
Part 1 General

1.1 GENERAL

- .1 This Section covers items common to Sections of Division 16. This section supplements requirements of Division 1.
- .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 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 his 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 General 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 Contractors 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 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1-1-1955.
 - .2 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.

1.9 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.

1.10 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.

1.11 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.

1.12 ENGINEERING OBSERVATIONS

- .1 Contractor's Work will be observed periodically by City, and/or Contract Administrator or their representatives, 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.

1.13 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 or his representative 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.

1.14 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 Identification to be English.
- .7 Co-ordinate names of equipment and systems with Division 15 to ensure that identical names are used.
- .8 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .9 Nameplates for disconnects, starters and contactors: Indicate equipment being controlled and voltage.
- .10 Nameplates for terminal cabinets and pull boxes: Indicate system and voltage.
- .11 Nameplates for transformers: Indicate capacity, primary and secondary voltages.
- .12 Nameplates for control devices: indicate equipment controlled.
- .13 Adjacent to each breaker in CDP type panelboards, provide and mount lamacoid nameplates identifying the respective load and location.
- .14 To match existing where applicable.
- .15 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.

1.15 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.

1.16 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
Telephone	green	
Other communication systems	green	blue
Emergency voice	red	blue
Other security systems	red	yellow
Control	blue	
Fibre optic	orange	
- .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.

1.17 WIRING TERMINATIONS

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

1.18 MANUFACTURERS AND CSA CERTIFICATION LABELS (OR EQUIVALENT)

- .1 Visible and legible after equipment is installed.

1.19 WARNING SIGNS

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

1.20 LOCATION OF OUTLETS

- .1 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.
- .2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.
- .3 Locate light switches on latch side of doors.

1.21 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.

1.22 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.

1.23 FIELD QUALITY CONTROL

- .1 Conduct and pay for following tests:
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.

- .4 Motors, heaters, and associated control equipment including sequenced operation of systems where applicable.
- .5 Systems: Security system, communication systems.
- .6 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.

1.24 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 Contract Administrator 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. Contract Administrator and structural conditions shall govern, and this Section shall make without charge, changes or additions to accommodate these conditions. Check all Contract Administrator 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.

1.25 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 Three (3) copies of each Shop Drawing shall be submitted.
- .7 Cross out or eradicate all non-related items.
- .8 Bind each system separately. 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. Shop 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 Sub-Contractors. 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 Main distribution and utility metering Shop Drawings must be approved by local utility prior to submission to Contract Administrator.
- .16 Incomplete submissions will be returned for updating and re-submittal without Contract Administrator's review.

1.26 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, dimmers, timers, occupancy sensors with manual over-ride: 1200mm.
 - .2 Wall receptacles:
 - .1 General: 400mm.
 - .3 Panelboards, annunciators etc.: 2000mm to top.
 - .4 Voice/data and interphone outlets: 400mm.
 - .5 Wall mounted telephone and interphone outlets: 1200mm.
 - .6 Thermostats: 1200mm.
 - .7 Speed controls: 1200mm.
 - .8 Manual starters: 1200mm.

- .9 Emergency power off buttons: 1200mm.
- .10 Heights as above or at bottom of nearest block or brick course except where required to comply with Manitoba Building Code, other applicable codes, authorities having jurisdiction, etc.
- .11 Heights to match existing where applicable except where required to comply with Manitoba Building Code, other applicable codes, authorities having jurisdiction, etc.
- .12 All controls for the operation of building services or safety devices including electrical switches, dimmers, thermostats, intercom switches, card access readers, door security request to exit pushbuttons, fire alarm pull stations, etc. that are intended to be operated by the occupant, must be mounted between 400mm and 1200mm above the finished floor (to comply with the Manitoba Building Code for accessibility to a person in a wheelchair).

1.27 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 five (5) 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.

1.28 TEMPORARY LIGHTING AND POWER

- .1 All temporary and construction lighting and power Work and costs for same are not included as part of the scope of the Work of this section. Refer to such clauses in other sections of the Specification.

