts shall be determined as the Work progresses. The location of equipment, outlets, etc., as given on the Drawings are approximately correct, but it shall be understood that they are subject to such modifications as may be found necessary or desirable at the time of installation to meet any structural or architectural requirements. Such changes shall be implemented as directed by the Contract Administrator, without additional charge.
- .4 Electrical Drawings do not show all structural and other details. Architectural and structural conditions shall govern, and this Section shall make without charge, changes or additions to accommodate these conditions. Check all architectural plans, elevations and details for location of electrical devices, equipment and equipment to be connected.
- .5 Where Drawings indicate the general location and route to be followed by conduit, cable, etc., these locations must be governed by job conditions. Where the required conduit, cable, or boxes are not shown on Drawings or only shown diagrammatically, they shall be installed to conserve maximum head room and interfere as little as possible with free use of space through which they pass. Maximum clearance above floor shall be maintained under all suspended conduit and equipment, unless otherwise shown on the Drawings, or approved by the Contract Administrator.
- .6 Submit a complete set of Drawings for the proposed installation to the Inspection Department having jurisdiction and receive written approval before installation or fabrication of any equipment. No extra compensation will be allowed for any changes or rearrangement of any electrical apparatus or Materials necessary due to failure to receive this approval.

1.30 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- .1 Submit Shop Drawings, produce detailed data and samples in accordance with previous sections, as specified herein, and to Contract Administrator's satisfaction.

- .2 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or Material.
- .3 Where applicable, include actual wiring, single line and schematic diagrams. Include all technical data and full details of each component.
- .4 Include wiring Drawings or diagrams showing interconnection with Work of other sections.
- .5 Shop Drawings of all equipment must be submitted to the Contract Administrator for review in sufficient time to enable him to retain them for at least ten (10) Working days.
- .6 One print and one PDF file of each Shop Drawing shall be submitted.
- .7 Cross out or erase all non-related items.
- .8 Bind each system separately eg. P.A., CCTV, Nurse Call, Intercom, Fire Alarm, etc. One common binder from one supplier will not be acceptable.
- .9 Shop Drawing submission shall include a photocopy of all applicable Specification sections showing a complete compliance/ non-compliance listing. Refer to spec. detail sheet "Shop Drawing Compliance List Sample" for example.
- .10 Division 16 shall check all Shop Drawings and make necessary changes, or cause the supplier to make necessary changes, prior to submission to the Contract Administrator. Drawings will be reviewed by the Contract Administrator and if re-submission is required, Division 16 shall ensure that the supplier's Drawings have been changed to comply before returning them to the Contract Administrator for review again.
- .11 Review of the Shop Drawings by the Contract Administrator shall not relieve the Contractor from responsibility for errors and omissions therein.
- .12 Each Drawing submission to bear the following signed stamp, and shall include name of project, equipment supplier, and clause number equipment is specified under.

CONTRACTORS CERTIFICATION

This Drawing has been reviewed by
(firm name)

All dimensions have been checked and found compatible with the Contract Drawings and all capacities, quantities, sizes, and other data contained in the Contract documents have been listed by the supplier on this Drawing and have been checked by the undersigned and found correct.

Date Per:

- .13 Clearly show division of responsibility. No item, equipment or description of Work shall be indicated to be supplied or Work to be done "By Others" or "By Purchaser". Any item, equipment or description of Work shown on Shop Drawings shall form part of Contract, unless specifically noted to the contrary.

- .14 Provide field dimensions required by electrical suppliers and Subcontractors. In cases where fabrication is required prior to field dimensions being available, check all related Drawings and obtain clarification from Contract Administrator if necessary.
- .15 Incomplete submissions will be returned for updating and re-submittal without Contract Administrator's review.

1.31 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centre line of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1200mm.
 - .2 Wall receptacles:
 - .1 General: 400mm.
 - .2 In mechanical or generator rooms: 915mm.
 - .3 Panelboards, annunciators etc.: 2000mm to top.
 - .4 Fire alarm speakers and strobes: 2100mm.
 - .5 Thermostats: 1200mm.
 - .6 Manual starters: 1200mm.
 - .7 Emergency power off buttons: 1200mm.

1.32 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into operation and maintenance manuals specified.
- .2 Include in operations and maintenance data:
 - .1 Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension, and expansion of any portion or feature of the electrical installation.
 - .2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature alone is not acceptable.
 - .3 Wiring and schematic diagrams and performance curves.
 - .4 Names and addresses of local suppliers.
 - .5 Copy of reviewed Shop Drawings.
- .3 Provide four (4) complete, hard-backed, D-ring loose leaf Maintenance Manuals. These shall consist of typewritten or printed instructions for operating and maintaining all systems and equipment provided under this section of the Specification. Manuals shall also contain Shop Drawings, wiring diagrams, test results and manufacturer's brochures

on all equipment, together with typed index tab sheets. Manuals shall also contain a DVD with PDF files of the contents of the manuals.

- .4 As Work progresses, record on one (1) set of Contract Drawings, installed conduit layout as well as any approved changes and deviations from the original Contract and/or Working Drawings, including outlets, equipment and panel locations. Have these Drawings available for reference and inspection at all times. At completion of Work, submit to the Contract Administrator, ACAD files of the Record Drawings and one hardcopy set of Record Drawings. The Contract shall not be considered complete and no final payment shall be made until these Drawings are accepted by the Contract Administrator. Provide separate Drawings for each system in order not to "crowd" Drawings.

1.33 TEMPORARY LIGHTING AND POWER

- .1 All temporary and construction lighting and power Work and costs for same are included as part of the scope of the Work of this section.

1.34 TESTING

- .1 Test all circuits and wires for continuity, insulation resistance and high impedance grounds. Those circuits which test non-continuous, with an insulation resistance less than 2 Megohms or with high impedance grounds shall be replaced.
- .2 All empty conduits shall be left with an insulated #14 AWG fish wire.
- .3 Test all panels under full load and make necessary reconnection of single phase loads from one leg or phase to another to balance the load on legs or phases as nearly as possible. Test results, test values measured, date of each measurement, company name and signature of person making each measurement shall be neatly recorded. Record all changes on Record Drawings.
- .4 Keep a record of all final tests, bind, and turn over typewritten results to the Contract Administrator as a part of the maintenance manual. All final test values measured, date of each measurement, company name and signature of person making each measurement shall be neatly recorded. After all tests have been successfully completed, each test report shall contain a summary which clearly states that all results were satisfactory.
- .5 Upon completion of the Work and adjustments of all equipment, all systems shall be tested in the presence of the Contract Administrator to demonstrate that all equipment furnished and installed or connected as a part of this section of the Contract shall function electrically in the required manner as determined by the Contract Administrator.
- .6 All circuits shall be tested to ensure that the circuit numbers are correct and that the proper neutral conductors have been provided and installed.
- .7 Voltage tests shall be conducted and transformer taps adjusted or other corrective measures carried out as directed by the Contract Administrator. Refer also to 4.1 Care, Operation and Start-Up.

1.35 CUTTING AND PATCHING

- .1 Perform all cutting and patching required for installing electrical systems.
- .2 Cutting to be 'neat' sizes. Patch all edges such as cover plates, etc. Hide cut edges.
- .3 Div. 16 - Electrical to perform all cutting only of existing surfaces as required as a result of the removal and/or relocation of existing equipment and conduit and/or installation of new equipment and conduit in the existing building to be included by the Div. 16 in the Bid Opportunity price.
- .4 If, in the opinion of Contract Administrator, cutting of holes has been improperly performed (i.e. too large for conduits or cables) Division 16 - Electrical to do all patching as per original Specifications and all costs will be borne by him.

1.36 FIREPROOFING

- .1 Where cables or conduits pass through floors, block or concrete walls and fire rated walls, seal openings with 3 M Brand 7900 Series Fire Barrier System or equivalent, to maintain fire rating.
- .2 Fireproofing of electrical cables, conduits, trays, etc. passing through fire barriers shall conform to local codes and inspection authorities.

1.37 ACCESS DOORS

- .1 Provide and install access doors where electrical equipment requiring access is built-in. Access doors to be 2.5mm (12 ga.) steel, approximately 300mm x 300mm (12" x 12") minimum or as approved, finished prime coat only, with concealed hinges, anchor straps, plaster lock and without screws, all equal to Milcor manufacturer. All locks to be flush type, screwdriver operated. Where it is necessary for persons to enter through door, doors to be at least 600mm x 600mm.
- .2 In applied tile or exposed glazed or unglazed structural tile, access doors shall take the tile and be sized and located to suit tile patterns. In masonry walls access doors to be sized and located to suit masonry unit sizes. In removable acoustic tile ceilings, no access doors are required.
- .3 Access doors located in fire rated ceilings or walls shall be approved fire rated doors and frames.
- .4 Co-ordinate access door types, locations, etc. with Contract Administrator.

1.38 PROTECTION

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

1.39 SCHEDULING OF WORK

- .1 Existing buildings will remain in use during construction. Arrange Work so that interruption of services is kept to a minimum. Obtain permission from City prior to cutting into electrical services. Where deemed necessary by Contract Administrator, temporary electrical shall be installed and/or Work shall be carried out at night and on weekends.
- .2 Contractor to maintain continuous and adequate all existing electrical systems and other services during entire time of this Contract. Provide temporary conduit, wire, equipment, etc. where necessary to meet this requirement.

1.40 EXAMINATION OF DOCUMENTS AND SITE

- .1 Carefully examine all plans and Specifications pertaining to this Contract and become familiar with all details. Visit the Site and determine all factors affecting this section of the Work; include all costs for same in Bid Opportunity.

1.41 DEMOLITION OF EXISTING ELECTRICAL

- .1 Remove all unnecessary existing electrical equipment, wiring, fixtures, in those portions of the existing building which are being remodelled or demolished. All devices/fixtures, etc. are not necessarily shown on the plans. The City shall select from the Materials and/or equipment remaining that which he wishes to retain, and the remainder shall be removed from the Site. Any electrical equipment in remodelled sections or in structures removed or altered, adjacent to new Work, necessary for the operation of existing building, shall be relocated as necessary. All existing equipment re-used shall be made good and guaranteed. Power interruptions to be kept to a minimum and shall be at a time suitable to the building occupant. Refer to plans for demolition areas/phasing.
- .2 Drawings do not show all electrical requiring removal to accommodate renovations such as receptacles, switches, lights, starters, motors, components, heaters, etc. Division 16 shall visit Site, refer to all Drawings and include all costs for demolition.
- .3 Refer to Specification Section 16195 - Work in Existing Building.

1.42 SPARE PARTS

- .1 The Contractor shall submit 15 days after Award of Contract a list of spare parts that the Contractor considers essential/important/useful to the operation of the systems described herein. This list shall be in addition to any spares/consumables called for in the Contract Documents and those which are required up to practical completion and hand over.
- .2 Each spare part listed shall include the manufacturer's/ supplier's price including all mark-ups, delivery and packaging. The prices shall remain valid for 12 months following handover of the project.
- .3 These spare parts may or may not be ordered during the Contract period. The Contractor shall only include these items in the Contract sum if specifically instructed to do so.
- .4 Any spare parts listed shall be completely interchangeable with those specified in the Contract Documents and included in the Works.

- .5 Any spares ordered shall be delivered to the specified City's representative complete with all documents/instructions.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements

1.2 LOCATION OF CONDUIT

- .1 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.
- .2 Produce layout sketches of conduit runs through mechanical and electrical service areas in order to pre-avoid any conflict with other construction elements and to determine the most efficient route to run conduit.

Part 2 Products

2.1 CONDUITS

- .1 Rigid galvanized steel threaded conduit.
- .2 Electrical metallic tubing (EMT): with couplings. Minimum size shall be 19mm.
- .3 Rigid PVC conduit.
- .4 Flexible metal conduit and liquid-tight flexible metal conduit.

2.2 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel Work.
- .3 U channel type supports for two or more conduits at 1500 mm oc. (Surface mounted or suspended).
- .4 Six mm dia. galv. threaded rods to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Fittings for raceways: to CSA C22.2 No. 18.
- .2 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .3 Factory "ells" where 90 deg. bends are required for 25 mm and larger conduits.
- .4 Steel set screw connectors and couplings. Insulated throat liners on connectors.

- .5 Raintight connectors and fittings c/w O-rings for use on weatherproof or sprinklerproof enclosures. Raintight couplings to be used for surface conduit installations.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 or 200 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

- .1 Polypropylene c/w 3m spare length at each conduit end.

Part 3 Execution

3.1 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms.
- .3 Use rigid galvanized steel threaded conduit where specified.
- .4 Use electrical metallic tubing (EMT) except where specified otherwise.
- .5 Use flexible metal conduit for connection to surface or recessed fluorescent fixtures, transformers and equipment subject to vibration or movement. Provide a separate insulated grounding conductor within flexible conduit.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment.
- .7 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .8 Conduit stubs from floor slabs where exposed to damage to be rigid galv. steel.
- .9 The conduit sizes as shown or indicated are the minimum acceptable and shall not be reduced without the approval of the Contract Administrator.
- .10 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .11 Mechanically bend steel conduit over 19 mm dia.
- .12 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .13 Install fish cord in empty conduits.

- .14 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .15 Dry conduits out before installing wire.
- .16 Conduit to be sized as per Canadian Electrical Code or as shown on Drawings. Note that the sizes of branch circuit conductors scheduled and/or specified on the Drawings are minimum sizes and must be increased as required to suit length of run and voltage drop in accordance with Canadian Electrical Code. Where conductor sizes are increased to suit voltage drop requirements, increase the conduit size to suit.
- .17 Running threads will not be permitted; proper couplings shall be used.
- .18 No circuits fed from emergency or essential power sources shall be run in the same conduit as other systems.
- .19 Provide separate conduit system for emergency distribution.
- .20 All conduit runs passing across expansion joints of the building shall be installed utilizing approved expansion fittings, and bonding devices.
- .21 Refer to 16010 for identification requirements.
- .22 All conduit systems in hazardous areas to be rigid galvanized steel to meet the requirements of the authorities having jurisdiction.

3.2 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 150 mm parallel to steam or hot water lines with minimum of 75 mm at crossovers.
- .7 No power driven pins (Ramset) shall be utilized to secure any portion of the conduit.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings
- .3 Section 16191 Fastenings and Support

Part 2 Products

2.1 MATERIALS

- .1 Conductors in Conduit:
 - .1 Type: RW90
 - .2 Conductors:
 - .1 Solid Copper #10 AWG and smaller.
 - .2 Stranded Copper #8 AWG and larger.
 - .3 Sized as indicated (Minimum # 12 AWG).
 - .3 Insulation: cross link polyethylene (RW90), (RWU90), 90 deg. C.
 - .4 Configuration: Single conductor.
 - .5 Voltage Rating: Minimum 600V.
 - .6 Certification: CSA C22.22 No. 38 or latest revision.
- .2 Armored Cable (BX):
 - .1 Type: AC90
 - .2 Conductors:
 - .1 Solid Copper #10 AWG and smaller.
 - .2 Stranded Copper #8 AWG and larger.
 - .3 Sized as indicated (Minimum # 12 AWG).
 - .3 Insulation: cross link polyethylene (XLPE), 90 deg. C.
 - .4 Configuration: Multi-conductor, as required, c/w a separate bare CU ground wire.
 - .5 Voltage Rating: Minimum 600V
 - .6 Certification: CSA C22.22 No. 51 or latest revision.
- .3 Armored Cable (TECK):
 - .1 Type: TECK
 - .2 Conductors:
 - .1 Solid Copper #10 AWG and smaller.
 - .2 Stranded Copper #8 AWG and larger.
 - .3 Sized as indicated (Minimum # 12 AWG).

