Part 1 General

1.1. WORK INCLUDED

.1 Refer to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

.2 The Contractor for this project shall be responsible for the coordination of all the trades.

.3 General conditions shall conform to the general instructions as indicated in Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. DEMOLITION WORK

.1 Decommission and remove all existing 44kV outdoor and indoor components (PTs, CTs, relays, etc.) associated with 44kV Hydro Ottawa automatic transfer switch control system. The remote 44kV relays, meters, controls and auxiliaries are installed in cell 11 of building 17.

.2 Decommission and remove 13.2kV switchgear (10 cells) and associated relays, meters, controls and auxiliaries in building 17.

.3 Disconnect and remove existing PILC cables as shown on single line drawings.

.4 Contractor to dispose all existing redundant equipment off site.

1.3. NEW WORK

.1 Supply and install new 10-cell 13.2kV switchgear and associated relays, digital meters, controls and auxiliaries to include new 13.2kV automatic transfer switch control system for Hydro.

.2 Coordinate with Hydro for power shut down. Contractor to include all associate costs from Hydro Ottawa in tender price. Refer to section 01 21 00 – Allowances.

.3 Supply and install new high and medium voltage cables as shown on single line drawings.

.4 Provide arc flash protection and coordination study.

Part 2 Products

2.1. NOT USED

Part 3 Execution

3.1. NOT USED

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to the requirements which apply to and forms part of all sections of the work.

1.2. DESCRIPTION OF SECTION

.1 The specification is divided into sections of work and a section may consist of the work of more than one subcontractor. The responsibility as to which electrical subcontractor provides labour, materials, equipment and services required to complete the work rests solely with the Electrical Contractor.

1.3. SECTIONS AFFECTED

.1 These instructions apply to and form a part of all electrical sections.

1.4. SCOPE

.1 Provide all labour, materials, equipment and services to complete the work of the electrical division as further specified and as shown on the drawings.

.2 Should any discrepancy appear between any parts of the specifications and/or the drawings to cause doubt as to the true meaning and intent of the drawings and specifications, a ruling shall be obtained from the Departmental Representative before submitting the tender. If this is not done the following will be assumed:

.1 Where a discrepancy occurs between the specification and the drawings, the drawings take precedence.

.2 Where a discrepancy occurs in the drawings the more expensive alternative will be deemed as included in the contract.

.3 Where a discrepancy occurs in the specifications the more expensive alternative will be deemed as included in the contract.

1.5. REGULATIONS

.1 All work shall be performed in accordance with the latest codes, rules, regulations, by-laws and requirements of all authorities having jurisdiction.

.2 Do complete installation in accordance with current edition of the Ontario Electrical Safety Code except where specified otherwise.

.3 These specifications are supplementary to the requirements above.

.4 Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the contractor shall notify the Departmental Representative.

1.6. PERMITS, FEES REVIEW

.1 Make submissions to obtain all permits. Include for and pay for all fees and arrange for all reviews required for the work of this division.

.2 If required by code, plans and specifications have been previously submitted to the Electrical Safety Authority as per Rule 2-010.

.3 Furnish certificates of Acceptance from the electrical review department and authorities having jurisdiction and include them in the Operation and Maintenance manual.

1.7. VOLTAGE RATINGS

.1 Operating voltages are as specified in CAN3-C235-83.

.2 Motors, electric heating, control and distribution devices and equipment are to operate satisfactorily at 60 Hz within operating limits established by the above standard.

1.8. PLYWOOD BACKBOARDS, EQUIPMENT MOUNTING, & HOUSEKEEPING PADS

.1 Provide fire rated plywood backboards as shown on the drawings and mount where all communication equipment is to be wall mounted. Plywood is to be 21 mm Forestry Initiative (SFI) or CSA Z809-08 certified. Plywood to be either fire rated with the appropriate label displayed once installed or coated with fire retardant paint. All Certification not to be painted. Surface mounted electrical equipment boxes are to be installed on galvanized Unistrut stand-offs. Electrical equipment boxes shall include, but not be limited to electrical panels, LV lighting control, fire alarm, security, communication, electrical sub-metering, etc. Panels are to be grouped on common base wherever practical.