1.29 RECORD DRAWINGS

- .1 The Contractor is to maintain red line mark-ups of the record Drawings on Site on a regular basis, indicating all deviations from the original Contract Drawings. They shall be made available for review by the City or Contract Administrator when required. The red line mark-ups shall be used by others to create the final record Drawings in AutoCad

format. The Contractor shall review the complete AutoCad Drawings before issue to the City.

1.30 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 Test all required ground rods for ground resistance, with standard test equipment.
- .5 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.
- .6 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.
- .7 All circuits shall be tested to ensure that the circuit numbers are correct and that the proper neutral conductors have been provided and installed.
- .8 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.

1.31 CUTTING AND PATCHING

- .1 Cutting, patching and repairs to existing surfaces required as a result of the removal and/or relocation of existing equipment and piping, and/or installation of new equipment and piping in existing building(s) to be included by Div. 16 - Electrical in Bid Opportunity price. Division 16 - Electrical to employ and pay appropriate sub-trade whose Work is involved, for carrying out Work described above.
- .2 Perform all cutting and patching required for installing electrical systems.
- .3 Division 16 shall retain services of General Sub-trades to carry out actual Work involved in cutting wall openings, floor openings and the like, and in patching up after installation has been completed.
- .4 Division 16 shall mark all openings required for conduits, cables, ducts, and the like.

- .5 Cutting to be 'neat' sizes. Patch all edges such as cover plates, etc. Hide cut edges.
- .6 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.
- .7 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.

1.32 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.

1.33 SECURITY FASTENERS AND HARDWARE

- .1 Refer to other sections of the Specifications for Security Fasteners. Division 16 to install security fasteners required for Division 16 Work.
- .2 This shall also include security tamperproof screws that are exposed such as in light fixtures, coverplates, system devices, outlet covers, etc.
- .3 Refer to other sections of the Specifications for security hardware.

1.34 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.

1.35 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.

1.36 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.

1.37 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.
- .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 Contract Administrator and electrical Drawings and include all costs for demolition.
- .3 Refer to Specification Section 16195 - Work in Existing Building.

1.38 SPARE PARTS

- .1 The Contractor shall submit 15 days after Bid Opportunity 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 client'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 Epoxy coated conduit: with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical metallic tubing (EMT): with couplings. Minimum size shall be 19mm.
- .4 Rigid PVC conduit.
- .5 Flexible metal conduit and liquid-tight flexible metal conduit.
- .6 FRE conduit: Size 75 mm and above.
- .7 Flexible PVC 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 exposed to moisture or sprinkler heads.
- .6 Explosion proof in hazardous areas to meet requirements of authorities having jurisdiction.

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 epoxy coated conduit in corrosive areas.
- .5 Use electrical metallic tubing (EMT) except where specified otherwise.
- .6 Use rigid PVC conduit or FRE duct for underground installations.
- .7 Use flexible metal conduit for connection to motors in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures, transformers and equipment subject to vibration or movement. Provide a separate insulated grounding conductor within flexible conduit.
- .8 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

- .9 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .10 Conduit stubs from floor slabs where exposed to damage to be rigid galv. steel.
- .11 The conduit sizes as shown or indicated are the minimum acceptable and shall not be reduced without the approval of the Contract Administrator.
- .12 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .13 Mechanically bend steel conduit over 19 mm dia.
- .14 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .15 Install fish cord in empty conduits.
- .16 Run a minimum of 2-25 mm spare conduits up to ceiling space and 2-25 mm spare conduits down to ceiling space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in surface type box.
- .17 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .18 Dry conduits out before installing wire.
- .19 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.
- .20 Running threads will not be permitted; proper couplings shall be used.
- .21 Not less than 900mm (3'-0") of flexible conduit (and of sufficient length to allow the lighting fixture to be relocated to any location within a 6 ft. (1.8m) radius) shall be used for the connection of recessed lighting fixtures. A separate drop to be used for each fixture unless fixtures are mounted in continuous rows.
- .22 No circuits fed from emergency or essential power sources shall be run in the same conduit as other systems.
- .23 Provide separate conduit system for emergency distribution.
- .24 All conduit runs passing across expansion joints of the building shall be installed utilizing approved expansion fittings, and bonding devices.
- .25 Refer to 16010 for identification requirements.
- .26 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.