- .3 Insulation: cross link polyethylene (RW90), 90 deg. C.
- .4 Configuration: Multi-conductor, as required, c/w a separate bare CU ground wire.
- .5 Colour Code: Black, red, blue and white in 4/C cable. Cables of more than 4/C to be number coded.
- .6 Voltage Rating: 1KV, 5KV, or 15KV as indicated.
- .7 Inner Jacket:
 - .1 Black polyvinyl chloride (PVC)
 - .2 Low Flame Spread (LFS)
 - .3 Low Gas Emission (LGE)
- .8 Armor: Inter-locked aluminum
- .9 Outer Jacket:
 - .1 Black polyvinyl chloride (PVC), -40 deg. C
 - .2 Low Flame Spread (LFS)
 - .3 Low Gas Emission (LGE)
- .10 Flame Rating: FT4
- .11 Certification: CSA C22.22 No. 131 or latest revision.
- .4 Electronic Cables:
 - .1 Conductors:
 - .1 Minimum #18 AWG - STC Solid Copper
 - .2 Insulation: polyvinyl chloride (PVC)
 - .3 Configuration: twisted pairs (No. as indicated)
 - .4 Shielding: Copper braid
 - .5 Voltage Rating: 300V
 - .6 Certification: CSA
 - .7 Suitable for use with VFD and DDC controller.
 - .8 Ground the shield as per equipment manufacturer's instructions.
- .5 Fire Alarm Cable:
 - .1 Conductor: Solid Copper minimum #18 AWG
 - .2 Insulation: 105 deg. C Flame retardent PVC
 - .3 Configuration: Multi-conductor, (minimum 4 conductors per cable).
 - .4 Voltage Rating: 300V
 - .5 Conductor Identification: Colour coded
 - .6 Shielding: Aluminum mylar foil
 - .7 Outer Jacket: 105 deg. C red PVC jacket
 - .8 Certification: CSA Class #5851-01 File #LR41741
 - .9 Flame Rating: FT4
 - .10 Refer to Fire Alarm section for wiring to suit addressable fire alarm systems.
- .6 Low Voltage Control Cables:
 - .1 Type: LVT

- .2 Conductor: Solid Copper #18 AWG
- .3 Insulation: Thermoplastic, colour coded
- .4 Configuration: single, two conductor - parallel, three or more conductors twisted
- .5 Voltage Rating: 30V
- .6 Outer Jacket: thermoplastic
- .7 Certification: CSA C22.22 No. 35
- .8 Flame Rating: FT4
- .7 Mineral Insulated Cables:
 - .1 Type: M.I., two hour fire rated.
 - .2 Conductors:
 - .1 Solid Copper Sized as indicated
 - .3 Insulation: magnesium oxide
 - .4 Configuration: Single, two, three or four conductor as indicated.
 - .5 Voltage Rating: 600V
 - .6 Outer Jacket: copper
 - .7 Acceptable manufacturers: Pyrotex (BICC Cables).
 - .8 Pressure type connectors, fixture type splicing connectors, cable clamps and lugs as required.
- .8 RA90 Cables
 - .1 Single conductor RW90 insulation, minimum 600V, -40C
 - .2 Stranded copper, size as indicated.
 - .3 Liquid and vapour tight corrugated aluminum sheath.
 - .4 Overall PVC jacket rated FT-4.

Part 3 Execution

3.1 GENERAL

- .1 All branch circuits including lighting circuits shall be minimum #10 AWG for all circuits longer than 21 metres and shall be minimum #8 for all circuits longer than 35 metres.
- .2 All branch circuit wiring and conduit shall be installed to minimize voltage drop. Install additional conduit runs as required to take the most direct and shortest route to outlets, light fixtures, etc.

3.2 INSTALLATION IN RACEWAYS

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 16111.
 - .2 Ensure conduits are dry and free of debris before pulling cables.
 - .3 Colour coding and identification as per this section.
 - .4 Wires in outlet, junction and switch boxes, not having a connection within box shall not be spliced, but shall continue unbroken through the box.

3.3 INSTALLATION OF SINGLE CONDUCTOR CABLES

- .1 Single conductor cables shall be installed one cable diam. apart on suspended cable tray or channel supports and shall be clamped with aluminum cable clamps. Cables shall be terminated using non-magnetic connectors. Cable armor shall be grounded via an aluminum plate at the supply end and isolated via an insulating plate, at the load end of the cable. A #3/0 AWG bare (unless otherwise noted) copper ground wire shall be installed with each feeder. Cable bending radius shall be at least twelve times the overall cable diam. and bends shall not damage or distort the outer sheath.
- .2 Do not install PVC jacketed cables in circulating air plenums.
- .3 Single conductor cables installed underground shall be installed in the installation configuration outlined in Appendix B of the Canadian Electrical Code to provide the allowable ampacity required for the feeder.

3.4 INSTALLATION OF FLEXIBLE ARMOURED CABLE

- .1 Type AC90 armoured cable (BX) shall be used for connections from conduit systems to wiring devices in steel stud partitions and for interconnection of wiring devices within steel stud partitions only. Cable to be clipped before entering junction or outlet boxes. Cable to be clamped within partitioning with steel galvanized tie-wire.

3.5 INSTALLATION OF MINERAL - INSULATED CABLES

- .1 Mineral insulated (MI) wiring shall have a minimum of two hour fire rating unless otherwise noted. Mineral insulated (MI) cables shall be as manufactured by (Pyrotenax) (BICC Cables).
 - .1 Refer to Drawings and Specifications for MI power feeders. All testing is to be done after cables are bent and formed within panelboards but before the cables are terminated on breakers or lugs. All insulation resistance values to be 50 megohms or more. Any cables with values less than 50 megohms are to be re-terminated and re-tested. At completion of all testing and verification, submit a final report to the Contract Administrator. The report is to include test results for each cable, confirmation that all cables and terminations have been installed according to manufacturer's installation instructions and confirmation that there are no outstanding deficiencies in the installation.
 - .2 Division 16 shall arrange for and shall pay all necessary charges for Pyrotenax to provide the testing services and to verify all terminations have been done correctly. Division 16 shall provide sufficient advance notice to Pyrotenax to allow them to be present at the required time to provide training prior to start of cable installation and to perform testing.
 - .3 Division 16 shall provide sufficient advance notice to Pyrotenax to allow them to be present at the required time to provide training prior to start of cable installation.
 - .4 All mineral insulated (MI) cables shall be spaced and installed to manufacturers recommendations. Continuous lengths of M.I. cable without joints shall be used. Mineral insulated cable shall be clipped on minimum 1m centres. All cables shall be terminated with the self threading sealing end pot inside the brass gland body. In no case shall the copper sheath and sealing end pot extend beyond the brass gland body. Complete installation to meet all Code requirements and

manufacturer's recommendations necessary for a two hour rating. All forming/bending of M.I. cable shall be done by manufacturer's recommended method.

- .5 All Pyrotenax cable terminations shall be tested and verified. Each and every termination is to be tested immediately on completion of terminations and test results turned over to Contract Administrator immediately.
- .6 Lugs for M.I. cable shall be CSA approved for M.I. cable. Where CSA approved lugs are not available for M.I. cable, Pyrotenax "Quick Terminating Kits" shall be used.
- .7 Type "P" cable clamps shall not be used to secure M.I. cable. Use approved two piece strut clamps.

3.6 INSTALLATION IN EQUIPMENT

- .1 Group and lace-in neatly wire and cable installed in switchboards, panelboards, cabinets, wireways and other such enclosures.

3.7 TERMINATIONS

- .1 Terminate wires and cables with appropriate connectors in an approved manner.
- .2 Compression adapters intended to terminate larger feeders on small lugs are not acceptable. All lugs, including breaker lugs, are to be sized to accommodate the cable being terminated.

3.8 IDENTIFICATION

- .1 Wire in conduit #2 AWG and smaller shall have solid coloured insulation, color coded as listed below.
- .2 Wire in conduit 1/0 AWG and larger and single conductor cables for normal power feeders shall be identified at each outlet box and termination with a 150 mm band of coloured vinyl tape of the appropriate colour. Emergency power feeders shall be provided with an additional 75 mm band of red vinyl tape installed adjacent to the 150 mm band of the coloured phase identification tape, as listed below. Neutral and ground conductors shall be identified. Paint or other means of colouring the insulation shall not be used.
- .3 Color code wire in conduit and single conductor cables as follows:
Phase A - red
Phase B - black
Phase C - blue
Neutral - white
Ground - green
- .4 Maintain phase sequence and colour coding throughout project.
- .5 Use colour coded wires in communication cables, matched throughout system.
- .6 Identify control conductors in motor control equipment, contactors, fire alarm panels, etc. with mylar/cloth wire markers.
- .7 Refer to 16010 for additional requirements.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings
- .3 Section 16191 Fastenings & Supports

1.2 LOCATION

- .1 Locate splitters, junction and pull boxes as indicated or as needed for each system.

Part 2 Products

2.1 SPLITTERS

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position. Sprinklerproof
- .2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3 Minimum three spare terminals on each set of lugs in splitters.
- .4 Explosion proof in hazardous areas to suit the hazardous classification.
- .5 Weatherproof where installed outdoors.
- .6 Enclosures in other areas to suit environment.

2.2 JUNCTION AND PULL BOXES

- .1 Welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.
- .3 Cast type with gasketed covers where exposed to weather.
- .4 Explosion proof in hazardous areas to suit the hazardous classification.

2.3 CABINETS

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

- .3 Provide other systems cabinets as specified and located on Drawings.

Part 3 Execution

3.1 SPLITTER INSTALLATION

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

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor.
- .3 Install terminal block as indicated.
- .4 Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.
- .5 Install junction and pull boxes clear of all mechanical ductwork and piping.

3.3 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.
- .2 Identify splitters with size 7 nameplates.
- .3 Identify junction and pull boxes with size 3 nameplates.
- .4 Identify cabinets with size 5 nameplates.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 Sectional boxes shall not be used without specific approval of the Contract Administrator.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.
- .6 In finished areas switch, convenience receptacle, voice/data and blank cover plates shall be stainless steel. In finished area ceilings, junction and pull box covers shall be solid covers, painted to match the finish of the adjacent surface.
- .7 In moist or dusty areas, gasketed watertight or dust tight boxes and covers shall be provided.
- .8 Explosion proof in hazardous areas to suit requirements of authorities having jurisdiction.

2.2 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel device boxes for flush installation, minimum size 102 mm square outlet boxes with extension and plaster rings as required.
- .2 Electro-galvanized steel device boxes for flush installation in drywall and minimum size 102mm square outlet boxes with extension and square cornered tile covers as required.
- .3 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, sized as required for the installation.
- .4 102 mm square or octagonal outlet boxes for lighting fixture outlets.

2.3 CONDUIT BOXES

- .1 Cast FS or FD ferrous boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle where exposed to moisture.

2.4 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved Material to prevent entry of debris during construction. Remove upon completion of Work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Boxes to be mounted plumb and square with building lines.
- .6 Install pull boxes, or fittings, in conduit runs where more than four bends are necessary.
- .7 Install pull boxes where run exceeds 23.0 (75 feet) in length.
- .8 All junction, outlets and pull boxes shall be so installed that they are always readily accessible.
- .9 No power driven pins (Ramset) shall be utilized to secure boxes without specific approval from Contract Administrator.
- .10 Check opening provided for each recessed outlet box and if it is not completely covered by cover plate, report discrepancy to the division responsible and ensure that it is rectified.
- .11 All concealed junction boxes, conduit fittings, etc. to be c/w galv. steel covers, secured with two bolts.
- .12 Apply acoustic sealant to and seal wires penetrating moulded vapour barrier boxes.
- .13 No more than two extension rings shall be used in sequence.
- .14 For installations in hazardous areas, meet all requirements of authorities having jurisdiction.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16132 Outlet Boxes, Conduit Boxes and Fittings

1.2 SUBMITTALS

- .1 Submit Shop Drawings and product data in accordance with Section 16010.

Part 2 Products

2.1 SWITCHES

- .1 Toggle operated general purpose AC Switches 15A and 20A 120Vac single pole, double pole, three-way and four-way switches as indicated, with the following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea molding.
 - .4 Suitable for back and side wiring.
 - .5 Brown toggle for normal power; red toggle for emergency power.
 - .6 Fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .2 Switches of one manufacturer throughout project.
- .3 Switches to be premium Specification grade.
- .4 Acceptable manufacturers:

<u>Manufacturer</u>	<u>120 Volt</u>
Hubbell	1200 Series
Bryant	4800 Series
Leviton	1200 Series

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 Vac, 15 A, U ground, with following features:
 - .1 Nylon face, brown or ivory for normal power, red for emergency power.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Double wipe contacts and rivetted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 VAC, 15 A, U ground with following features:

- .1 Nylon face, brown or ivory for normal power, red for emergency power.
- .2 Suitable for No. 10 AWG for back and side wiring.
- .3 Receptacles of one manufacturer throughout project.
- .4 Acceptable manufacturers: Hubbell, Arrow Hart, Bryant, Pass & Seymour, Slater. Catalogue No. 5262 for all manufacturers.
- .5 Acceptable manufacturers for ground fault receptacles shall be:
 - .1 Arrow Hart - GF 5242
 - .2 Bryant - GFR 52FT
 - .3 Hubbell - GF 5252
 - .4 Pass & Seymour - 1591-R

2.3 SPECIAL WIRING DEVICES

- .1 Special wiring devices: as indicated on Drawings.
- .2 Pushbutton stations to be flush or surface mounted as required. Units to be complete with up/down or start/stop buttons, as required, and green pilot light.

2.4 COVER PLATES

- .1 Cover plates from one manufacturer throughout project.
- .2 Stainless steel cover plates for wiring devices mounted in flush-mounted outlet boxes to be minimum plate thickness of 1.0mm.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .4 Cast gasketed cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

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 Section 16010 or as indicated.
 - .4 Where pilot lights are required, or shown on the Drawings, install flush neon pilots in outlet box grouped with associated switch.
 - .5 Switches shall be mounted 1.4m (4'-6") above finished floor on the strike side of the door.
- .2 Receptacles:

- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles horizontally at height specified in Section 16010 or as indicated.
 - .3 Where switch and convenience outlets are shown close to one another, mount receptacles below and in line with the switch.
 - .4 Suitably ground all receptacles with #12 green insulated wire to outlet box.
- .3 Coverplates:
- .1 Install suitable common cover plates where wiring devices are ganged.
 - .2 Do not use cover plates intended for flush outlet boxes on surface-mounted boxes.
 - .3 Provide a coverplate on each outlet.

3.2 IDENTIFICATION

- .1 Identify receptacles with size 1 nameplate indicating panel and circuit number. Nameplates to be mechanically fastened. Refer to Section 16010.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA C22.2No.65-1956(R1965) Wire Connectors.
- .2 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as required.
- .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, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required.