.2 Provide steel re-enforced concrete housekeeping pads under all floor mounted electrical equipment and where noted on the drawings. All housekeeping pads to be a minimum of 100mm high above finished floor and shall not extend beyond 50mm beyond the electrical equipment unless shown otherwise on the drawings.

1.9. FINISHES

.1 Metal enclosure surfaces are to be finished by the application of rust resistant primer on both the inside and outside, with at least two coats of enamel.

.2 Clean and touch up all surfaces of equipment scratched or marred during shipment or installation. Match the original paint.

.3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

1.10. SAFETY

.1 Protect exposed live equipment during construction for personnel safety.

.2 Shield and mark all live parts "LIVE 120 VOLTS", or with appropriate voltage in English.

.3 Arrange for the installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of an electrician.

1.11. FIRE STOPPING

.1 Provide fire stopping in accordance with front end documents and as describe herein. Contractor to coordinate fire stopping with General Contractor. All paints, coatings, sealants and adhesives shall meet the VOC limits in accordance with the LEED Specification sections. Fire stopping and smoke seal systems: in accordance with CAN4 S115 M85.

- .1 Asbestos free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of CAN4 S115 M85 and not to exceed opening sizes for which they are intended.
- .2 Fire stop system rating for service penetrations: to suit Ontario Building Code 1997, 3.1.9.1 Fire Stopping of Service Penetrations.
- .3 Fire stop system rating for sealing junction of rated walls to rated floors and ceilings: to suit Ontario Building Code.

.2 Service penetration assemblies: certified by ULC in accordance with CAN4 S115 M85 and listed in ULC Guide No. 40 U19.

.3 Service penetration fire stop components: certified by ULC in accordance with CAN4 S115 M85 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC.

.4 Fire resistance rating of installed fire stopping assembly not less than the fire resistance rating of surrounding floor and wall assembly, and in accordance with Ontario Building Code.

.5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal; do not use cementitious or rigid seal at such locations.

.6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal; do not use a cementitious or rigid seal at such locations.

.7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.

.8 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.

.9 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.

.10 Sealants for vertical joints: non-sagging.

.11 Colour: industry standard.

.12 Through non-fire or non-smoke separations or where waterproof membrane is field applied, where pipes are insulated, sleeves shall be sized to accommodate the insulation and vapour barrier.

.13 Where holes are core drilled in existing structures, sleeves shall be provided as specified complete with fire stopping as noted above.

.14 Submit a complete fire stopping system shop drawing package, identifying the products that may be used on the project. Prior to submitting data, review with Authority having Jurisdiction to confirm acceptability of proposed materials and assemblies.

.15 Installation:

.1 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.

.2 Seal holes or voids made by through penetrations, poke through termination devices, and un-penetrated openings or joints to ensure continuity and integrity of fire separation are maintained.

.3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.

.4 Tool or trowel exposed surfaces to a neat finish.

.5 Remove excess compound promptly as work progresses and upon completion.

1.12. HOISTING

.1 Electrical Contractor will be responsible for the hoisting of all the equipment in the contract. Contractor to coordinate with General Contractor for use of the general hoisting facilities. If hoist facilities are inadequate then subcontractors must provide their own. Subcontractors must inform general contractors of requirements before tender closing date. Any hoisting required in addition to that provided by the General, will be included in the bid price.

.2 Electrical Contractor to include for the qualified millwrights to move and place all equipment over 455kg.

1.13. CLEANING AND WASTE REMOVAL

.1 Clean all electrical equipment that has been exposed to construction dust and dirt.

.2 Contractor to clean all electrical equipment, inside and out, prior to turn over to Departmental Representative. Equipment is subject to review by Departmental Representative.

.3 Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.

1.14. TEMPORARY LIGHT AND POWER

.1 Temporary light and power for construction shall be provided and maintained by the electrical trade, as directed by the General Contractor; but each trade shall provide all extension cords, lamps, etc., required to complete their work.

.2 All temporary light to be fluorescent. Provide adequate lighting to meet all health and safety standards.