3.3 CONCEALED CONDUITS

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

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.

Part 3 Execution

3.1 GENERAL

- .1 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 recessed luminaires in accessible ceilings. Cable to be of sufficient length to allow the lighting fixture to be relocated to any location within a 6' (1.8M) radius. Cable shall be clamped before entering the lighting fixture and shall be clipped before entering the conduit system junction box.
- .2 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, cable to be clipped before entering junction or outlet boxes. Cable to be clamped within partitioning with steel galvanized tie-wire.

3.5 INSTALLATION IN EQUIPMENT

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

3.6 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.

3.7 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.
- .5 347 V outlet boxes for 347 V switching devices c/w holes on centres to reject all other switches.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.
- .7 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.
- .8 In moist or dusty areas, gasketed watertight or dust tight boxes and covers shall be provided.
- .9 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 MASONRY BOXES

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

2.4 CONCRETE BOXES

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

2.5 FLOOR BOXES

- .1 Concrete tight electro-galvanized sheet steel floor boxes with gasket, floor plate, levelling screws and adjustable finishing rings to suit floor finish with brass faceplate. Device mounting plate to accommodate short or long ear duplex receptacles.

2.6 CONDUIT BOXES

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

2.7 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

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

2.8 MOULDED VAPOUR BARRIER BOXES

- .1 Moulded box vapour barrier: factory moulded polyethylene box c/w flange for use with recessed electric switch and outlet boxes.

2.9 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.

2.10 SERVICE FITTINGS

- .1 Pedestal type 'high tension' receptacle fitting, 5" square low profile, 2 piece; steel frame with black plastic housing for two duplex receptacles. Bottom plate with knockout and BX connector for centered installation.
- .2 Pedestal type 'low tension' fitting 5" square low profile, 2 piece steel frame with black plastic housing to accommodate two amphenol jack connectors. Bottom plate with slot for conduit entry.
- .3 Pedestal type 'Combination Telephone/Receptacle Fitting 5" x 10"', low profile, 2 piece; steel barriered frame with black plastic housing to accommodate two duplex receptacles

and two amphenol jack connectors. Bottom plate with BX connector in power section and slot for conduit entry in telephone section.

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 Maintain continuity of vapor barrier where boxes are installed in exterior walls and ceilings. Use air/vapor barrier boxes for outlets installed in walls or ceilings with a vapor barrier.
- .6 Boxes to be mounted plumb and square with building lines.
- .7 Install pull boxes, or fittings, in conduit runs where more than four bends are necessary.
- .8 Install pull boxes where run exceeds 23.0 (75 feet) in length.
- .9 All junction, outlets and pull boxes shall be so installed that they are always readily accessible.
- .10 No power driven pins (Ramset) shall be utilized to secure boxes without specific approval from Contract Administrator.
- .11 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.
- .12 All concealed junction boxes, conduit fittings, etc. to be c/w galv. steel covers, secured with two bolts.
- .13 Co-ordinate boxes in masonry with brick or block configuration, boxes to be saw cut in bottom of appropriate brick or block. They shall be of sufficient depth to allow conduit to pass through center of block.
- .14 Co-ordinate locations with millwork.
- .15 Apply acoustic sealant to and seal wires penetrating moulded vapour barrier boxes.
- .16 Verify exact location of floor boxes with Contract Administrator. Adjust floor boxes level with finished floor.

- .17 No more than two extension rings shall be used in sequence.
- .18 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 and 347Vac 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>	<u>347 Volt</u>
Hubbell	1200 Series	18200 Series
Bryant	4800 Series	6800 Series
Leviton	1200 Series	18200 Series
Pass & Seymour	AG-1 Series	3700 Series
Smith & Stone	4-4800 Series	1-3700 Series
Slater	710 Series	3400 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.
- .5 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .6 Weatherproof cover plates complete with gaskets for single receptacles or switches as indicated.