Part 3 Execution

3.1 INSTALLATION

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

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings
- .3 Section 16122 Wires and Cables

Part 2 Product

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted, suspended or set in poured concrete walls and ceilings or as required.
 - .1 Manufacturers: B-Line, Burndy, Electrovert, Unistrut, Pilgrim, Pursley.

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.
- .2 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .4 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole malleable iron straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel Work.
- .5 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .6 For surface mounting of two or more conduits use channels at 1500 mm oc spacing.
- .7 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

- .8 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .9 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .10 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Contract Administrator.
- .11 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .12 Threaded rod to be minimum 6 mm diam. galv. or nickel plated. Black steel rod is not acceptable.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Division 15000 Mechanical Specifications
- .2 Section 16010 Electrical General Requirements
- .3 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings
- .4 Section 16122 Wires and Cables
- .5 Section 16132 Outlet Boxes, Conduit Boxes and Fittings
- .6 Section 16440 Disconnect Switches - Fused and Non-Fused up to 1000V
- .7 Section 16811 Motor Starters to 600V

1.2 SYSTEM DESCRIPTION

- .1 Provide complete electrical power and control connections for mechanical equipment, except as noted herein.

Part 2 Products

2.1 MATERIALS

- .1 Include motor starters, disconnects, conduit, wire, fittings, interlocks, line voltage control inter-connections, outlet boxes, junction boxes, and all associated equipment required to provide power wiring for mechanical equipment, unless otherwise indicated.
- .2 Include pushbutton stations, motor protective switches, interlocks, conduit, wire, devices and fittings required to provide control wiring for mechanical equipment except for temperature/humidity control systems.
- .3 Unless otherwise noted, motors and control devices shall be supplied by Div. 15. Motor horsepower ratings shall be as shown in the Div. 15 Specifications. Motor voltage and phase ratings shall be as shown on the Div. 16 Drawings.

2.2 EXTERIOR EQUIPMENT

- .1 All equipment mounted on the exterior of the building shall be weatherproof.

Part 3 Execution

3.1 POWER WIRING

- .1 Install power feeders, starters, disconnects and associated equipment and make connections to all mechanical equipment.

- .2 Install branch circuit wiring for mechanical systems control panels, time clocks and control transformers. Control panels for equipment on emergency power to be connected to emergency branch circuits.
- .3 Install main power feeders to starter/control panels furnished by Div. 15. Install branch circuit wiring for motors, electric coils, etc.

3.2 CONTROLS

- .1 Install all electrical controls except controls supplied under Division 15, unless otherwise noted herein. Controls which have both electrical and mechanical connections shall be installed by the trade supplying the control.
- .2 Wire and connect remote thermostats, control panels, P/E switches, etc. condensing units, force flows and gas-fired unit heaters.
- .3 Wire and connect float switches, pressure switches, alternators, alarms, etc. for sump pumps, sewage pumps, domestic hot water recirculating pumps, booster pumps, jockey pumps, fuel transfer pumps and compressors.
- .4 Section 15900 shall supply and install all conduit, wire, devices and fittings required to wire and connect control systems specified in 15900. Control wiring shall be installed in conduit.
- .5 Wire and connect electrical interlocks for starters supplied by Div. 16.

3.3 COORDINATION

- .1 Refer to mechanical Drawings for the exact location of motor control devices, and other mechanical equipment requiring an electrical connection.
- .2 Obtain full information from Div. 15, regarding wiring, controls, overload heaters, equipment ratings and overcurrent protection. Notify the Div. 15 Subcontractor, at once, if any information provided is incorrect or unsatisfactory.
- .3 Coordinate control wiring requirements with Div. 15 and provide all control wiring and connections as required to make the control systems operate as specified.
- .4 Refer to Div. 15 Specifications for any further electrical requirements.

3.4 SHOP DRAWING REVIEW

- .1 Review Div. 15 equipment Shop Drawings and adjust breaker/feeder sizes as required.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings
- .3 Section 16131 Splitters, Junction, Pull Boxes and Cabinets
- .4 Section 16132 Outlet Boxes, Conduit Boxes and Fittings
- .5 Section 16141 Wiring Devices
- .6 Section 16191 Fastenings and Supports

1.2 COORDINATION

- .1 The building shall remain open and in normal operation during the construction period.
- .2 Where existing services such as electrical power, fire alarm system, sound system, etc. are required to be disrupted and/or shut down, coordinate the shut-downs with the City and carry out the Work at a time and in a manner acceptable to them. Carefully schedule all disruption and/or shut-downs and ensure that the duration of same is kept to the absolute minimum. Submit for approval a written, concise schedule of each disruption at least 120 hours in advance of performing Work and obtain City's written consent prior to implementing.
- .3 Should any temporary connections be required to maintain services during Work in the existing building, supply and install all necessary Material and equipment and provide all labour at no extra cost. Should any existing system be damaged, make full repairs without extra cost, and to the satisfaction of the City and Contract Administrator.
- .4 If existing equipment shown on Drawings is defective it shall be brought to the Contract Administrator and City's attention prior to Work completion.
- .5 Refer to General Conditions for phasing and staging of Work and adhere to that schedule. Comply with instructions regarding Working hours necessary to maintain the building in operation.

1.3 EXISTING DEVICES IN NEW CONSTRUCTION

- .1 Where existing devices (receptacles, switches, etc.) presently mounted on a wall which will be covered with a new finish, provide an extension ring, coverplate, etc. or relocate as required to mount the device to the new wall.
- .2 Where existing conduits pass vertically through a floor area, relocate those conduits to be installed concealed in a new wall or surface mounted in a service area. Extend conduit, wiring, etc. as required.

- .3 Existing junction boxes in walls and ceiling spaces required to maintain existing circuits shall remain accessible.
- .4 Where services are concealed within walls, floors or ceilings and cannot be visually identified, Contractor shall provide electronic scanning devices or other approved means to locate and identify concealed services prior to drilling.

Part 2 Products

2.1 MATERIALS

- .1 Provide all Materials required for the complete interface and reconnection installation as herein described and as indicated on the Drawings.
- .2 New fire alarm devices, speakers, starters, panelboards, etc. required to be tied in to existing systems shall match the existing devices.
- .3 New wiring required to interconnect new devices to existing systems shall be provided to suit the manufacturers requirements and instructions.

Part 3 Execution

3.1 INSTALLATION

- .1 Install boxes, conduit and wiring through existing areas as required for the new installation.
- .2 Add modules, switches, etc. in existing control panels, as required, to extend existing systems to new or renovated areas.
- .3 Patch and repair walls and ceilings in existing areas that have been damaged or cut open due to the new electrical installation.
- .4 Where new cables or conduits have been installed through existing fire rated walls, seal opening around cables and conduit to maintain fire rating.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16477 Moulded Case Circuit Breakers

1.2 SHOP DRAWINGS PRODUCT DATA

- .1 Submit Shop Drawings and product data in accordance with Section 16010.
- .2 Indicate on Shop Drawings:
 - .1 Floor or wall anchoring method and foundation template.
 - .2 Dimensioned cable entry and exit locations.
 - .3 Dimensioned position and size of bus.
 - .4 Overall length, height and depth of complete switchgear.
 - .5 Dimensioned layout of internal and front panel mounted components.
- .3 Include time-current characteristic curves for breakers as required for the coordination study.

1.3 MAINTENANCE DATA

- .1 Provide maintenance data for secondary switchgear for submission to Contract Administrator and incorporation into manual specified in Section 16010.

1.4 STORAGE

- .1 Store switchgear on Site in protected, dry location. Cover with plastic to keep off dust.

1.5 COORDINATION AND SHORT CIRCUIT STUDY

- .1 Switchboard manufacturer to provide a coordination and short circuit study as per section 16010, and submit to Contract Administrator with switchboard Shop Drawings.

Part 2 Products

2.1 RATING

- .1 Secondary switchgear: indoor 347/600V, 3 phase, 4 wire, 60 Hz or 120/208 V, 3 phase, 4 wire, 60 Hz as indicated on Drawings. Minimum interrupting capacity (rms symmetrical) as indicated on Drawings but in any case no less than 35,000 Amps RMS symmetrical at 600 Volts and 22,000 Amps RMS symmetrical at 208 Volts. Amperage rating as indicated on Drawings.

2.2 ENCLOSURE

- .1 Distribution sections to contain:
 - .1 Molded case circuit breakers sized as indicated.
 - .2 High conductivity aluminum bus.
 - .3 Panel covers.
 - .4 Hinged doors with lock. All locks to be keyed alike.
- .2 Blanked off spaces for future units.

- .3 Metal enclosed wall or floor mounted, dead front, indoor CSA Enclosure 1 or 2. Sprinklerproof construction to suit local authority having jurisdiction, which includes panel cover on distribution section.
- .4 Switchboard to be CDP type.
- .5 Access from front.

2.3 BUSBARS

- .1 Three phase and full capacity neutral bare busbars, continuous current rating as indicated on Drawings, self-cooled, extending full height of cubicle suitably supported on insulators.
- .2 Main connections between bus and major switching components to have continuous current rating to match major switching components.
- .3 Busbars and main connections: 99.30% conductivity aluminum.
- .4 Tin plated joints, secured with non-corrosive bolts and Belleville washers.
- .5 Identify phases of busbars by suitable marking.

2.4 GROUNDING

- .1 Copper ground bus not smaller than 50 x 6 mm extending full width of switchboard and situated at bottom.
- .2 Lugs at each end sized for grounding cables.

2.5 MOLDED CASE CIRCUIT BREAKERS

- .1 The Moulded Case Circuit Breakers shall be manually operable fixed mounted c/w frame size and trip settings as indicated. Breakers feeding transformers 45 kVa and larger to be c/w fully and independently adjustable LSI settings.

2.6 FINISHES

- .1 Apply finishes in accordance with Section 16010 - Electrical General Requirements.
 - .1 Cubicle exteriors gray.
 - .2 Supply 2 spray cans touch-up paint.
 - .3 Treated to inhibit rusting.

2.7 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.
- .2 Nameplates:
 - .1 Provide a size 7 nameplate to indicate voltage, amp rating and designation.
 - .2 Sub-breakers: Nameplates to indicate panel or equipment fed.

2.8 MANUFACTURERS

- .1 Cutler Hammer, Schneider, Square D, Siemens.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate switchboard as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Connect load side of breakers in distribution cubicles to distribution feeders.
- .3 Check factory made connections for mechanical security and electrical continuity.
- .4 Check trip unit settings against co-ordination study to ensure proper Working and protection of components.
- .5 Where floor mounted, arrange for switchboard to be mounted on 100mm housekeeping pad.

END OF SECTION

Part 1 General

1.1 PRODUCT DATA

- .1 Submit product data in accordance with Section 16010.

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Fusible and non-fusible disconnect switch in CSA Enclosure and size as indicated. To suit the environment (i.e. weatherproof, watertight, dust-tight, general purpose, etc.)
- .2 Provision for padlocking in on-off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, to Section 16478 - Fuses - Low Voltage.
- .5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action, heavy duty industrial grade.
- .7 ON-OFF switch position indication on switch enclosure cover.
- .8 Disconnects used for service entrances shall be approved service entrance switches.
- .9 Disconnects for two speed motors to be six pole. Refer to motor schedule and Drawings for two speed motors and provide a six pole disconnect switch for each two speed motor.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.
- .2 Indicate name of load controlled and voltage on size 6 nameplate.

Part 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses as indicated.
- .2 Install additional brackets, supports, etc. required for mounting the disconnect switches.
- .3 Install six pole disconnects at all two speed motors.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16122 Wires and Cables
- .3 Section 16461 Dry Type Transformers up to 600V Primary

1.2 REFERENCES

- .1 Ground equipment to: CSA C22.2 No. 41.
- .2 Copper grounding conductors to: CSA G7.1.

Part 2 Products

2.1 EQUIPMENT

- .1 Grounding conductors system, circuit and equipment, grounding to be bare (or green insulated if indicated/required) stranded copper sized in accordance with the Canadian Electrical Code.
- .2 System and circuit, equipment, grounding conductors, bare stranded copper, tinned, soft annealed, size as indicated.
- .3 Insulated grounding conductors: green, type RW-90.
- .4 Ground bus: copper, size 50 mm by 6 mm by 300 mm long complete with insulated supports, fastenings, connectors.
- .5 Non-corroding accessories necessary for grounding system, type, size, Material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Grounding or bonding clamps. All grounding and bonding clamps shall be brass where attached to copper pipes. Clamps for other applications shall be of a type and Material that will minimize deterioration from galvanic action due to dissimilar metals.
 - .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, system and circuit, equipment, grounding systems including, electrodes, conductors, connectors, accessories, as indicated, to conform to requirements of local authority having jurisdiction over installation.
- .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. Soldered joints not permitted.

- .5 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.
- .6 Connect building structural steel and metal siding to ground by welding copper to steel.
- .7 Make grounding connections in radial configuration only, with connections terminating at single grounding point street side of water pipe. Avoid loop connections.
- .8 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- .9 All conduit runs containing feeders and branch circuits shall be complete with an insulated green ground wire bonded to all outlet boxes, junction boxes, pull boxes, equipment enclosures, etc. The conduit system shall be continuous but shall not be relied on to serve as the equipment grounding means. Ground conductors shall be sized according to the Canadian Electrical Code, but shall be minimum #12 AWG. All locknuts and couplings shall be securely tightened. All flexible conduit shall include an insulated ground wire and shall be properly grounded through an approved fitting. A separate ground conductor shall be installed in all fibre, PVC or plastic duct runs and shall be connected to maintain the grounding of the system.

3.2 SYSTEM AND CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to neutral points of 600V and 208 V system.

3.3 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, frames of motors, motor control centres, starters, control panels, building steel Work, generators, elevator distributions, panels, outdoor lighting.

3.4 GROUNDING BUS

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

3.5 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 16010.
- .2 Perform ground continuity and resistance tests using method appropriate to Site conditions and to approval of the local inspection authority. A report shall be submitted to the Contract Administrator from the testing agency.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator, if provided, during tests.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings
- .3 Section 16426 Secondary Switchgear (120/208V & 347/600V)
- .4 Section 16450 Grounding - Secondary

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 16010.
- .2 Dry-type transformers: to CSA C22.2 No. 47, CSA C9, CSA C802.

Part 2 Products

2.1 TRANSFORMERS - VENTILATED

- .1 Use transformers of one manufacturer throughout project.
- .2 Type: ANN. K rating to be minimum K-13 or as indicated on Drawings. Parking lot transformers need not be K-13 rated.
- .3 3 phase, 600V Delta primary, 120/208V wye, secondary, 60 Hz, copper windings.
- .4 Voltage taps: 4 @ 2 1/2 %; two FCAN; two FCBN.
- .5 Insulation: Class H; 150C temperature rise above 40C ambient.
- .6 Basic Impulse Level (BIL): standard
- .7 Hipot: standard
- .8 Average sound level: 50 db for up to 150 kVA & 55 db above 150 kVA.
- .9 Impedance at 75 deg. C: to be 3% to 5% for transformers up to 225kVA (minimum 3.75% for 225 kVA transformers and 5% for transformers 300 kVA and larger).
- .10 Enclosure: EEMAC 1, removable metal front panel, sprinklerproof in sprinklered buildings.
- .11 Mounting: floor or wall.
- .12 Finish: in accordance with Section 16010 - Electrical General Requirements.