1.15. EXAMINATION AND PROTECTION OF SITE

.1 Contractor to document any existing conditions on site and submit a pre-condition survey including pictures. Contractor will be responsible to return the site back to its original form, which includes but is not limited to ground repair including grading and new sod and repair of damaged walls, doors and/or floors.

.2 Contractor is to protect trees and plants on site and on adjacent properties. Plants to be protect with burlap. Trees and roots within construction area to be protected by the erection of temporary 2m high plywood hoarding at the drip line of the tree. Contractor to avoid unnecessary traffic, dumping and storage of materials at or near trees or plants.

.3 When requested by the Departmental Representative, the Contractor is to provide digital pictures of the site, including but not limited to progress of work and installed equipment, via e-mail to the Departmental Representative.

1.16. DRAWINGS AND INSTALLATION

.1 The drawings are intended to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operative installation.

.2 The location, arrangement and connection of equipment and materials shown on the drawings represent a close approximation to the intent and requirements of the contract. The right is reserved by the Departmental Representative to make reasonable changes required to accommodate conditions arising during the progress of the work.

.3 Certain details indicate on the drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence on the drawings.

.4 The location and size of existing services shown on the drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced. Particular attention shall be paid to buried services.

.5 Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades.

.6 Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.

.7 The Contractor will reimburse the Departmental Representative for their time spent on answering any written questions or requests for information where the answer is clearly identified on the drawings or in the specifications.

1.17. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS

.1 The Contractor is to complete installation, interference and setting drawings, dimensioned and to scale for all systems. They shall be made available for review by the Departmental Representative, if requested. The drawings are required to make clear the work intended or to show its relation to adjacent work or to the work of other trades. When an alternative piece of equipment is to be substituted for equipment shown, drawings of the area involved shall be prepared by this division.

1.18. PRODUCTS AND MATERIALS

.1 Make and quality of materials used in the construction of this project shall be subject to the approval of the Departmental Representative.

.2 All equipment and material are to be CSA certified or approved by an accredited organization. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Authorities.

.3 Factory assemble control panels and component assemblies.

.4 Materials and equipment supplied by this division shall be new and free from defects and shall be equivalent in physical characteristics and performance to that specified by the manufacturer's name and catalogue reference.

.5 Within 30days of the award of contract, the Contractor is to submit a complete list of the manufacturers for all equipment being supplied on the project.

1.19. CO-OPERATION WITH OTHER DIVISIONS

.1 Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.

.2 Electrical conduits shall not touch or be supported on pipe or duct walls.

.3 Each section shall confine itself to installing all materials in the spaces shown without encroaching upon space for materials installed under other sections or divisions. Where the space allocated to another section or division is encroached upon, the materials shall be relocated to their proper space allocation in such a manner to complete the work using space allocated to the various sections and divisions. Relocation of materials and work involved shall be paid for by the section responsible for the encroachment.

.4 The supply of all items is to have built-in to the delivery schedule, ample time for rapid progress of work. Proceed with work determined by the construction schedule.

1.20. TEMPORARY USE OF EQUIPMENT

.1 Where the electrical systems are operated during construction, the Electrical Contractor shall maintain the system and equipment in proper operating condition.

.2 Before any area of the building is turned over to the Departmental Representative for acceptance and for beginning of the guarantee/warranty period, the systems and equipment shall be returned to the initial new condition.

.3 Permanent electrical equipment is only to be used upon permission of Departmental Representative and is only to be used on a limited basis. All equipment must be cleaned prior to turnover.

1.21. METRIC CONVERSIONS

.1 Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, but not limited to, equipment, conduit and site services in both new and existing installations.

1.22. INTERRUPTION OF SERVICES

.1 Any interruption of the electrical services to any part of the building shall come at a time agreeable to the Departmental Representative. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.

.2 Testing and operation of major equipment shall be approved by the Departmental Representative to avoid excessive hydroelectric charges. Such testing to be generally carried out after normal working hours or on weekends.