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 Study the Architectural plans and co-operate with other trades so that the location and elevation of switch outlets shall not necessitate any unnecessary cutting of dadoes, tile, fitments, etc. If this is not done, this Contractor will be required to move these outlets at no additional cost to the contract. Properly locate all switches with reference to door swing, regardless of indicated position or doorswing shown on electrical Drawings.
 - .6 Where finished construction of walls consist of a symmetrical pattern of finish materials, install wall switches where directed by the Contract Administrator.
 - .7 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 Horizontally mounted receptacles shall have the hot line terminal on the bottom. This shall include car park receptacles.
 - .4 Install cordsets on ranges and dryers.
 - .5 Where switch and convenience outlets are shown close to one another, mount receptacles below and in line with the switch.
 - .6 Where finished construction of walls consist of a symmetrical pattern of wood or other panels, install and locate receptacles and switches as directed to suit the pattern.
 - .7 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 poured concrete with cast in or expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation. Provide additional support as required.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole malleable iron straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel Work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

- .8 For surface mounting of two or more conduits use channels at 1500 mm oc spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Contract Administrator.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .14 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

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, 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.
- .2 Install, wire and connect controls which are an integral part of any packaged unit and are supplied by the trade supplying the packaged unit. Include wiring for controls for such items as roof-top air handling units, etc.
- .3 Control wiring shall be installed in conduit.

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, 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 The 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 The 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.
- .6 Coordinate complete installation of relocated utility services, if required, with Utilities to ensure minimum interruption of service. Coordinate the transfer of the existing hydro service point to the new service point with the Hydro utility in order to keep power interruptions to a minimum.

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.

1.4 SCHEDULE OF WORK

- .1 Carefully note and refer to the general schedule of Work and include for all requirements to conform to it.

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 devices. 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 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 Clamps for grounding of conductor, size as required to electrically conductive underground water pipe.
- .3 System and circuit, equipment, grounding conductors, bare stranded copper, tinned, soft annealed, size as indicated.
- .4 Insulated grounding conductors: green, type RW-90.
- .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, 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 Install separate ground conductor to outdoor lighting standards.
- .7 Connect building structural steel and metal siding to ground by welding copper to steel.
- .8 Make grounding connections in radial configuration only, with connections terminating at single grounding point street side of water pipe. Avoid loop connections.
- .9 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.
- .10 Provide separate ground conductors in PVC conduit, plastic or fibreglass raceways.
- .11 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.
- .12 A minimum #3/0 AWG bare ground wire shall be installed in all cable trays.

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 COMMUNICATION SYSTEMS

- .1 Install grounding connections for telephone, data, sound, fire alarm, intercommunication systems, etc. as follows:
 - .1 Telephones: make telephone grounding system in accordance with telephone installer's requirements.

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.
- .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 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 - NON-VENTILATED

- .1 Epoxy potted. K rating to be minimum K-13 or as indicated on Drawings.
- .2 Power ratings as indicated on Drawings.
- .3 Voltage taps: 4 @ 2 1/2%; two FCAN; two FCBN.
- .4 115 deg. temp. rise insulation system.
- .5 Basic Impulse Level (BIL): standard.
- .6 Hipot: standard
- .7 Average sound level: standard
- .8 Impedance at 75 deg.C: standard
- .9 Enclosure: sealed
- .10 Mounting: floor or wall as indicated.
- .11 Finish: in accordance with Section 16010.

2.2 APPROVED MANUFACTURERS

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

Part 3 Execution

3.1 MOUNTING

- .1 Mount dry-type transformers as indicated.
- .2 Ensure adequate clearance around transformer for ventilation.
- .3 Install transformers in level upright position.
- .4 Remove shipping supports only after transformer is installed and just before putting into service.