2.2 APPROVED MANUFACTURERS

- .1 Schneider, Hammond, Rex Manufacturing, Cutler Hammer, Delta, Siemens, B-Mag.
- .2 All transformers shall be of same manufacturer.

Part 3 Execution

3.1 MOUNTING

- .1 Mount dry-type transformers up to 75 kVA as indicated.

- .2 Mount dry type transformers above 75 kVA on (100mm) high concrete housekeeping pad, unless otherwise indicated.
- .3 Ensure adequate clearance around transformer for ventilation.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.
- .7 Mount transformers with vibration isolation.

3.2 CONNECTIONS

- .1 Make primary and secondary connections indicated on wiring diagram.
- .2 Energize transformers immediately after installation is completed, where practicable.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings
- .3 Section 16477 Moulded Case Circuit Breakers

1.2 SHOP DRAWINGS

- .1 Submit Shop Drawings in accordance with Section 16010.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.3 PLANT ASSEMBLY

- .1 Install circuit breakers in panelboards before shipment.
- .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

Part 2 Products

2.1 PANELBOARDS

- .1 Panelboards: to CSA C-22.2 No. 29.
- .2 Panelboards: product of one manufacturer.
- .3 250V branch circuit panelboards: bus and breakers rated for 10kA (RMS symmetrical) interrupting capacity minimum or as indicated and 347/600V panels: bus and breakers rated for 14 ka (RMS symmetrical) or as indicated.
- .4 Sequence phase bussing such that circuit breakers will be numbered in consecutive order, with each breaker identified by permanent number identification as to circuit number and phase.
- .5 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .6 Provide panel covers for all panelboards and supply two keys for each panelboard and key panelboards alike.
- .7 Aluminum bus with neutral of same ampere rating as mains.
- .8 Mains: suitable for bolt-on 25mm wide breakers.
- .9 Trim and door finish: baked grey enamel.
- .10 Sprinkler proof to meet code requirements when located in Mechanical and Electrical areas.

2.2 BREAKERS

- .1 Breakers: to Section 16477 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Lock-on devices for 5% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to The City.

- .4 Lock-on devices for fire alarm, emergency lighting, door supervisory, intercom, paging, stairway, exit, night light circuits and similar circuits.
- .5 Branch circuit breakers to be 15A single pole unless otherwise indicated on Drawings.

2.3 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.
- .2 Nameplate for each panelboard size 5 engraved as indicated.
- .3 Complete circuit directory with typewritten legend showing location and load of each circuit.

2.4 MANUFACTURERS

- .1 Acceptable Manufacturers: Cutler Hammer, Schneider, Square D and Siemens.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Except in public areas, install surface mounted panelboards on U-channels. Where practical, group panelboards on common U-channels.
- .3 Mount panelboards to height specified in Section 16010 - Electrical General Requirements or as indicated.
- .4 Connect loads to circuits.
- .5 Connect branch circuit neutral conductors to common neutral bus. Common neutrals shall be shared by vertically adjacent breakers except for GFI protected branch circuits and dimmer circuits which shall not share neutrals with other circuits. Neutral conductors shall be identified with mylar/cloth wire markers showing the circuit numbers of the circuits sharing the neutral.
- .6 Trims of recessed panelboards to be flush with wall. Coordinate installation with wall installer to ensure that walls with recessed equipment will be deep enough to accept the equipment.
- .7 Locate all panelboards as shown on the Drawings, an arrow indicating the front.
- .8 Wiring in panelboards shall be neat and set in as if laced. All neutral conductors shall be identified in the panel with their associated circuit numbers by means of Brady Markers.
- .9 All panelboards throughout the building shall be phased together such that the left-hand, centre and right-hand panelboard busses represent phases A, B and C respectively. All indicating meters shall be identified to this sequence.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16471 Panelboards Breaker Type

1.2 SUMMARY

- .1 This Section describes the Materials and installation requirements for transient voltage surge suppressors (TVSS) for the protection of all AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA)
- .2 Canadian Electrical Code (CEC)
- .3 American National Standards Institute of Electrical and Electronic Engineers (ANSI/IEEE)
- .4 Underwriters Laboratories Canada (ULC)

1.4 SUBMITTAL FOR APPROVAL

- .1 Shop Drawings, product data and manufacturer's installation instructions shall be submitted for review ten days prior to the bid date.
- .2 The submittals shall include:
 - .1 Dimensional Drawing of each TVSS unit.
 - .2 CSA Approval.
 - .3 UL Standard 1449 Listing, Standard for Safety, Transient Voltage Surge Suppressors, documentation.
 - .4 UL Standard 1283 Listing, Electromagnetic Interference Filters, documentation.
 - .5 IEEE C62.41-1991 Category C3 (20kV-1.2/50, 10kA-8/20us waveform) clamping voltage test results from an independent test lab. The test procedure shall be in accordance with IEEE C62.45-1987.

Part 2 Product

2.1 SERVICE ENTRANCE SWITCHBOARD

- .1 Suppressors shall be listed in accordance with UL 1449, Standard for Safety, Transient Voltage Surge Suppressors, and UL 1283, Electromagnetic Interference Filters.
- .2 Suppressors shall be independently tested with the Category C3 high exposure waveform (20kV-1.2/50us, 10kA-8/20us) per ANSI/IEEE C62.41 - 1991.
- .3 Suppressors shall provide redundant suppression modules between each phase conductor and the neutral conductor and between the neutral conductor and ground.
- .4 Suppressor manufacturer shall provide certified test data confirming a "fail-short" failure mode.

- .5 Visible indication of proper suppressor connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable.
- .6 The suppressor shall incorporate copper bus bars for the surge current path. Small gauge round wiring or plug-in connections shall not be used in the path for surge current diversion. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.
- .7 Suppressors shall meet or exceed the following criteria:
- .1 Maximum single impulse current rating shall be no less than 320 kA per phase.
 - .2 Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41 Category C transients without failure or degradation of UL 1449 clamp voltage by more than 10%.
 - .3 UL 1449 clamping voltage must not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>N-G</u>
120/208	400V	400V
277/480	800	800
347/600	1000	1000
 - .4 The ANSI/IEEE C-62.41 - 1991 Category C3 clamping voltage shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>N-G</u>
120/108	675V	675V
277/480	1250	1250
347/600	1500	1500
- .8 The TVSS shall be constructed using surge current modules (MOV based). Each module shall be fused with user replaceable 200,000 AIR rated fuses. The status of each module shall be monitored on the front cover of the switchboard as well as on the module.
- .9 The TVSS shall be equipped with an audible alarm which shall actuate when any one of the surge current modules has failed. An alarm on/off switch shall be provided to silence the alarm and an alarm push-to-test switch shall be provided to test the alarm. Both switches and audible alarm shall be located on the front panel of the switchboard.
- .10 Terminals shall be provided for all of the necessary power and ground connections. Each terminal shall accommodate wire sizes of #8 to #1 AWG.
- .11 The suppressor shall have a response time no greater than 5 nanoseconds for any of the individual protection modes.
- .12 The suppressor will have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.
- .13 The suppressor shall be equipped with the following optional items:
- .1 TVSS units shall be equipped with a disconnect switch or circuit breaker.
 - .2 A transient voltage surge counter shall be located on the front cover of the switchboard. The counter shall be equipped with a manual reset and a battery to retain memory upon loss of AC power.

- .3 A DB-9 connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate a failure of a phase or the entire unit.
- .4 A remote monitoring device shall be provided to directly connect to the suppressor with a DB-9 connector for simple installation. The device will have indicator lights to monitor each AC phase for a fault or good condition and include an audible alarm to indicate module failure.

2.2 SECONDARY SERVICE SURGE PROTECTED PANELBOARDS

- .1 Integral Surge Suppressor
 - .1 The panelboard shall be approved to CSA Specification C22.2 No. 29-M1989. The TVSS device shall be UL 1449 Component Recognized. The TVSS device shall have passed all UL testing required by the UL 1449 standard. Panelboard markings shall include clamp voltage at the TVSS terminals as well as clamp voltage at the panelboard line terminals.
 - .2 Suppressors shall be independently tested with the category C3 high exposure waveform (20 kV - 1.2/50us, 10 kA - 8/20us) per ANSI/IEEE C62.41 - 1991.
 - .3 Suppressors shall incorporate copper bus bars for the surge current path. Small round wiring or plug-in connections shall not be used in the path for surge current diversion.
 - .4 Suppressors shall be constructed using surge current modules (MOV based). Each module shall be fused with user replaceable 200,000 AIR rated fuses. The status of each module shall be monitored on the front cover of the panelboard enclosure as well as on the module.
 - .5 All encapsulated suppressors shall utilize an encapsulant that is UL listed and holds a 94-V2 fire retardant rating. No encapsulant compounds that incorporate epoxy shall be allowed.
 - .6 Suppressors shall be equipped with an audible alarm which shall activate when any one of the surge current modules has failed. An alarm on/off switch shall be provided to silence the alarm and an alarm push-to-test switch shall be provided to test the alarm. The switches and alarm shall be located on the front cover of the panelboard enclosure.
 - .7 Suppressors shall meet or exceed the following criteria:
 - .1 Maximum single impulse current rating shall be no less than 120 kA per phase (calculated from component manufacturer's Specifications).
 - .2 Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41 Category C transients without failure or degradation.
 - .3 The clamping voltage shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>N-G</u>
120/208	400V	400V
277/480	800	800
347/600	1000	1000
 - .8 The suppressor shall have a response time no greater than five nanoseconds for any of the individual protection modes.
 - .9 Suppressors shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
 - .10 Visible indication of proper suppressor connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable.

- .11 Suppressors shall have a minimum EFI/RFI filtering of 34dB at 100kHz with an insertion loss ratio of 50:1 using Mil Std. 220A methodology.
- .12 Suppressors shall have a five year warranty, incorporating unlimited replacements of suppressor modules if they are destroyed by transients during the warranty period.
- .13 Suppressors shall be equipped with the following optional items:
 - .1 TVSS units shall be equipped with a disconnect switch or circuit breaker.
 - .2 A transient voltage surge counter shall be located on the front cover of the suppressor. The counter shall be equipped with a manual reset and a battery to retain memory upon loss of AC power.
 - .3 A DB-9 connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate a failure of a phase or the entire unit.
 - .4 A remote monitoring device shall be provided to directly connect to the suppressor with a DB-9 connector for simple installation. The device will have indicator lights to monitor each AC phase for a fault or good condition and include an audible alarm to indicate module failure.
- .2 Approved Manufacturers
 - .1 Schneider Canada
 - .2 Cutler-Hammer
 - .3 Siemens

Part 3 Execution

3.1 SECONDARY DISTRIBUTION PANELS

- .1 Install panelboards as required and according to manufacturer's recommendations. The surge suppression is integrated into the surge protected panelboards.
- .2 Conductors between suppressor and point of attachment shall be kept short and straight.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16426 Secondary Switchgear (120/208V & 347/600V)
- .3 Section 16471 Panelboards Breaker Type

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 16010.
- .2 Include time-current coordination characteristic curves for breakers.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded case circuit breakers: to CSA C22.2 No. 5.
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. C ambient.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 5-10 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Minimum Interrupting Ratings (RMS Symmetrical) unless otherwise indicated on the drawings:
 - .1 120/208 Volts - 22,000 Amps
 - .2 347/600 Volts - 35,000 Amps

2.2 THERMAL MAGNETIC BREAKERS

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

2.3 SOLID STATE TRIP BREAKERS

- .1 Moulded case circuit breaker 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 and ground fault tripping.
 - .1 Each breaker shall have the following independent and fully adjustable curve shaping characteristics:
 - .1 Adjustable long time pickup
 - .2 Adjustable long time delay
 - .3 Adjustable short time pickup
 - .4 Adjustable short time delay with selective curve shaping
 - .5 Adjustable instantaneous pickup

- .6 Adjustable ground fault pickup
- .7 Adjustable ground fault delay with selective curve shaping
- .2 Breakers feeding transformers 45 kVA and larger shall have solid state trips, fully and independently adjustable LSIG settings.

2.4 MANUFACTURERS

- .1 Acceptable manufacturers: Cutler Hammer, Schneider, Square D, Siemens.

Part 3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit Shop Drawings and product data in accordance with Section 16010.
- .2 Submit fuse performance data characteristics for each fuse type and size above 30 A. Performance data to include: average melting time-current characteristics, I_c(for fuse coordination), and peak let-through current.

1.3 MAINTENANCE MATERIALS

- .1 Provide maintenance Materials in accordance with Section 16010.
- .2 Three spare fuses of each type and size installed above 600 A.
- .3 Six spare fuses of each type and size installed up to and including 600 A.

1.4 DELIVERY AND STORAGE

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

Part 2 Products

2.1 FUSES GENERAL

- .1 Plug and cartridge fuses: to CSA C22.2 No. 59.
- .2 Fuse type references L1, L2, J1 etc. have been adopted for use in this Specification.
- .3 Fuses: product of one manufacturer.

2.2 FUSE TYPES

- .1 HRC-L fuses (formerly Class L), motor loads:
 - .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .2 Type L2, fast acting.
- .2 HRCI-J fuses (formerly Class J), Panel loads:
 - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .2 Type J2, fast acting.

2.3 FUSE STORAGE CABINET

- .1 Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door finished in accordance with Section 16010 - Electrical-General Requirements.

Part 3 Execution

3.1 INSTALLATION

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
 - .1 Install Class R rejection clips for HRCI-R fuses.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Provide a fuse cabinet in each main and Sub-electrical room where fuses are installed.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit Shop Drawings in accordance with Section 16010.
- .2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for approval by Contract Administrator.
- .3 Submit list of replacement lamp data for each luminaire. Include lamp type, voltage, base type and order code.

1.3 GUARANTEE

- .1 Replace:
 - .1 Fluorescent lamps burning out within 12 months of takeover.
 - .2 Ballasts that fail or exceed their labelled noise level rating within 12 months of takeover.

1.4 CO-ORDINATION

- .1 Co-ordinate luminaire locations with Work of other trades.
- .2 Co-ordinate luminaire types with ceiling finishes to ensure compatability.
- .3 Luminaires to be c/w lamps, suspension devices, plaster rings and other attachments required for best appearance and proper mechanical installation.
- .4 Every light outlet in the building shall be provided with a suitable fixture. In the event that the fixture type is not designed for any particular outlet, supply a suitable fixture for the application, as approved by the Contract Administrator.

Part 2 Products

2.1 MATERIALS

- .1 Electric discharge fixtures: to CSA C22.2 No. 9.
- .2 Fluorescent lamps: to ANSI C78 series.
- .3 Ballasts: to CSA C22.2 No. 74.
- .4 Plastic lenses and diffusers ULC labelled.

2.2 LUMINAIRE DETAILS

- .1 Luminaires shall carry the CSA label.
- .2 Provide supporting devices, plaster frames, junction boxes and outlet boxes where required.
- .3 Provide lenses or diffusers of glass or acrylic Material as indicated. Acrylic lenses used with fluorescent luminaires shall be a K-12 pattern with a minimum of .125" (3mm) thickness.