.3 Modifications to existing electrical equipment, which will require shutdown, must be coordinated with the Departmental Representative and will only be permitted on weekdays from 10:00 pm to 6:00 am and on weekends from Friday at 7:00 pm to Sunday 6:00 pm. Exact weekends to be co-ordinated with the Departmental Representative. Consecutive weekends of shutdowns will not be allowed. Contractor to pay for all Hydro costs associated with shutdowns. Any work not associated with live equipment can be done during normal working hours. Work considered disruptive to the normal operation of the building will be done after normal business hours. Exact times to be co-ordinated with Departmental Representative.

.4 Contractor to provide a minimum of 5 days written notice of a requirement for a shutdown. Contractor to include for separate meetings with the Departmental Representative to discuss the shutdown in detail and to coordinate all the work being performed.

.5 The Contractor is responsible for co-ordination and isolating of all existing services at all voltage levels required the disconnections and connections to existing buildings. This includes shutting down and isolating existing low and medium voltage services. The Departmental Representative will not perform any isolation for the contractor but might be present during the work. The contractor is to use qualified personnel for these shutdowns ensuring compliance with all applicable safety requirements.

.6 The Contractor is responsible for any damages caused to existing systems when making connections.

.7 The Contractor is to keep shutdowns of existing buildings to a minimum by scheduling the work and providing the required number of personnel to keep the shutdown to a minimum. This Contractor is to include for as many multiple teams of electricians is feasible to keep the shutdown work to the minimum.

1.23. DEMOLITION

.1 The demolition drawings show the general scope of the demolition and not exact details or total extent. For exact details and total extent each service must be carefully checked on site. Before removing services follow the service through to ensure other areas of the building are not affected.

.2 Whenever existing services or equipment are to be removed, all electrical connections for such services shall be removed and securely terminated in an approved manner. If necessary to facilitate installation of new work, any existing services and equipment shall be removed and then replaced by this division.

.3 Make safe and disconnect all power and systems, as and when, and to the extent required to facilitate with the demolition.

.4 Ensure that all existing equipment which is to be reused and/or relocated is thoroughly reviewed and refurbished to ensure correct operation when put back into service and to meet the requirements of the local authorities having jurisdiction. All existing electrical equipment which is no longer required shall be removed and disposed of off-site.

.5 Carry out the work with a minimum of noise, dust and disturbance.

.6 Provide tools and clean up equipment. Obtain the Departmental Representative's permission for the use of electrical, plumbing or drainage outlets.

.7 Where a device is shown to be relocated on the drawings, contractor to remove and re-install device and back box and re-feed the device with new conduit and wire from the nearest existing accessible junction box.

.8 Electrical Contractor is responsible for the patching and re-painting the entire wall where a device and/or box has been added, removed or relocated.

Part 2 Products

2.1. NOT USED

Part 3 Execution

3.1. NOT USED

END OF SECTION

Part 1 General

1.1. ABBREVIATIONS

.1 Abbreviations for electrical term are as specified in CSA Z85-1983.

Part 2 Products

2.1. NOT USED

Part 3 Execution

3.1. NOT USED

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section of Division 01 00 10 – General Instructions.

.2 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

.3 Conform to Section 26 08 01 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.

1.2. REFERENCES

.1 Canadian Standards Association (CSA).

.1 CAN/CSA-C22.2 No.131-, Type TECK 90 Cable.

.2 CSA C68.5-07 Primary Shielded and concentric neutral cable for distribution utilities 15-46kV.

.3 CSA C68.10 Shielded Power commercial and industrial applications, 5-46kV.

.4 CAN/CSA C49.1 M87 (R1993), Round Wire, Concentric Lay, Overhead Electrical Conductors.

.2 National Electrical Manufacturers Association (NEMA)/Insulated Cable Departmental Representatives Association (ICEA):

.1 NEMA WC74-2006/ICEA S-93-639 - Shielded Power Cables 5,000 - 46,000V.

.2 ANSI/ICEA - S-94-649-2004 -Concentric Neutral Cables Rated 5 Through 46 kV.

.3 ICEA - S-70-547-2000 - Weather Resistant Polyethylene Covered Conductors.