- .5 Loosen isolation pad bolts until no compression is visible.
- .6 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

- .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

1.2 DESCRIPTION OF SYSTEM

- .1 Generating system consists of:
 - .1 Natural gas 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 as emergency standby power source unattended.
- .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 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.
- .5 Approved manufacturers are: ONAN or approved equal by the Contract Administrator.

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 Natural gas 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 Low battery voltage/battery charge.
 - .9 Other shutdowns and alarms.
- .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 natural gas 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 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 generator set supplier.
- .2 Ensure room environment control is operational and that all controls required for generator set operation are fed from emergency circuits.
- .3 Ensure doors and Contract Administrator Work in the room is complete.
- .4 Notify Contract Administrator 7 days in advance of on-Site test.
- .5 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 4 hours, taking readings at 15 minute intervals, and record following:

- .1 Time of reading.
- .2 Running time.
- .3 Ambient temp in deg. C.
- .4 Lube oil temp in deg. C.
- .5 Engine coolant temp in deg. C.
- .6 Exhaust stack temp in deg. C.
- .7 Alternator voltage: phase 1, 2, 3.
- .8 Alternator current: phase 1, 2, 3.
- .9 Power in kW.
- .10 Frequency in Hz.
- .11 Power Factor.
- .12 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 Short circuit.
 - .5 Alternator overvoltage.
 - .6 Low battery voltage, or no battery charge.
 - .7 Manual remote emergency stop.
 - .8 High alternator temperature.
- .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). 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.

1.8 DESIGN PARAMETERS

- .1 Mechanical ventilation and exhaust systems are designed based on an ONAN ESG-642 Series, Model GGFE generator set.
- .2 Approval requests from suppliers will require that detail sheet ESD-1 and ESD-2 be properly filled out and submitted to Contract Administrator.
- .3 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.

1.9 TRAINING

- .1 Provide a minimum of 6 hours of "hands-on" training of personnel in operation and maintenance procedures of all aspects of the standby generating system.
- .2 Training shall include system operation descriptions, review of manual and automatic operation, review of controls, regular maintenance procedures, etc.
- .3 Provide a videotape of the training session for future use by the City.

Part 2 Products

2.1 NATURAL GAS ENGINE

- .1 Two or Four cycle, after cooled as required, synchronous speed 1800 r/min.
- .2 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%.
- .3 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.
- .4 Fuel:
 - .1 Natural gas.
- .5 Fuel system: solid injection, fuel filters and air cleaner, fuel rack solenoid energized when engine running, flexible fuel line connections, fuel oil pressure gauge, etc.
- .6 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.
- .7 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.
- .8 Starting system:
 - .1 Positive shift, gear engaging starter 12 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.
- .9 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.
- .10 Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.
- .11 Drip tray.
- .12 Provide output contacts to connect the generator fail alarm point to station control panel.
- .13 Provide output contacts to connect the generator running alarm point to station control panel.
- .14 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.
- .3 Output at 40 deg. C ambient:
 - .1 100% full load continuously.
 - .2 125% full load for 1 min.

- .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: rotating brushless or 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 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.
- .12 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

- .1 Totally enclosed, sprinkler proof, mounted on generator with vibration dampers or free standing.
- .2 Panel door with formed edges and lockable handle with 2 keys.
- .3 Flexible conductors between door and fixed panel.
- .4 Instruments:
 - .1 Analogue or 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.
- .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 battery voltage or high battery voltage.
 - .2 Ventilation failure.
 - .3 Engine high temperature (above 110%).
 - .4 Engine low lube oil pressure (at 80%).
 - .5 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 All devices to be wired to a terminal block.
 - .12 Provide other shutdowns and alarms as required.

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, residential 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 Provide flexible piping at motor connection point.

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.

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 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.
- .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 TESTING

- .1 Perform tests in accordance with Section 16010 - Electrical - General Provisions and "Site Tests" in Part 1.
- .2 Notify Contract Administrator 7 Working days in advance of test date.
- .3 Provide and install necessary load banks for testing.
- .4 Provide fuel for testing on acceptance.
- .5 Run unit on load for minimum period of 4 h to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling.
- .6 At end of test run, check battery voltage to demonstrate battery charger has returned battery to fully charged state.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 16010 Electrical General Requirements
- .2 Section 16622 Natural Gas Power Generation

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.