- .4 Include finishes to Section 16010 and as indicated.
- .5 Provide gasketting, stops and barriers to prevent light leaks.

2.3 LAMPS

- .1 Provide lamps as indicated.
- .2 Fluorescent lamps (T5) shall be programmed start, 5000 lumens, rated 25,000 hours, 3500 K.
- .3 Fluorescent lamps (T8) shall be rapid start, 2850 Lumens rated 20,000 hours, 3500 K.

2.4 BALLASTS AND ACCESSORIES

- .1 Provide ballasts and accessories as indicated.
- .2 Provide ballasts with non-PCB type capacitors with pressure sensitive devices to prevent rupturing.
- .3 Provide fluorescent ballasts of 120 V design, automatic reset thermal protected, 90% power factor, group A noise rating. Ballasts to be Phillips/Advance Mark III.
- .4 Fluorescent ballast: CBM certified, energy efficient electronic type, design. (Hybrid type not acceptable).
 - .1 Rating: 60 Hz, voltage as indicated, for use with 2-32 W, T-8, rapid start lamps.
 - .2 Totally encased and designed for 40 deg C ambient temperature.
 - .3 Power factor: minimum 90% with 95% of rated lamp lumens.
 - .4 Capacitor: non PCB, thermally protected.
 - .5 Thermal protection: non-resettable auto reset on coil.
 - .6 Sound rated: A.
 - .7 Mounting: remote integral with luminaire.
 - .8 Total harmonic distortion less than 20%.
 - .9 Ballast must be listed by Manitoba Hydro as acceptable by their "Power Smart" rebate program.
 - .10 Line amperes for ballast with two 4-foot T-8 lamps to be 0.6 Amps at 120 V maximum, 68 VA. volt-amperes for ballast with four 4-foot T-8 lamps to be 1.0 Amps at 120V maximum.

Part 3 Execution

3.1 INSTALLATION

- .1 Install luminaires at locations indicated, c/w lamps, all wiring, connections, fittings, hangers, aligners, box covers and accessories, as required.
- .2 Install luminaires parallel with building lines. Wall mounted luminaires to be installed plumb.
- .3 All luminaires and assemblies shall be properly secured and supported. Support luminaires independent of the ceiling construction c/w all fasteners, framing and hangers as may be required. Do not secure luminaires to mechanical ductwork or other vibration producing apparatus, unless specifically detailed on the Drawings.
- .4 Co-ordinate the installation of luminaires with the Work of other trades, ensuring that the necessary depths and mounting spaces are provided. Luminaires which cannot be

installed due to a conflict with structural members, pipes or ductwork shall be relocated to a more suitable location, as directed by the Contract Administrator.

3.2 WIRING

- .1 Connect luminaires to lighting circuits as indicated.

3.3 LAMPS

- .1 Adjust lamp position in adjustable lampholder type luminaires to produce the proper beam distribution for the specified lamp.

3.4 TESTS

- .1 Perform tests in accordance with Section 16010.

3.5 CLEANING

- .1 Prior to take-over of the project, clean the lenses and reflectors of all luminaires with a damp cloth to remove dust, smudges and fingerprints.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings
- .3 Section 16122 Wires and Cables
- .4 Section 16132 Outlet Boxes, Conduit Boxes and Fittings

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 16010.
- .2 Data to indicate system components, mounting method, source of power and special attachments.

1.3 OPERATION AND MAINTENANCE DATA

- .1 Provide data for incorporation into Maintenance Manual specified in Section 16010.
- .2 Operation and Maintenance Manual to include:
 - .1 Operation and maintenance instructions for complete battery system to permit effective operation and maintenance.
 - .2 Technical data - illustrated parts lists with parts catalogue numbers.
 - .3 Copy of approved Shop Drawings.

1.4 MAINTENANCE MATERIALS

- .1 Provide maintenance Materials in accordance with Section 16010.
- .2 Include:
 - .1 Five spare lamps of each type supplied for remote heads.

1.5 WARRANTY

- .1 Provide a written guarantee, stating that the battery for emergency lighting is guaranteed against defects in Material and workmanship for a period of 10 years, with a no-charge replacement during the first lustrum and a pro-rate charge on the second lustrum, from the date of the Final Acceptance from the City.

1.6 SYSTEM DESCRIPTION

- .1 The system to include battery unit(s) controls, remote heads, wire and conduit etc. to provide backup emergency lighting in the event of a loss of AC power to the normal lighting system.

Part 2 Products

2.1 EQUIPMENT

- .1 Supply voltage: 120 V, ac.
- .2 Output voltage: 12 V dc. as indicated.

- .3 Operating time: 60 min.
- .4 Battery: sealed, long life, lead acid or lead calcium maintenance free.
- .5 Charger: solid state, multi-rate, pulse type, voltage/current regulated, inverse temperature compensated, short circuit protected, modular construction.
- .6 Solid state transfer.
- .7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage c/w 2-fused DC output circuits.
- .8 Signal lights: solid state, life expectancy 100,000 h minimum, for 'AC Power ON' and 'High Charge'.
- .9 Lamp heads: integral on unit 360 deg. horizontal and 180 deg. vertical adjustment. Lamp type: tungsten-halogen, 12 W, glare free, (mini style).
- .10 Cabinet: minimum 20 gauge steel cabinet c/w white polyester paint finish c/w knockouts for conduit.
- .11 Auxiliary equipment:
 - .1 Low voltage disconnect switch.
 - .2 Lamp disconnect switch.
 - .3 Test switch.
 - .4 Time delay relay.
 - .5 Battery disconnect device.
 - .6 ac input and dc output terminal blocks inside cabinet.
 - .7 Shelf where required.
 - .8 Cord and 3-prong straight blade NEMA 5-15P plug connection for ac.
- .12 Wall mounted battery banks to be direct wall mounted or with wall mounting shelf. Provide removable or hinged front panel for easy access to the batteries. LED diagnostics display and test switch mounted by side of enclosure.
- .13 For battery units located in diesel generator rooms, provide a series rated TVSS mounted in a W.P. enclosure. TVSS to be Square D #TVS120C15.

2.2 MANUFACTURERS

- .1 Acceptable Manufacturers: Dual-Lite, Emergi-lite, Lithonia, Lumacell, Luxnet, Uniglo.

Part 3 Execution

3.1 INSTALLATION

- .1 Install unit equipment for emergency lighting in accordance with CSA C22.1.
- .2 Install conduit and wiring as indicated.
- .3 Install unit equipment and remote mounted fixtures as indicated.
- .4 Cut and re-cap cord to remove surplus.
- .5 Direct heads indicated to provide maximum lighting level along means of egress routes.
- .6 Mount double remote heads on outlet box such that the two heads will be horizontal with the building lines.

- .7 Charge the batteries and test the system for proper operation (minimum of 65 minutes discharge time).
- .8 Adjacent to each battery bank unit install a 120V duplex receptacle and wire to AC night lighting circuit.
- .9 Battery banks in diesel generators to be direct wired to TVSS mounted in a W.P. enclosure adjacent to the battery bank.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 Section 15800 Air Distribution
- .2 Section 15900 Controls/Instrumentation
- .3 Section 16010 Electrical General Requirements
- .4 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings
- .5 Section 16122 Wires and Cables
- .6 Section 16627 Automatic Load Transfer Equipment
- .7 Section 16723 Fire Alarm System

1.2 DESCRIPTION OF SYSTEM

- .1 Generating system consists of:
 - .1 Diesel engine.
 - .2 Alternator.
 - .3 Control panel.
 - .4 Automatic transfer equipment with manual bypass switch.
 - .5 Battery charger and battery.
 - .6 Automatic engine room ventilation system.
 - .7 Fuel supply system.
 - .8 Exhaust system.
 - .9 Structural steel mounting base.
- .2 System designed to operate in as emergency standby power source unattended, rated at 750 kVA.
- .3 The engine, generator, and all major items of auxiliary equipment shall be products of manufacturers regularly engaged in the production of such equipment. The assembly shall be made up of coordinated components by an organization regularly engaged in assembling such equipment. The assembler or his authorized distributor shall maintain a parts and service facility satisfactory to the Contract Administrator.
- .4 Supply and install surge arrestors on M.I. cable from control panel as recommended by cable manufacturer.
- .5 Before submitting Bid Opportunity, the manufacturers shall ensure that the requirements of the Specifications are met and that the equipment to be supplied can be accommodated in the standby generator room with clearances to meet code requirements.

1.3 SHOP DRAWINGS

- .1 Submit Shop Drawings in accordance with Section 16010.
- .2 Include:
 - .1 Engine: make and model, with performance curves.
 - .2 Alternator: make and model.
 - .3 Voltage regulator: make, model and type.
 - .4 Automatic transfer switch with manual bypass switch: make, model and type.
 - .5 Battery: make, type and capacity.

- .6 Battery charger: make, type and model.
- .7 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 Flow diagrams for:
 - .1 Diesel fuel.
 - .2 Lubricating oil.
 - .3 Cooling air.
- .12 Dimensioned Drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, and total weight.
- .13 Continuous full load output of set at 0.8 PF lagging.
- .14 Description of set operation including:
 - .1 Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
 - .2 Manual starting.
 - .3 Automatic shut down and alarm on:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator overvoltage.
 - .7 Lube oil high temperature.
 - .8 Thermistor overtemperature on alternator.
 - .9 Low battery voltage/battery charge.
- .15 Submit engine generator set performance tests together with Shop Drawings before manufacture of equipment. Tests shall have been carried out on a prototype of the generating set series in accordance with procedures certified by an independent testing laboratory. Tests shall include the following:
 - .1 Max. power level.
 - .2 Max. motor starting capability.
 - .3 Single step load pick-up.
 - .4 Torsigraph analysis.
 - .5 Steady-state and transient voltage response.
 - .6 Steady-state and transient frequency response.
 - .7 Harmonic analysis and voltage waveform deviation.
 - .8 Three phase circuit strength (mechanical and electrical).

1.4 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for diesel generator for incorporation into manual specified in Section 16010.
- .2 Include in Operation and Maintenance Manual instructions for particular unit supplied and not general description of units manufactured by supplier and:
 - .1 Operation and maintenance instructions for engine, alternator, control panel, automatic transfer switch, manual bypass switch, battery charger, battery, fuel system, engine room ventilation system, exhaust system, accessories, etc. 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 Certified copy of site test results.
- .6 Maintenance and overhaul instructions and schedules. Complete set of service manuals are to be the same as those issued to factory trained technicians.
- .7 Precise details for adjustment and setting of time delay relays or sensing controls which are required on site adjustment.
- .8 Spare parts list.

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.
 - .6 3 pairs of ear protectors.
 - .7 1 set of belts.

1.6 SOURCE QUALITY CONTROL

- .1 Factory test generator set including engine, alternator, control panels, transfer switch, accessories, etc. to ensure compliance with Specifications and send certified test results to the Contract Administrator prior to shipping.

1.7 DESIGN PARAMETERS

- .1 Approved alternate suppliers will be responsible for all costs required for Div. 15 revisions to their mechanical systems arising from different requirements. Costs to include re-engineering costs that may be required.

Part 2 Products

2.1 DIESEL ENGINE

- .1 Diesel engine: to ISO 3046/1.
 - .1 Engine: standard product of current manufacture, from company regularly engaged in production of such equipment.
- .2 Two or Four cycle, turbo charged and after cooled as required, synchronous speed 1800 r/min.
- .3 Capacity:
 - .1 Rated continuous power in kW at 1800 r/min, after adjustment for power losses in auxiliary equipment necessary for engine operation; to be calculated as follows:

$$\text{Rated continuous output} = \frac{\text{Generator kW}}{\text{Generator Eff @ FL}}$$

- .1 Under following site conditions:
 - .1 Altitude: 500 m.
 - .2 Ambient temperature: 30 deg. C.
 - .3 Relative humidity: 90%.
- .4 Cooling System:
 - .1 Liquid cooled: heavy duty industrial radiator mounted on generating set base with engine driven pusher type fan to direct air through radiator from engine side. Thermostatically controlled, with ethylene glycol anti-freeze non-sludging above minus 46 deg. Ensure radiation fan has sufficient capacity to exhaust air through the plenum (and area wells where specified) to provide proper cooling.
 - .2 To maintain manufacturer's recommended engine temperature range at 10% continuous overload in ambient temperature of 40 deg. C.
 - .3 Block heater: thermostatically controlled liquid coolant heater to allow engine to start in room ambient 0 deg. C.
 - .4 Provide flexible hose connections.
 - .5 Engine to have coolant temperature gauge.
- .5 Fuel:
 - .1 Type A fuel oil: to CGSB 3-GP-6c.
- .6 Fuel system: solid injection, mechanical fuel transfer pump with hand primer, fuel filters and air cleaner, fuel rack solenoid energized when engine running, flexible fuel line connections, fuel oil pressure gauge, etc.
- .7 Governor:
 - .1 Electronic type:
 - .1 Steady state speed band of plus or minus 0.5%.
 - .2 Isochronous speed regulation no load to full load.
 - .3 Adjustable isochronous to 5% droop.
 - .4 Transient frequency variation shall not exceed 15% of rated frequency when full load at rated power factor is applied. Recovery to stable operation shall occur within five seconds.
- .8 Lubrication system:
 - .1 Pressure lubricated by engine driven pump.
 - .2 Lube oil filter: replaceable, full flow type, removable without disconnecting piping.
 - .3 Lube oil cooler.
 - .4 Engine sump drain valve.
 - .5 Oil level dip-stick.
 - .6 Lube oil temperature gauge.
 - .7 Lube oil pressure gauge.
- .9 Starting system:
 - .1 Positive shift, gear engaging starter 24 Vdc.
 - .2 Cranking limiter to provide 3 cranking periods of 10 s duration, each separated by 5 second rest.
 - .3 Lead acid, 12 V storage batteries with sufficient capacity to crank engine for 3 min at 0 deg. C without using more than 25% of ampere hour capacity. To be complete with battery cables, interconnectors and steel rack.

- .4 Battery charger: constant voltage, solid state, two stage from trickle charge at standby to boost charge after use. Regulation: plus or minus 1% output for plus or minus 10% input variation. Automatic boost for 6 h every 30 days. Equipped with dc voltmeter, dc ammeter and on-off switch. Charger to be capable of recharging completely discharged batteries to 80% capacity within 12 hours.
- .10 Vibration isolated engine instrument panel with:
 - .1 Lube oil pressure gauge.
 - .2 Lube oil temperature gauge.
 - .3 Coolant temperature gauge.
 - .4 Running time meter: non-tamper type.
 - .5 Fuel oil pressure gauge.
- .11 Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.
- .12 Drip tray.
- .13 Connect the following alarms to a common supervisory trouble zone in main fire alarm panel.
 - .1 Overcranking
 - .2 Overspeed
 - .3 High engine temperature
 - .4 Low lube oil pressure
 - .5 Short circuit
 - .6 Alternator overvoltage
 - .7 Low battery voltage or no battery charge
 - .8 Manual remote emergency stop
 - .9 High alternator temperature
- .14 Provide output contacts to connect the low fuel alarm panel to a separate supervisory trouble alarm zone in main fire alarm panel.
- .15 Provide output contacts to connect the generator fail alarm point to a separate supervisory trouble zone in main fire alarm panel.
- .16 Provide output contacts to connect the generator running alarm point to a separate supervisory trouble zone in the main fire alarm panel.
- .17 All piping and connections to the engine and generator shall include a flexible section supplied with the engine.