.3 The Association of Edison Illuminating Companies (AEIC):

.1 AEIC CS1-90 – Impregnated Paper-Insulated Metallic-Sheathed Cable, Solid Type.

Part 2 Products

2.1. GENERAL

.1 Medium-high voltage (5-46 kV) cables shall be constructed and tested to applicable standards for the system voltage specified.

.2 Design shielded cables to safely withstand a ground fault current without damage for 8 cycles with an available shield fault of 3000 amps.

.3 Coverings and outer jackets shall be rated for -40 deg. C.

2.2. POWER CABLE

.1 Cable: to CSA C68.5-07 Primary Shielded and concentric neutral cable for distribution utilities 15-46kV.

.2 Conductor: copper, size and number as indicated.

.3 Conductor shield: Extruded semi conducting layer over conductor.

.4 Insulation: TR XLPE rated 90 deg. C. and a 133% insulation level.

.5 Insulation shielding: Extruded semi-conductor layer over insulation.

.6 Metallic Shield: Copper tape applied helically over semi-conductor layer.

.7 Overall PVC jacket rated -40 deg. C. rated at a minimum of FT-1 and "Sun Res".

2.3. CONCENTRIC NEUTRAL POWER CABLES

.1 Concentric neutral power cable: to NEMA WC7 1992/ICEAS 66 524/ CSA C68.10 Shielded Power commercial and industrial applications, 5-46kV.

.2 Conductor: copper, size and number as indicated.

.3 Conductor shield: Extruded semi conducting layer over conductor.

.4 Insulation: TR XLPE rated 90 deg. C. and 133% Insulation Level.

.5 Insulation shield: Semi conducting insulation shielding layer.

.6 Metallic Shield: Copper neutral wires applied helically over insulation shield with a minimum of one third full capacity.

.7 Overall PVC jacket rated -40 deg. C. rated at a minimum of FT-1 and "Sun Res".

2.4. TECK POWER CABLE

.1 Cable: to CAN/CSA C22.2 No. 131 and C68.10 Shielded Power commercial and industrial applications, 5-46kV.

.2 Conductor: Copper, size and number as indicated.

.3 Conductor shield: Extruded semi conducting layer over conductor.

.4 Insulation: TR XLPE 90 deg. C. and a 133% insulation level.

.5 Insulation shielding: Extruded semi-conductor layer over insulation.

.6 Metallic Shield: Copper Wires or Tape shielding: All single conductor teck cables to have helically wound concentric ground wire over extruded semi-conductor layer and all three conductor teck cables to have copper tape, helically applied over semi-conductor layer.

.7 Ground Conductors: For single conductor cable, same copper wires applied helically over insulation shields can be used as grounding conductor. For three conductor's cables, an un-insulated stranded copper conductor serve as bonding conductor.

.8 Inner jacket; flame retardant PVC inner jacket.

.9 Armor: Interlocked aluminium armour.

.10 Overall PVC jacket rated -40 deg. C. rated at a minimum of FT-4 and "Sun Res".

2.5. VERTICAL RISER TECK POWER CABLE

.1 Cable: to CAN/CSA C22.2 No. 131 and CSA CSA C68.10 Shielded Power commercial and industrial applications, 5-46kV.

.2 Conductor: copper, size and number as indicated.

.3 Conductor shield: Extruded semi conducting layer over conductor.

.4 Insulation: TR XLPE 90 deg. C. and a 133% insulation level.

.5 Insulation shielding: Extruded semi-conductor layer over insulation.

.6 Metallic Shield: Copper Tape shielding: cables to have copper tape, helically applied over semi-conductor layer.

.7 Ground Conductors: An un-insulated stranded copper conductor serve as bonding conductor.

.8 Inner jacket; flame retardant PVC inner jacket.

.9 Armor: Interlocked steel armour.

.10 Overall PVC jacket rated -40 deg. C. rated at a minimum of FT-4.

2.6. PRIMARY OVERHEAD CONDUCTORS (46KV)

.1 Copper conductor TRXLPE insulation copper shielded power cable: 350 kCM.