2.5 BYPASS

- .1 The transfer switch shall come with integral bypass.
 - .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.

2.6 ACCEPTABLE MANUFACTURER

- .1 ASCO 962 series with internal bypass.
- .2 ONAN BT Series by-pass Isolation transfer switch.

2.7 EQUIPMENT IDENTIFICATION

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

2.8 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.

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.

END OF SECTION

Part 1 General

1.1 GENERAL

- .1 All drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 REQUIREMENTS SPECIFIED ELSEWHERE

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

Part 2 Products

2.1 ELECTRIC HEATERS

- .1 Provide, install, wire and connect all fan forced heaters c/w thermostats sized and positioned as indicated on the drawings and schedules. All heaters shall be rated for specified voltage, constructed of minimum 18 ga. steel, as manufactured by Canadian Chromalox Company Ltd., Westcan or approved equal.
- .2 Remote thermostats shall be: low voltage c/w wall plate, sub-base, covering ring and clear key, lock cover for non and tamperproof locations.
- .3 All heaters with 3 phase power and all heaters in excess of 4000 watts shall be c/w built-in contactor controlled by thermostat. All units in excess of 240 volts shall be c/w built-in contactor and control transformer.
- .4 All heaters mounted on wall shall be above baseboard unless otherwise noted.
- .5 Provide built-in relays and control transformers in either the heater or on a separate matching blank heater section.
- .6 Unless specified, provide control transformers controlling more than one relay and narrow type heaters shall be mounted in a separate matching enclosure adjacent to the heater.

Part 3 Execution

3.1 ELECTRIC HEATERS AND CABLES

- .1 Install wire and connect all heaters c/w thermostats positioned as indicated on the drawings.
- .2 Make power and control connections.
- .3 Install relays, transformers and thermostats.
- .4 Interconnect heater relays to be controlled from one common thermostat.

END OF SECTION

ALTERNATE EMERGENCY GENSET DATA SHEET

DESCRIPTION	ONAN ESG-642 SERIES MODEL: GGFE	ALTERNATE A
<p>ENGINE</p> <p>DESIGN BORE & STROKE DISPLACEMENT COMPRESSION RATIO STARTING CHARGING ALTERNATOR FUEL SYSTEM LUBE OIL CAPACITY</p> <p>ALTERNATOR</p> <p>DESIGN</p> <p>STATOR ROTOR VOLTAGE REGULATION PMG COOLING</p> <p>MOTOR STARTING</p> <p>MAX. SURGE kW MAX. kVA</p> <p>FUEL L/hr.</p> <p>CONSUMPTION AT .25 LOAD CONSUMPTION AT .50 LOAD CONSUMPTION AT .75 LOAD CONSUMPTION AT 1.0 LOAD</p> <p>COOLING</p> <p>COOLANT CAPACITY HEAT REJECTION TO COOLANT HEAT RADIATED TO ROOM</p> <p>AIR</p> <p>COMBUSTION AIR ALTERNATOR COOLING AIR RADIATOR COOLING AIR</p> <p>EXHAUST</p> <p>GAS FLOW (FULL LOAD) GAS TEMPERATURE</p> <p>SIZE</p> <p>LENGTH (OVERALL) WIDTH (OVERALL) HEIGHT (OVERALL)</p>	<p>NATURALLY ASPIRATED 96.8mm/95mm 4.2L 9.3:1 12 VOLT, NEGATIVE GROUND 65 AMPS NATURAL GAS 5.7L</p> <p>BRUSHLESS, 4 POLE, DRIP PROOF, REVOLVING FIELD 2/3 PITCH DIRECT COUPLED BY FLEXIBLE DRIVE DISC 347/600V YES DIRECT DRIVE CENTRIFUGAL BLOWER</p> <p>47.3KW 163KVA</p> <p>6.1M³/HR 9.4M³/HR 13.2M³/HR 16.3M³/HR</p> <p>26.5L 2.9MJ/min. 500BTU/min.</p> <p>3.1M³/min. 18M³/min. 135.8M³/min.</p> <p>9.1M³/min. 584.4°C</p> <p>2103mm 1016mm 1285mm</p>	