2.2 ALTERNATOR

- .1 Alternator: to NEMA MG1.
- .2 Rating: 3 phase, 347/600V, 4 wire, 60 Hz, continuous duty, 125C temperature rise as outlined in CSA C282.
- .3 Output at 40 deg. C ambient:
 - .1 100% full load continuously.
- .4 Revolving field, brushless, single bearing.
- .5 Drip proof.
- .6 Amortisseur windings.
- .7 Synchronous type.

- .8 Dynamically balanced rotor permanently aligned to engine by flexible disc coupling.
- .9 Exciter: permanent magnet. The exciter shall have capacity to provide 150% of required excitation at rated load and voltage. Excitation shall provide for current output of 300% for 10 seconds.
- .10 EEMAC class H insulation on windings.
- .11 Thermistors embedded in stator winding and connected to alternator control circuitry.
- .12 Voltage regulator: solid state thyristor controlled rectifiers with phase controlled sensing circuit:
 - .1 Stability: 0.1% maximum voltage variation at any constant load from no load to full load.
 - .2 Regulation: 0.5% maximum voltage deviation between no-load steady state and full-load steady state.
 - .3 Transient: 10% maximum voltage dip on one-step application of 0.8 PF full load.
 - .4 Transient: 15% maximum voltage rise on one-step removal of 0.8 PF full load.
 - .5 Transient: 2s maximum voltage recovery time with application or removal of 0.8 PF full load.
 - .6 Transient: 10% maximum voltage dip in most severe motor starting condition.
 - .7 Transient voltage variation shall not exceed 20% of rated voltage when full load at rated power factor is applied or removed. Recovery to stable operation shall occur within two seconds.
- .13 Alternator: capable of sustaining 300% rated current for period not less than 10 s permitting selective tripping of down line protective devices when short circuit occurs.

2.3 CONTROL PANEL - REMOTE TYPE

- .1 Totally enclosed, sprinkler proof, mounted on generator with vibration dampers or free standing to meet requirements of CSA C282.
- .2 Panel door with formed edges and lockable handle with 2 keys.
- .3 Flexible conductors between door and fixed panel.
- .4 Instruments:
 - .1 Digital indicating type 2% accuracy, rectangular scale, flush panel mounting:
 - .1 Voltmeter: ac, scale 0 to 750 V.
 - .2 Ammeter: ac, scale 0 to 125% of rated amperage.
 - .3 Wattmeter: scale 0 to 125% of rated kW.
 - .4 Frequency meter: scale 55 to 65 Hz.
 - .5 Power Factor meter.
 - .6 Running time meter.
 - .2 Voltmeter selector switch, rotary, panel mounting, four position, labelled "Off-Phase A-Phase B-Phase C".
 - .3 Ammeter selector switch, rotary, maintained contacts, panel mounting, designed to prevent opening of current circuits, four position labelled "OFF- Phase A-Phase B-Phase C".
 - .4 Fuses for indicating instruments: miniature, glass, fast acting, fitted at rear of instrument.
 - .5 Instrument Transformers
 - .1 Potential-dry type for indoor use:
 - .1 Ratio: 600 to 120.
 - .2 Rating: 600 V, 60 Hz, BIL 3 kV.

- .2 Current-dry type for indoor use:
 - .1 Ratio: as required.
 - .2 Rating: 600 V, 60 Hz, BIL 3 kV.
 - .3 Positive action automatic short-circuiting device in secondary terminals.
- .6 Emergency shut-down pushbutton on control panel and remote pushbutton at entry to room.
- .5 Controls:
 - .1 Engine start button.
 - .2 Selector switch: Off-Auto-Manual.
 - .3 Engine emergency stop button and provision for remote emergency stop button.
 - .4 Alternator output breaker:
 - .1 Circuit breaker: bolt-on, moulded case, temperature compensated for 40 deg. C ambient, dual thermal-magnetic trip.
 - .5 Voltage control rheostat: mounted on the inside of the control panel and to be screwdriver adjust type with locking nut.
 - .6 Operating lights, panel mounted:
 - .1 "Normal power" pilot light.
 - .2 "Emergency power" pilot light.
 - .3 Green pilot lights for breaker on and red pilot lights for breaker off.
 - .7 Solid state indicator lights for alarm with 1 set manually reset NO/NC form "C" contacts wired to terminal block for remote annunciation on:
 - .1 Low fuel level.
 - .2 Low battery voltage or high battery voltage.
 - .3 Ventilation failure.
 - .4 Engine high temperature (above 110%).
 - .5 Engine low lube oil pressure (at 80%).
 - .6 Low coolant.
 - .8 Solid state controller for automatic shutdown and alarms with 1 set manually reset NO/NC form "C" contacts wired to terminal block for remote annunciation on:
 - .1 Engine overcrank.
 - .2 Engine overspeed.
 - .3 Engine high temperature (shutdown at 115%).
 - .4 Engine low lube oil pressure (shutdown at 40%).
 - .5 Short circuit.
 - .6 Alternator over voltage.
 - .9 Push to test lamp buttons.
 - .10 Provision for remote monitoring.
 - .11 Provide the following contacts for Div. 15900 to monitor:
 - .1 Engine running
 - .2 Engine trouble
 - .3 Normal power failed
 - .4 Transfer switch - trouble (not in auto)
 - .5 Common shutdown.
 - .12 All devices to be wired to a terminal block.
 - .13 Provide other shutdowns and alarms as required by CSA C282.

2.4 STRUCTURAL STEEL MOUNTING BASE

- .1 Complete generating set mounted on structural steel base of sufficient strength and rigidity to protect assembly from stress or strain during transportation, installation and under operating conditions on suitable level surface.
- .2 Assembly fitted with vibration isolators and control console resiliently mounted.
 - .1 Spring type isolators with adjustable side snubbers and adjustable for levelling.
- .3 Sound insulation pads for installation between isolators and concrete base.

2.5 EXHAUST SYSTEM

- .1 Heavy duty, hospital grade type, horizontally mounted exhaust silencer with condensate drain, plug and flanged couplings. Refer to Drawings for physical space allowed for silencer.
- .2 Silencer to be provided with mounting lugs for hangers. Coordinate quantity and locations of hangers with Division 15.
- .3 Heavy duty flexible exhaust pipe with flanged couplings as required.
- .4 Fittings and accessories as required.
- .5 Expansion joints: stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion.
- .6 Provide sound criteria as part of the Shop Drawing submission.

2.6 FUEL SYSTEM

- .1 Fuel storage tanks: Refer to Specification section 15000 for tank sizes and piping.
- .2 Provide flexible piping at motor connection point.
- .3 Division 16 to fill sub-basement storage tank and day tank for testing. See Section 3.3. After completion of all testing, Division 16 to fill sub-basement storage tank and day tank.

2.7 FINISHES

- .1 Apply finishes in accordance with Section 16010 - Electrical General Requirements.
- .2 Alternator control cubicle: inside finish white, exterior to match engine and alternator.
- .3 Other ducts and racks grey.
- .4 Supply 0.25 L of touch-up enamel, color to suit unit.

2.8 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 16010 - Electrical - General Provisions.
- .2 Control panel:
 - .1 Size 5 nameplates for controls such as alternator breakers and program selector switch.
 - .2 Size 2 nameplates for meters, alarms, indicating lights and minor controls.

2.9 FABRICATION

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

2.10 SPARE PARTS

- .1 Spare Parts
 - .1 Provide spare parts, in quantities specified in individual Specification sections.
 - .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.
 - .2 Provide items of same manufacture and quality as items in Work.
 - .3 Deliver to Site; place and store as directed by Contract Administrator.
 - .4 Receive and catalogue items. Submit inventory listing to Contract Administrator. Include approved listings in Maintenance Manual.
 - .5 Obtain receipt for delivered products and submit prior to final payment.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate generating unit and install as indicated.
- .2 Muffler drains to be piped to nearest floor drain by Division 15.
- .3 Complete wiring and interconnections as indicated.
- .4 The initial start-up shall be performed by factory-trained representative of the diesel generator set supplier.
- .5 Start generating set and test to ensure correct performance of components.
- .6 Provide wiring between generator control panel and transfer switch in conduit. Wiring as required. Division 16 is responsible for all generator set controls/inter-connects and wiring.
- .7 Provide emergency circuits for all generator set accessories and for all Division 15 controls required for generator set operation. Confirm all systems are fully operational when utility power is not available.

3.2 PRE-TESTING PROCEDURE

- .1 The Manufacturer or a qualified factory trained Technical representative shall provide the following:

- .1 Materials, components and installation for electric power generating equipment transfer switch and system start-up.
- .2 References
 - .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-B139-00(October 2001), Installation Code for Oil-Burning Equipment.
 - .2 Underwriters' Laboratories of Canada (ULC - C282)
- .3 System Start-Up
 - .1 Preparation: before starting unit, carry out thorough mechanical and electrical inspection of equipment, and perform following checks and adjustments:
 - .1 Disconnect battery cables from batteries to prevent accidental starting.
 - .2 Turn engine several revolutions by means of hand-barring devices to ensure parts are free and there are no obstructions to its running.
 - .3 Check engine/generator alignment readings to ensure they match readings attained at time of manufacture.
 - .4 Check fluid levels and top up as necessary. Pre-lubricate engine and turbochargers as recommended by engine manufacturer. Install drip pan beneath engine.
 - .5 Ensure cooling system antifreeze is effective to at least minus 40 degrees C.
 - .6 Check belts for correct tension and adjust as necessary.
 - .7 Check and grease grease points.
 - .8 Check and tighten properly nuts, bolts, etc.
 - .9 Ensure safety guards are in place and properly secured. Check linkages for damage and freedom of movement.
 - .10 Check fuel supply system for leakage.
 - .11 Ensure fuel supply and fuel injection systems are properly primed.
 - .12 Check and tighten properly electrical connections.
 - .13 Check starting battery electrolyte level specific gravity and for proper installation.
 - .14 Check battery charger for proper operation and adjust as necessary.
 - .15 Carry out generator winding insulation resistance test. If reading is unacceptable, carry out recognized drying procedure. Do not start unit until satisfactory reading has been achieved.
 - .16 Check jacket coolant heater for proper operation.
 - .17 Complete additional preparations deemed necessary.
 - .2 Performance verification: on completion of start-up preparations, take following action:
 - .1 Have at hand, during initial start-up, means for choking off air supply to engine air induction manifold in event of engine run away or other emergency.
 - .2 Reconnect starting battery cables to starting battery.

- .3 Start unit only in presence of Contract Administrator and allow to warm up. Stop unit if abnormal conditions are encountered.
- .4 Check for and correct leakage from exhaust system, fuel system, cooling system, and lubricating oil system.
- .5 Adjust vibration isolators.
- .6 Observe and ensure that lubricating oil pressure and coolant temperature are within limits and no harmful vibration or sounds are evident. Ensure voltage is within operating parameters and automatic voltage regulator is operating correctly.
- .7 Ensure manual voltage control is operating correctly.
- .8 Ensure frequency is within operating parameters and electronic governor is operating correctly.
- .9 Check engine air ventilation system for proper operation.
- .10 Check operation of engine-mounted protective sensing devices and adjust as necessary.
- .11 Check phase sequence of normal power supply and ensure emergency power supply are in same sequence.
- .12 Check operation of electronic controller protection, transfer, timing, metering, and annunciator functions and adjust as necessary.
- .13 Check operation and calibration of analog metering and adjust as necessary.
- .14 Perform additional tests as required by Contract Administrator to ensure unit is operating satisfactorily.

3.3 SITE TEST

- .1 Provide on site testing of complete generator set installation including engine alternator, control panels, transfer switch and accessories, environmental system, fuel system, etc. Testing shall be performed by factory-trained representative of the diesel generator set supplier.
- .2 Provide load bank, calder, labour and fuel for all tests required by this specification. Provide same for any tests that are to be repeated. Re-fill fuel tanks completely after completion.
- .3 Ensure room environment control is operational and that all controls required for generator set operation are fed from emergency circuits.
- .4 Ensure doors and architectural Work in the room is complete.
- .5 Notify Contract Administrator 7 days in advance of on-site test.
- .6 Tests:
 - .1 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, kVA, V, A, r/min, Hz.

- .2 Mark check sheet and record data on forms in duplicate as test proceeds.
- .2 Tests:
 - .1 With 100% rated load, operate set for 6 hours, taking readings at 30 minute intervals, and record following:
 - .1 Time of reading.
 - .2 Running time.
 - .3 Ambient temp in deg. C.
 - .4 Lube oil pressure in kPa.
 - .5 Lube oil temp in deg. C.
 - .6 Engine coolant temp in deg. C.
 - .7 Exhaust stack temp in deg. C.
 - .8 Alternator voltage: phase 1, 2, 3.
 - .9 Alternator current: phase 1, 2, 3.
 - .10 Power in kW.
 - .11 Frequency in Hz.
 - .12 Power Factor.
 - .13 Alternator stator temp in deg. C.
 - .2 After completion of run, demonstrate operation of all shut down devices and alarms including:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator overvoltage.
 - .7 Low battery voltage, or no battery charge.
 - .8 Manual remote emergency stop.
 - .9 High alternator temperature.
 - .3 Next use as oscilloscope with printing capabilities to record frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments to include:
 - .1 No load to full load to no load.
 - .2 No load to 70% load to no load.
 - .3 No load to 20% load to no load.
 - .4 20% load to 40% load to no load.
 - .5 40% load to 60% load to no load.
 - .6 60% load to 80% load to no load.
- .3 Demonstrate:
 - .1 Automatic starting of set, automatic transfer of load on failure of normal power and retransfer to normal power on automatic control.
 - .2 Automatic shut down of engine on resumption of normal power.
 - .3 Operation of manual bypass switch.
 - .4 That battery charger reverts to high rate charge after cranking.
 - .5 Unit start and shut down on "Manual" control.
 - .6 Unit start and transfer on "Test" control.
 - .7 Unit start on "Engine start" control.
 - .8 Satisfactory performance of dampers in ventilating system to provide adequate engine cooling.
 - .9 Demonstrate units ability to start and accept full load in 10 seconds (with a one second start delay) and within the tolerances specified in CSA

C282. Provide necessary test instruments to record start signal, voltage, current and frequency over time.

- .4 Demonstrate low oil pressure, high engine temperature and other shutdown and alarm device operation without subjecting engine to these excesses.
- .5 Provide additional testing as required by Manitoba Building Code, Canadian Electrical Code and CSA Standards.
- .6 Prior to energizing the emergency generator set on line, verify that elevator controls have been tested and that the elevator controls allow only one of the elevators to run at a time when on emergency power.

3.4 DEMONSTRATION AND TRAINING

.1 Description

- .1 The Contract Administrator shall call upon the Manufacturers factory trained Technician, near the install completion to demonstrate the operation and maintenance of the equipment to City Personnel.
- .2 The City will provide list of personnel to receive instructions, and will co-ordinate their attendance at agreed-upon times. The factory trained Technician shall video tape training and provide six (6) - DVD copies to the City.