2.7. FIRE/ARCH PROOFING

.1 Fire proofing tape to be Scotch® Fire-Retardant Electric Arc Proofing Tape 77.

2.8. TESTING

.1 Cable shall be tested at the manufacturer's plant prior to shipping. Tests shall include:

.1 Standard quality control testing to verify cable construction parameters.

.2 Insulation resistance.

.3 Compliance with CSA.

2.9. DELIVERY

.1 Cable shall be delivered on reels in a manner to suit the installation requirements of the Electrical Contractor.

Part 3 Execution

3.1. GENERAL

.1 Cables to be installed in rigid steel conduit or in concrete encased duct banks.

.2 Where medium voltage cables are shown on cable tray, maintain separation of 25 mm between adjacent cables.

.3 Where cables are run in a vertical riser in a building, Contractor to provide and install vertical-riser Teck cables.

.4 Splices and terminations to be made by personnel skilled in this type of work. Submit evidence of this experience and obtain approval prior to commencing this work.

.5 Installation of cable, splices and terminations to be performed by firms specializing in this type of work.

3.2. INSTALLATION OF CABLES

.1 Determine cable lengths with care, using field measurements, so that number of splices is minimized.

.2 Perform Pulling calculations prior to cable installation / cable pulling in duct or on tray. Submit calculations as shop drawings for review and records.

.3 Protect cable from damage when handling cable on reel and when installing cable in duct or tray.

.4 Clean and test ducts, before installing cable, by pulling steel wire brush through ducts followed by steel bound mandrel made up of four discs having an over length of not less than 300 mm. Diameter of discs to be 6 mm less than nominal inside diameter of duct.

.5 Pull cables in accordance with best standard practice, and as recommended by cable manufacturer. Do not exceed pulling tensions on cables. If recommended pulling tensions are exceeded, cable is to be removed and replaced. When pulling in very-low temperatures, check the with cable supplier.

.6 Do not pull cable splices inside ducts.

.7 While cable is being pulled, inspect sheath for any visible cracks or other damage. If damage is evident, pulling to be stopped immediately, and cable to be replaced or repaired. Pulling, except for short runs, to be done through use of pulling eye attached directly to conductors that make up cable. Use CSA approved cable lubricants, suitable for ambient temperatures.

.8 Seal cable ends to prevent entrance of moisture.

.9 Fireproof cables in manholes, vaults and splices in manholes, vaults and cable tray using two helically wound layers of fireproofing tape.

3.3. SPLICES AND TERMINATIONS

.1 All splicing and terminations to be performed by qualified and experienced personnel.

.2 All cables to be terminated with two-hole long barrel Burndy compression type lugs. Cables to be crimped to the manufacturer's recommendations.

.3 Make splices using packaged kits, assembled in accordance with cable type, voltage rating and cable manufacturer's recommendations.

.4 Terminations are to be packaged kits, installed as per the manufacturer's recommendations.

.5 Terminations or splices are not to be made if cable internals will be exposed to inclement weather. In an emergency, splices or terminations may be made in tent or other protective enclosure with prior approval from Departmental Representative.

.6 Shielding grounding is to be reviewed with Departmental Representative prior to installation. Shielding to be grounded a source end. If step voltage greater than 50V is developed based on the length of cable, then the cable shall be grounded at both ends.

3.4. TESTING

.1 Arrange and pay for high voltage cables to be tested by the Technical Services Division Start-U Services Contractor before being placed in service.

.2 Conduct these tests, at time suitable to Departmental Representative, with Departmental Representative present as witness.

.3 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.4 Use updated and latest "Field test" procedure and criteria from Cable manufacturer.

.5 Check phase rotation and identify each phase conductor of each feeder.

.6 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.7 Pre-acceptance tests:

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 5000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.3 Verify phasing of cabling.

.8 Acceptance Tests:

.1 Ensure that terminations and accessory equipment are disconnected.

.2 Ground shields, ground wires, metallic armour and conductors not under test.

.3 High Potential (Hipot) Testing:

.1 Conduct hipot testing at 80% of original factory test voltage in accordance with ICEA recommendations.