SMS ENGINEERING

SMS Engineering Ltd. Consulting Engineers
770 Bradford Street Winnipeg MB Canada R3H 0N3
Telephone 204.775.0291 Fax 204.772.2153
sms@smseng.com

MANITOBA AVENUE PUMPING STATION GENSET REHABILITATION

WINNIPEG

MANITOBA

EMERGENCY GENERATOR DATA SHEET

Drawn By RC	Approved By SB	Reference 0
File No. 09-006-01	Date APRIL 2009	Detail Sheet ESD-1

SMS ENGINEERING

SMS Engineering Ltd. Consulting Engineers
 770 Bradford Street Winnipeg MB Canada R3H 0N3
 Telephone 204.775.0291 Fax 204.772.2153
 sms@smseng.com

MANITOBA AVENUE PUMPING STATION GENSET REHABILITATION

WINNIPEG

MANITOBA

SHOP DRAWING COMPLIANCE LIST SAMPLE

Drawn By RC	Approved By SB	Reference 0
File No. 09-006-01	Date APRIL 2009	Detail Sheet ESD-2

(Space for system manufacturer's name)
 SHOP DRAWING REVIEW

DETAILED PLC COMPLIANCE LIST

- EACH COMPONENT SHALL BE INDIVIDUALLY MARKED**
- .3 The controller system shall be of a modular design with a plug-in processing unit, input/output frames or assemblies, and plug-in peripherals. All plug-in components of the controller system shall have the same physical mounting dimensions, and shall have provision for both mounting in a rack on a wall or panel. Wherever possible, all assemblies and sub-assemblies performing similar functions in separate controllers purchased under this specification shall be interchangeable. All necessary interconnecting cables shall be included.
- .4 All major assemblies, sub-assemblies, circuit cards, and end devices shall be permanently marked with the manufacturers part of identification number.
- .5 All components of the controller system shall be capable of continuous operation at temperatures of 10 to 40°C and humidity levels of 10 – 95%.
- .6 Electrical supply voltage to the controller shall be 24V DC. Controller system power supplies shall have circuit breakers for overload protection.
- .7 All programming and monitoring equipment (e.g. CRT programming panel, graphic annunciator) shall be able to be connected or disconnected with the controller in operation.
- .8 The controller, including output devices, shall shut down and alarm in an orderly fashion in the event of a disruption of program execution or scan, a loss of logic power, loss of communication between controller essential devices, or a memory error. Shut down shall be "fail safe" and shall allow the balance of the system to operate in the manual mode. Unless otherwise noted, all output contacts shall return to a normally open (NO) state upon controller shut down.
- .7 Central Processing Unit (CPU):
- .1 The CPU shall be a completely solid state device consisting of a mounting rack c/w plug-in power supply, control and memory modules as further described.
- .2 The mounting rack shall be standard 19" width with sufficient space to mount all necessary power supplies and modules. The mounting rack shall contain a system backplane which includes all necessary power and data connections to allow any modules to be plugged in and operate without any additional connecting cables.
- .3 Yes, plug into rack, and are the same size.
 Modules cannot be mounted separately on a wall or panel.
 Does not apply, only one plc supplied.
- .4 As per quote all internal interconnecting cables supplies. Details will be supplied to contractor for external communication cables to programming terminal etc. Contractor to supply and install cable.
- .5 Yes, the controller will operate within this temperature range.
- .6 Yes
- .7 Yes
- .8 Yes
- .7.1 Yes
- .2 Yes, with the exception of an internal ribbon cable which connects the arithmetic control modules to the logic control module.

GENERATING SYSTEM CONTROLS UPGRADE 16600 (21)