.2 Quality Control

- .1 When specified in individual Sections require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct The City's personnel, and provide written report that demonstration and instructions have been completed.

.3 Submittals

- .1 Submit schedule of time and date for demonstration of equipment two (2) weeks prior to demonstration for Contract Administrator's approval.
- .2 Submit reports within one (1) week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .3 Give time and date of each demonstration, with list of persons present.

.4 Conditions For Demonstrations

- .1 Equipment has been inspected and put into operation in accordance with Section 16622 3.2 Pre-Testing Procedure.
- .2 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions in accordance with Section 16010 1.32 Operation and Maintenance Data.

.5 Preparation

- .1 Verify that conditions for demonstration and instructions comply with requirements.
- .2 Verify that designated personnel are present.

.6 Demonstration And Instructions

- .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled times, at the equipment location.

- .2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
- .3 Review contents of manual in detail to explain aspects of operation and maintenance.
- .4 Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16426 Secondary Switchgear (120/208V & 347/600V)
- .3 Section 16622 Power Generation Diesel

1.2 DESIGN CRITERIA

- .1 Automatic load transfer equipment to:
 - .1 Monitor voltage of normal power supply.
 - .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage.
 - .3 Transfer load from normal supply to standby unit when standby unit reaches rated speed and voltage.
 - .4 Transfer load from standby unit to normal power supply when normal power restored.
 - .5 Shut down standby unit.
 - .6 The transfer switch shall have an integral bypass to allow manual transfer of load to either normal source or emergency source.

1.3 SHOP DRAWINGS

- .1 Submit Shop Drawings in accordance with Section 16010.
- .2 Include:
 - .1 Make, model and type.
 - .2 Single line diagram and wiring schematics showing controls, relays, etc.
 - .3 Description of equipment operation including:
 - .1 Automatic starting and transfer to standby unit and back to normal power.
 - .2 Test control.
 - .3 Manual control.
 - .4 Automatic shutdown.

1.4 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 16010.
- .2 Detailed instructions to permit effective operation, maintenance and repair.
- .3 Technical data:
 - .1 Schematic diagram of components, controls and relays.
 - .2 Illustrated parts lists with parts catalogue numbers.
 - .3 Certified copy of factory test results.

1.5 SOURCE QUALITY CONTROL

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested.
- .2 Tests:

- .1 Operate equipment both mechanically and electrically to ensure proper performance.
- .2 Check selector switch, in 4 positions (Test, Auto, Manual, Engine Start) and record results.
- .3 Check voltage sensing and time delay relay settings.
- .4 Check:
 - .1 Automatic starting and transfer of load on failure of normal power.
 - .2 Retransfer of load when normal power supply resumed.
 - .3 Automatic shutdown.
 - .4 In-phase monitor operation (where provided).

Part 2 Products

2.1 MATERIALS

- .1 Meters: to CAN3-C17.
- .2 Instrument transformers: to CAN3-C13.
- .3 Contactors: to NEMA ICS.

2.2 AUTOMATIC TRANSFER SWITCH

- .1 Three phase contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked, solenoid operated, with CSA sprinkler proof enclosure. To have integral bypass.
- .2 Rated: 347/600V, 60 Hz. Refer to Drawings for amperage rating.
- .3 Main contacts: silver surfaced, protected by arc disruption means including separate arcing contacts, arc splitters and blow out coils for load current.
- .4 Copper buswork.
- .5 Switch and relay contacts, coils, spring and control elements accessible for inspection and maintenance from front of panel without removal of switch panel or disconnection of drive linkages and power conductors.
- .6 Auxiliary contact: to initiate emergency generator start-up on failure of normal power.
- .7 The transfer switch shall have an in-phase monitor to ensure that the transfer or re-transfer only takes place when both the normal and emergency sources are within tolerances.
- .8 Short circuit withstand rating: 42 kA RMS symmetrical at rated voltage.
- .9 Inrush current rating minimum 20 times rated current.
- .10 Sprinklerproof.

2.3 CONTROLS

- .1 Selector switch - four position "Test" "Auto" "Manual" "Engine start".
 - .1 Test position - Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.
 - .2 Auto position - Normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.

- .3 Manual position - Transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.
- .4 Engine start position - Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.
- .2 Control transformers: dry type with 120 V secondary to isolate control circuits from:
 - .1 Normal power supply.
 - .2 Emergency power supply
- .3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:
 - .1 Time Delay adjustment from 0.5 to 6 seconds to prevent activation of 'engine start' on momentary normal voltage fluctuation. Factory set at 1 second.
 - .2 Time Delay adjustment from 0 to 60 seconds on transfer to emergency position after emergency source is available. Factory set at 0 seconds.
 - .3 Time Delay adjustment from 0 to 5 minutes on retransfer to normal. Factory set at 3 minutes. Should the emergency source fail during this timing period, there shall be an immediate retransfer to the normal source.
 - .4 Time delay adjustment from 0 - 4 minutes to delay resetting of 'engine start' signal after retransfer to the normal source [Engine cool down provision]. Factory set at 4 minutes.
 - .5 Adjustable, close differential, voltage sensing on all phases of the normal source. Pickup voltage adjustable from 85% [510V] to 100% [600V] of nominal. Dropout voltage is adjustable from 75% to 98% of pickup. Factory set at: Pickup 90% [540V] Dropout 85%[510V].
 - .6 Adjustable, close differential, voltage sensing on two phases of the emergency source. Pickup voltage adjustable from 85% [510V] to 100% [600V] of nominal. Factory set at: Pickup 95% [570V].
 - .7 Adjustable frequency sensing of emergency source. Pickup adjustable from 90% [54 Hz] to 100% [60 Hz]. Factory set at: Pickup 95% [57 Hz].
 - .8 Three spare normally open auxiliary contacts and three spare normally closed auxiliary contacts shall be provided.

2.4 ACCESSORIES

- .1 Pilot lights to indicate switch position, green for normal, red for standby, mounted in panel. Lamps to be LED type.
- .2 Solid neutral bar.
- .3 Auxiliary relay to provide 8 N.O. and 8 N.C. contacts for remote alarms.
- .4 Solid state electronic monitors:
 - .1 Voltage sensing, three phase with time delay and circuit opening closing arrangement.
 - .2 Under Over frequency sensing, with adjustable differential for nominal frequency of 60 Hz with 2 N.O. and 2 N.C. contacts, repetitive accuracy plus or minus 0.2 Hz.
 - .3 In-phase monitor.
- .5 'Elevator Emergency Mode Bypass' Keyswitch (local):
 - .1 A keyswitch shall be provided to bypass the elevator emergency mode during testing only. This will allow the elevators to function normally during a transfer switch test.

- .6 For each elevator controller, provide the following auxiliary contacts:
 - .1 Two auxiliary contacts that are closed when on normal power and open when on emergency power.
 - .2 One auxiliary contact that is closed except for an adjustable period of time (0 to 50 seconds adjustment, set initially at 15 seconds) prior to power supply transfer in either direction, from normal to emergency or from emergency to normal.

2.5 **BYPASS**

- .1 The transfer switch shall either come with an integral bypass or shall be cabled to an external bypass mechanism.
 - .1 The bypass mechanism shall be constructed so as to provide no interruption to the load during operation.
 - .2 The bypass mechanism shall be mechanically interlocked to prevent any chance of connecting the utility and emergency sources.
 - .3 The bypass mechanism shall give visual indication of each position.
 - .4 External bypass switches shall meet the following:
 - .1 Provide in separate sprinklerproof enclosures by-pass switches located as shown on Drawings.
 - .2 By-pass switches shall be totally enclosed, sprinklerproof, dead front, fabricated from formed and welded #12 gauge steel and front accessible only. Enclosure shall be painted uniformly with two coats of ASA61 grey. Prior to painting enclosure shall be cleaned and thoroughly phosphatized. Enclosure to have a door with lock. Locks shall be keyed the same as the panelboards.
 - .3 By-pass switches shall be moulded case non-auto type as indicated on Drawings. Breakers shall contain auxiliary contacts for breaker position. These contacts shall be wired to by-pass position indicating lights. Interrupting capacity of breakers to match rating of upstream breakers feeding the by-pass switch.
 - .4 Enclosure shall have a 120 Volt section at the top for by-pass indicating lights. The 120 Volt section shall be barriered from the circuit breaker section. This section shall contain transformer (if required), fusing, terminal strips for all wire terminations, heavy duty watertight, neon indicating lights, etc. as required. All wiring shall be identified. Refer to Drawings.
 - .5 Bus bars shall be tin plated copper braced to withstand a short circuit current of 50,000 Amperes symmetrical at 600 Volts. Neutral bus, where required, shall be full size. Ground bus shall be copper.
 - .6 Supply and install slide-bolt type interlocking as shown on Drawing. Sliding bar safety interlock shall not interfere with by-pass switch cover/trim removal/ replacement. Sliding bar shall have spring loaded ball and socket momentary stops at each position. It shall also be padlockable in the three operating positions.
 - .7 Supply and install lamacoids identifying each by-pass breaker and complete sequence of by-pass operation as directed by Contract Administrator. Supply and install schematic engraved on a lamacoid. Prior to fabrication, submit Shop Drawing to Contract Administrator for review and approval.

2.6 ACCEPTABLE MANUFACTURER

- .1 The automatic transfer switch shall be ASCO 940 series with external bypass or ASCO 962 series with internal bypass.

2.7 EQUALS

- .1 The following are acceptable equals to the ASCO transfer switch, providing all functionality, and rating can be maintained as previously specified, and there is adequate space.
 - .1 Air circuit breaker style ATS with Cutler-Hammer or Schneider air circuit breakers with bypass.
 - .1 In lieu of an in-phase monitor, an adjustable 0 - 6 second (set at 2 seconds) neutral position time delay shall be provided.
 - .2 Breakers to be non-automatic.
 - .2 Westinghouse Robonic style ATS with bypass.
 - .1 In lieu of an in-phase monitor, an adjustable 0 - 6 second (set at 2 second) neutral position time delay shall be provided.
 - .2 Breakers to be non-automatic.
 - .3 Thompson Technology Incorporated. Series 760/790 automatic transfer switches with bypass.

2.8 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

2.9 FABRICATION

- .1 Shop assemble transfer equipment including:
 - .1 Mounting base and enclosure.
 - .2 Transfer switch and operating mechanism.
 - .3 Control transformers and relays.
 - .4 Accessories.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate, install and connect transfer equipment.
- .2 Check solid state monitors and adjust as required.
- .3 Install and connect battery and remote alarms.
- .4 Wire and connect to elevator controllers, gen set, fire alarm panel, etc. as required.

3.2 FIELD QUALITY CONTROL

- .1 Factory trained and authorized technician of the transfer switch manufacturer shall set up, test and commission the automatic transfer switch and controls.
- .2 Perform tests in accordance with Section 16010 - Electrical General Requirements.
- .3 Energize transfer equipment from normal power supply.

- .4 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
- .5 Set selector switch in "Manual" position and check to ensure proper performance.
- .6 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.
- .7 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .8 Repeat, at 30 minute intervals, 7 times, complete test with selector switch in each position, for each test.
- .9 Test bypass switch for correct operation.

3.3 COMMISSIONING

- .1 Refer to Section 16622, include all test reports as part of the Power Generator Diesel reports.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16111 Conduits, Conduit Fastenings and Conduit Fittings
- .3 Section 16122 Wires and Cable
- .4 Section 16132 Outlet Boxes, Conduit Boxes and Fittings
- .5 Section 16195 Work in Existing Building

1.2 REFERENCES

- .1 CAN/ULC-S524 Installation of Fire Alarm Systems
- .2 ULC-S525 Audible Signal Appliances, Fire Alarm
- .3 CAN/ULC-S526 Visual Signal Appliances for Fire Alarm Systems
- .4 CAN/ULC-S527 Control Units, Fire Alarm
- .5 ULC-S528 Manually Actuated Signalling Boxes, Fire Alarm
- .6 CAN/ULC-S529 Smoke Detectors, Fire Alarm
- .7 ULC-S530 Heat Actuated Fire Detectors, Fire Alarm
- .8 CAN/ULC-S536 Inspection and Testing of Fire Alarm Systems
- .9 CAN/ULC-S537 Verification of Fire Alarm Systems
- .10 Manitoba Building Code

1.3 DESCRIPTION OF SYSTEM

- .1 The existing Base Building fire alarm system is an Edwards 'Quick-Start' addressable fire alarm panel located in the main Electrical Room.
- .2 Provide all components/wiring/modifications/programming/etc. as required to extend this existing system as indicated on the plans.
- .3 Provide new devices to match existing.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

- .1 The equipment and installation shall comply with the current ULC and Building Code requirements.
- .2 Manitoba Building Code.
- .3 Local and Municipal By-Laws.
- .4 Authorities having jurisdiction.

1.5 SHOP DRAWINGS

- .1 Submit Shop Drawings in accordance with Section 16010 for the complete Fire Alarm system including:

- .1 All devices.
 - .2 Control panels
 - .3 Zoning System, including isolator locations.
 - .4 Programming of the Fire Alarm System.
 - .5 Connection to fire suppression system.
 - .6 All other components of the fire alarm system.
 - .7 Description of the operational sequences of the system.
 - .8 Complete set of Drawings, indicating location of all devices, including analogue and signalling devices, control and annunciator panels, all interconnections to mechanical equipment, to fire suppression systems and to existing computer room system, all conduit routing and sizes, all wire sizes, types, number and a riser for each control panel indicating all of the above.
 - .9 Pictorial Drawings of control equipment indicating the location of the components and parts and their respective catalogue number and electrical characteristics.
 - .10 Interconnecting diagrams and cable manual.
 - .11 System descriptions of the actual installation.
 - .12 Maintenance instructions.
 - .13 Recommended spare parts list.
 - .14 Provide name, address and telephone number of the manufacturer's service representative to be contacted during the warranty period.
- .2 This information is to be revised to "as-built" after construction is completed. Insert as part of the Operating and Maintenance Manuals.

1.6 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual specified in Section 16010.
- .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 as-built Shop Drawings.

1.7 WARRANTY

- .1 Warranty all Equipment, Sensors, Materials, peripherals, installation, workmanship, etc. for one (1) year from the date of final acceptance of the system.
- .2 Provide a complete inspection and testing of the fire alarm system 1 year after final acceptance. Inspection tests to conform to be ULC-S536. Submit inspection report to Contract Administrator.
- .3 Provide all programming of system as directed during the warranty period at no cost to the City.

1.8 MAINTENANCE

- .1 Provide one year's free maintenance with two inspections by manufacturer during year. The second inspection can be done at the same time as the ULC-S536 inspection and testing specified in 1.7 Warranty.

1.9 TRAINING

- .1 Arrange and pay for on-Site lectures and demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.
- .2 Provide video tape (3 copies) of all training provided.
 - .1 Provide training sessions which will explain general system operation to staff.
 - .2 Provide training sessions for staff to explain detailed operating and maintenance procedures.

Part 2 Products

2.1 MATERIALS

- .1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer, to match existing.