.4 Leakage Current Testing:

.1 Raise voltage in steps from zero to maximum values as specified by ICEA for type of cable being tested.

.2 Hold maximum voltage for time period specified by ICEA

.3 Record leakage current at each step.

.9 Provide Departmental Representative with list of test results showing location at which each test was made, circuit tested and result of each test.

.10 Remove and replace entire length of cable if cable fails to meet any of test criteria.

3.5. ACCEPTABLE HIGH VOLTAGE CONTRACTORS

.1 The following contractors are approved to supply, install and terminate the high voltage cables:

.1 Carleton Electric

.2 K-Line Construction.

.3 Power Cable Installations.

.4 Independent High Voltage.

.2 Splices and terminations to be made by personnel skilled in this type of work. Submit evidence of this experience and obtain approval prior to commencing this work.

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. REFERENCES

.1 CSA C22.2 No.0.3 (latest edition), Test Methods for Electrical Wires and Cables.

.2 CSA C22.2 No.38 (latest edition), Thermoset-Insulated Wires and Cables

.3 CSA C22.2 No. 75 (latest edition), Thermoplastic-Insulated Wires and Cables

.4 CSA-C22.2 No. 51 (latest edition), Armoured Cables

.5 CSA-C22.2 No.131-M89 (latest edition), Type TECK 90 Cable.

.6 ASTM B800 - Standard Specification for 8000 Series Aluminium Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers

Part 2 Products

2.1. GENERAL

.1 Submit product data in accordance with specification 01 33 00 – Submittals Procedures.

2.2. BUILDING WIRES

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Contractor to provide copper conductors on conductors sizes up to and including #8AWG. Contractor to provide copper conductors for sizes larger than #8AWG unless identified as aluminum or NUAL on the drawings.

.3 All conductors to have size as indicated, with insulation of chemically cross-linked thermosetting polyethylene material rated RW90 or RWU90 to CSA C22.2 No.38 rated as follows:

.1 Insulation rated at 1000V for 600V systems that are ungrounded or have a neutral grounding resistor to limit ground fault current

.2 Insulation rated at 600V for the other 600V and 347/600V distribution systems not covered under item #1 above.

.3 Insulation rated at 600V for all systems rated at 480V and less.

.4 RWU-90 wiring is to be used for underground installations.

2.3. TECK CABLE

.1 Cables to CAN/CSA-C22.2 No.131.

.2 Conductors:

.1 Grounding conductor copper.

.2 Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.

.3 Insulation:

.1 Chemically cross-linked thermosetting polyethylene type RW90, rated 1000 V.

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: interlocking aluminum.

.6 Overall covering: thermoplastic polyvinyl chloride material rated at a minimum of FT-4. Provide FT-6 jacket when TECK cables are run in return air plenum.

2.4. ARMOURED CABLES

.1 Cables to: CSA-C22.2 No. 51-95.

.2 Circuit conductors: copper, size as indicated.

.3 Type: AC90 (BX).

.4 Armour: interlocking type fabricated from aluminum strip.

.5 Type: ACWU90 - PVC flame retardant jacket over armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No.0.3 with maximum flame travel of 1.2 m.

Part 3 Execution

3.1. GENERAL

.1 Provide a minimum of one grounding wire for each three ungrounded conductors on all cable runs. Size grounding to Table 16 of the Canadian Electrical Code. Provide separate ground conductors for ground fault circuit interrupter circuits. All ground conductors to be copper and insulated with a green coloured insulation.

.2 All equipment, junction boxes, pull boxes, liquid tight flex, etc. to be grounded through ground wires.

.3 Provide separate neutral conductor for each 120 volt circuit for all circuits feeding receptacles and power outlets.

.4 All cable terminations to be compression type fittings for wire sizes greater than #8AWG. All compression type fittings to be two-hole long barrel type. Where mechanical screw type lugs are allowed by the Departmental Representative, they will be suitable for quantity of parallel runs of wire that are to be terminated under.