2.2 MODULES

- .1 Single Input Module
 - .1 The intelligent Single Input Module shall be capable of a minimum of 4 personalities, each with a distinct operation.
 - .2 The personality of the module shall be programmable at Site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. Single function modules or modules requiring Eprom, ROM or PROM changes or DIP switch/jumper changes shall not be acceptable.
 - .3 The single input module shall support the following circuit types:
 - .1 Alarm Latching, Manual Station, Conventional Heat, Waterflow
 - .2 Delayed Waterflow
 - .3 Non-Latching Monitor
 - .4 Supervisory
 - .4 Input circuit wiring shall be supervised for open and ground faults.
 - .5 The input module shall have a minimum of 2 diagnostic LEDs mounted behind finished cover plate. 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.
 - .6 Terminal connections shall be accessible from the room side of the assembly. Devices which must be removed to gain access to the wiring terminals shall not be acceptable.
 - .7 The single input module shall be suitable for mounting on North American 2 1/2" (64mm) deep 1 gang, 1 1/2" (38mm) deep 4" square box with 1 gang cover.
 - .8 The input module shall be suitable for operation in the following environment:
 - .1 Temperature: 32F to 120F (0C to 49C)
 - .2 Humidity: 0-93% RH, non-condensing
 - .9 It shall be possible to address each module without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable.
- .2 Dual Input Module
 - .1 The intelligent Dual Input Module shall provide two (2) supervised input circuits capable of a minimum of 4 personalities, each with a distinct operation.
 - .2 The personality of the module shall be programmable at Site to suit conditions and may be changed at any time using a personality code downloaded from the

- Analog Loop Controller. Single function modules or modules requiring Eprom, ROM or PROM changes or DIP switch/jumper changes shall not be acceptable.
- .3 The dual input module shall support the following circuit types:
 - .1 Alarm Latching, Manual Station, Conventional Heat, Waterflow
 - .2 Delayed Waterflow
 - .3 Non-Latching Monitor
 - .4 Supervisory
 - .4 Input circuit wiring shall be supervised for open and ground faults.
 - .5 The dual input module shall have a minimum of 2 diagnostic LEDs mounted behind finished cover plate. 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.
 - .6 The dual input module shall be suitable for mounting on North American, 2 1/2" (64mm) deep 1 gang, 1 1/2" (38mm) deep 4" square box with 1 gang cover.
 - .7 Terminal connections shall be accessible from the room side of the assembly. Devices which must be removed to gain access to the wiring terminals shall not be acceptable.
 - .8 The input module shall be suitable for operation in the following environment:
 - .1 Temperature: 32F to 120F (0C to 49C)
 - .2 Humidity: 0-93% RH, non-condensing
 - .9 It shall be possible to address each module without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable.
- .3 Single Input Signal Module
- .1 The intelligent Single Input Riser/Signal Module shall provide one supervised output circuit. The output circuit shall be suitable for any of the following operations:
 - .1 24 vdc, polarized audible and visible signal appliances
 - .2 The personality of the module shall be programmable at Site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. Single function modules or modules requiring Eprom, ROM or PROM changes or DIP switch/jumper changes shall not be acceptable.
 - .3 Circuit wiring shall be supervised for open and ground faults.
 - .4 The signal module shall have a minimum of 2 diagnostic LEDs mounted behind finished cover plate. 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.
 - .5 The signal module shall be suitable for mounting on North American 2 1/2" (64mm) deep, 2 gang or 1 1/2" (38mm) deep, 4" square boxes.
 - .6 Terminal connections shall be accessible from the room side of the assembly. Devices which must be removed to gain access to the wiring terminals shall not be acceptable.
 - .7 The signal module shall be suitable for operation in the following environment:
 - .1 Temperature: 32F to 120F (0C to 49C)
 - .2 Humidity: 0-93% RH, non-condensing
 - .8 It shall be possible to address each module without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable.

- .4 Control Relay Module
 - .1 The intelligent micro-processor based Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps. @ 24 Vdc. to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. Provide auxiliary relays (wired for fail safe operation) where amp rating of Control Relay Module is exceeded.
 - .2 The position of the relay contact shall be confirmed by the system firmware.
 - .3 The control relay module shall have a minimum of 2 diagnostic LEDs mounted behind finished cover plate. 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.
 - .4 The control relay module shall be suitable for mounting on North American; 2 1/2" (64mm) deep, 1 gang, 1 1/2" (38mm) deep, 4" square box with 1 gang cover.
 - .5 The module shall be suitable for operation in the following environment:
 - .1 Temperature: 32F to 120F (0C to 49C)
 - .2 Humidity: 0-93% RH, non-condensing
 - .6 Terminal connections shall be accessible from the room side of the assembly. Devices which must be removed to gain access to the wiring terminals shall not be acceptable.
 - .7 It shall be possible to address each module without the use of DIP switches. Devices using DIP switches for addressing shall not be acceptable.
- .5 Universal Class A/B Module
 - .1 The intelligent Universal Class A/B Module shall be capable of a minimum of 15 distinct operations.
 - .2 The personality of the module shall be programmable at Site to suit conditions and may be changed at any time using a personality code downloaded from the ZAS-2, Analog Loop Controller. Single function modules or modules requiring Eprom, ROM or PROM changes or DIP switch/jumper changes shall not be acceptable.
 - .3 The Universal Class A/B module shall support the following circuit types:
 - .1 Two Class B or one Class A Initiating Device Circuits (IDC) capable of delayed waterflow alarm operation.
 - .2 One Class A or B Indicating Device (Signal) Appliance Circuit (IAC)
 - .3 One Class A or B Circuit for 2 wire Smoke Detectors (Verified or non-verified).
 - .4 One Form "C" (NO/NC) Dry Output Contact Relay
 - .4 Input/Output circuit wiring shall be supervised for open and ground faults.
 - .5 The universal Class A/B module shall have a minimum of 2 diagnostic LEDs mounted behind finished cover plate. 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.
 - .6 The module shall be suitable for mounting on North American 2 1/2" (64mm) deep, 2 gang or 1 1/2" (38mm) deep, 4" square boxes.
 - .7 Terminal connections shall be accessible from the room side of the assembly. Devices which must be removed to gain access to the wiring terminals shall not be acceptable.
 - .8 The universal Class A/B module shall be suitable for operation in the following environment:
 - .1 Temperature: 32F to 120F (0C to 49C)
 - .2 Humidity: 0-93% RH, non-condensing

- .9 It shall be possible to address each module without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable.
- .6 Addressable Heat Detectors
 - .1 Fixed Temperature Heat Detectors
 - .1 The intelligent heat detector shall have a 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.
 - .2 The integral micro-processor 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.
 - .3 The heat detector shall have a nominal rating of 135F (57C). 190 detectors to be provided in the Boiler Room or where indicated on plans.

Part 3 Execution

3.1 INSTALLATION

- .1 Install systems in accordance with CAN/ULC-S524, DFC-410(M), manufacturer's requirements, authorities having jurisdiction, etc.
- .2 Install end-of-line devices where required.
- .3 Locate and install intelligent modules as required.
- .4 Fire Suppression System: wire alarm switches, supervisory switches, solenoids, etc. and connect to control panel.
- .5 Connect sprinkler switches.

3.2 VERIFICATION, DATA AND TESTING

- .1 System Verification
 - .1 Upon completion of all wiring and installation of all equipment, devices, etc., do complete verification of the fire alarm system. Verification shall be in accordance with current edition of Standard CAN/ULC-S537 "The Verification of Fire Alarm Systems" and following requirements. Even if permitted by Code and recognized standards and regulations, grade of Work shall in no case be lower than specified in the project Specifications. Verify all new initiating and signal/solenoid zones and circuits, etc. Verify that every component installed, is working and functions as intended.
 - .2 Manufacturer with assistance of electrical Contractor shall do a complete verification of system to ULC S-537 to ensure:
 - .1 That system is installed as per plans and Specifications and is operative and acceptable to all authorities having jurisdiction.
 - .2 That system is installed as per recommendations of manufacturer.
 - .3 That system is electrically supervised, including all zone lamps. To accomplish this, manufacturer with assistance of electrical Contractor shall:
 - .1 remove each and every device from its applicable circuit by disconnecting circuit wiring

- .2 verify presence of the applicable trouble signal and indications at control panel and remote annunciators.
- .4 That all devices are operative. Check each switch, device, etc. for proper operation.
- .5 That all system functions are operating as intended, including:
 - .1 all main control circuits,
 - .2 all remote annunciator circuits,
 - .3 all manual and automatic initiating devices,
 - .4 all audible and visual alarm signals,
 - .5 all ancillary controls, including fan shutdown, door release, etc.
 - .6 All existing systems functions (such as alarm signals, ancillary controls, etc.) that are not modified, but are required to operate from any new zones added, shall be verified for correct operation.
 - .7 When fire alarm system is verified, Contractor shall measure and record all loop or circuit resistance values at the fire alarm panel when end-of-line resistor is shorted. Contractor shall highlight all values which exceed the manufacturer's recommendations and report them to the Contract Administrator for action to correct this deficiency.
- .3 Any necessary changes required to conform to the above shall be completed by the electrical Contractor with technical assistance provided by the system manufacturer.
- .4 During the period of this inspection, the electrical Contractor shall assist the manufacturer with the services of electricians.
- .5 To assist the electrical Contractor in preparing his bid, the manufacturer shall indicate in his Bid Opportunity the number of hours required to complete this inspection.
- .6 Upon completion of the above inspection, including any changes required, the manufacturer shall submit the following documentation to the Contract Administrator.
 - .1 Certification of Verification
 - .2 A complete report of all equipment verified, including:
 - .1 sprinkler system switches
 - .2 automatic detectors
 - .3 alarm signals
 - .4 annunciators
 - .5 door hold open devices
 - .6 fan shutdown
 - .7 the number and type of devices connected to each circuit
- .7 For each piece of equipment verified, the following information shall be included in the report:
 - .1 Catalogue number and type of device
 - .2 Location of device
 - .3 Zoning or circuit devices including ancillary devices
 - .4 Supervision test results
 - .5 Operation of device
 - .6 Inspection date
 - .7 Serial number of every smoke detector
 - .8 Sensitivity reading of every smoke detector, including duct detectors
 - .9 Record the time delay of all sprinkler flow switches

- .10 Zone circuit loop resistance
- .11 Fire alarm system supplier shall verify that alarm descriptions match and are consistent at each of following reporting locations:
 - .1 Fire alarm control panel
 - .2 Fire alarm remote annunciators
- .8 Report shall also indicate operation of ancillary functions such as remote alarm indicators, door release, fan shutdown, etc. which are required to be activated. Operation shall be verified by actual observation of the entire function (e.g. bells ringing, checking to ensure proper fans shut down, etc.). Observing a change of state in the fire alarm control panel (e.g. observing relay function) is not considered complete verification of the entire function. Verification shall include actual field checking of proper operation of ancillary devices and equipment. Complete fire alarm system verification report shall be submitted to Contract Administrator, City and authorities having jurisdiction minimum of one week before City of Winnipeg Acceptance Inspections.
- .9 All costs necessary for this verification shall be included in electrical trade's Bid Opportunity price.
- .10 Upon completion of this inspection, manufacturer shall demonstrate the operation of system to City.
- .11 Verify identification of all terminals (markers, directories and diagrams) in interconnecting wires and cables, certifying their correctness. Upon completion of verification, submit all documentation to Contract Administrator, including mylar sepia of as-built system riser block diagram and all tub or cabinet directories. Indicate on all documentation submitted that in fact it has been verified.
- .12 Any errors in verification report shall be just cause for complete reverification of all verification Work performed by Contractor, at discretion of Contract Administrator. Contractor shall be responsible for all costs associated with system reverification.
- .13 Verify number of detectors on each zone and include verification report quantity of detectors on each zone.
- .14 Sprinkler Flow Switches: Check and calibrate time delay of all sprinkler flow switches such that time delay is between 25 and 30 seconds. Record 'final setting' time delay of every flow switch in verification report.
- .15 Manitoba Fire Alarm Technician 'M' License:
 - .1 A Manitoba Fire Alarm Technician 'M' License is required to perform fire alarm verifications. The scope of this license allows holders to maintain, service, repair and verify fire alarm systems. Installations of fire alarm systems must still be performed by a licensed electrician. Fire alarm verifications shall be conducted by a qualified person other than the installing Contractor or Contract Administrator.
 - .2 In addition to the name and contact information of the verifying organization, the verification report must include the printed name, the signature, the 'M' license number and the CFAA (Canadian Fire Alarm Association) certificate number of the primary technician conducting the verification.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Electrical General Requirements Section 16010
- .2 Conduits, Conduit Fastenings
 and Conduit Fittings Section 16111
- .3 Wires and Cables Section 16122

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit Shop Drawings in accordance with Section 01300 - Submittals.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

1.3 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for motor starters for incorporation into IO&M manual.
- .2 Include operation and maintenance data for each type and style of starter.

1.4 MAINTENANCE MATERIALS

- .1 Provide maintenance Materials in accordance with Section 16010.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 4 contacts, stationary.
 - .2 4 contacts, movable.
 - .3 2 contacts, auxiliary.
 - .4 2 control transformers.
 - .5 2 operating coils.
 - .6 2 fuses.
 - .7 10 indicating lamps.

- .8 1 HOA kit.

Part 2 Products

2.1 MATERIALS

- .1 Starters: EEMAC E14-1.
 - .1 Half size starters not acceptable.
 - .2 Provide NEMA rated starters only; IEC rated starters are not 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 Overload heaters, manual reset, trip indicating handle.
- .2 Accessories:
 - .1 Toggle switch labelled as indicated.
 - .2 Indicating light: type and colour as indicated.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.
 - .4 Flush mounted type in public areas or as indicated.

2.3 FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic 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 Power and control terminals.
 - .4 Wiring and schematic diagram inside starter enclosure in visible location.
 - .5 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
 - .6 Control transformer.
 - .7 Starters to be two speed where required; type to match requirement of motor provided by Division 15.
- .2 Accessories:
 - .1 Pushbuttons and Selector switches: labelled as indicated.
 - .2 Indicating lights: type and color as indicated.
 - .3 2-N/O and 2-N/C spare auxiliary contacts unless otherwise indicated.
 - .4 HOA selector switch.

- .5 Two speed single winding starters shall have individual Red run pilot lights for LOW and HIGH speed run indication.
- .6 An adjustable 20 sec. - 3 min. time delay relay (set at 30 sec.) shall be installed in two speed starters. It shall function only during the transition from HIGH SPEED to LOW SPEED where the motor will be in a de-energized state for a period of 30 seconds after initiation of this switching.
- .7 Provide and install time delay relay (to sequence starting after power failure) adjustable 0 - 120 seconds for motors 15 horsepower and larger.

2.4 CONTROL TRANSFORMER

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

2.5 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 16010 - Electrical - General Provisions.

2.6 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 16010 - Electrical - General Provisions.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 4 engraved as indicated.

2.7 MANUFACTURERS

- .1 Acceptable manufacturers: Allen Bradley Canada Ltd.; Cutler Hammer Canada Ltd.; "System 89" Siemens Electric Limited; Square D.
- .2 All manufacturers shall provide their industrial quality product line; commercial quality starters are not acceptable.

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 TESTS

- .1 Perform tests in accordance with Section 16010 - Electrical - General Requirements and manufacturer's instructions.
- .2 Operate switches, contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.
- .5 Ensure motor rotation corresponds with the direction required by the driven equipment.

END OF SECTION