.5 Armoured Cable Type AC90 (BX) may only be used for individual drops from slab mounted junction box to recessed mounted light fixtures or where noted on the drawings where wiring is required to be installed within an existing wall. The maximum allowable distance of armoured cable is 3m. Contractor to receive written approval from the Departmental Representative to run armoured cable further than 3m from junction box. Daisy changing of fixtures is only acceptable in dry wall ceilings. Wiring in conduit is to be brought to a junction box to allow for the transition to armoured cable. Armoured cable is not to be installed directly into electrical panels or run in walls for receptacles.

.6 Branch circuit wiring to be upsized as follows to address voltage drop when:

.1 The entire length of the circuit wiring exceeds 25m – branch wiring to be a minimum of No. 10 AWG.

.2 The entire length of the circuit wiring exceeds 40m – branch wiring to be a minimum of No. 8 AWG.

.3 The entire length of the circuit wiring exceeds 60m – branch wiring to be a minimum of No. 6 AWG.

.7 Wire Splicing

.1 Splice up to and including No. 6 AWG with nylon insulated expandable spring type connectors.

.2 Splice larger conductors using compression type connectors wrapped in PVC insulation rated at the respective voltage.

3.2. INSTALLATION OF BUILDING WIRES

.1 Install all building wiring in conduit unless otherwise noted. Conduit to be sized to the electrical code unless noted on the drawings or in the specifications.

.2 All conductors are to be colour coded. Provide colour tape at all terminations to identify all conductors in each run.

3.3. INSTALLATION OF CONTROL CABLES

.1 Install control cables in conduit.

.2 Ground control cable shield.

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. REFERENCES

.1 CSA C22.2 No. 41-M2007 – Grounding and Bonding of Equipment

1.3. DESCRIPTION

.1 Provide system grounding to meet requirements of current Canadian Electrical Code and all applicable Codes.

.2 Supply and install a new ground bus system, consisting of a length of copper bus, 25 mm thick ebony pad with chamfered edges. The perimeter ground bus shall be continuous around the room and shall be continued above or below all such opening as door and vents.

.3 Connect each ground bar with a minimum of two #4/0 AWG conductors to the main ground grid for the building. Connect the ground bar to each of the ground rods with #3/0 minimum ground conductors if the ground rods are driven in the respective room otherwise run a minimum of two #4/0 AWG conductors to the remote ground grid.

.4 Connect to the ground loop all transformer neutrals, switchboard neutral and all metal equipment enclosures as well as all other metal parts such as mechanical pipes, ducts, waste lines, door frames, railings, grilles, fences, etc.

.5 Provide cable grips to receive all grounding conductors. Identify all grounding conductors at the ground pad using Lamicoid nameplates. Ground bus system to be provided in rooms as shown.

.6 Terminate the following conductors at the ground bus system:

Service neutral	-3/0 AWG
Telephone ground	-2 AWG
Main system ground	-3/0 AWG
Bonding cable	-3/0 AWG

.7 All metal parts at the electrical area main distribution center shall be bonded to the main ground bus using 4 AWG stranded bare copper cable or 6 mm x 13 mm copper strap.

.8 Bond and ground all metallic water and waste systems in accordance with code requirements.

.9 Install grounding connections to typical equipment included in, but not necessarily limited to, following list: frames of motors, starters, and control panels, building steel work, elevators, distribution panels and outdoor lighting.

Part 2 Products

2.1. GROUNDING & BONDING EQUIPMENT

.1 Meet standard of CSA C22.2 No. 41-M2007.

2.2. CONDUCTORS

.1 Bare or insulated, stranded, soft drawn annealed copper wire, for: ground bus, electrode interconnections, metal structures, ground connections, telephone ground.

Part 3 Execution

3.1. INSTALLATION

.1 Install complete permanent, continuous, system and circuit, equipment, grounding systems including, conductors, and 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 All grounding connections to be made with two hole, long barrel compression type fittings and lugs.

.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 Commission an approved Agency to perform a main system ground test and a copy of the report in the maintenance manual. (Refer to Part 3.0).

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. PRODUCT DATA

.1 Conduit and equipment provided under the Electrical division shall be complete with all necessary supports and hangers required for a safe and workmanlike installation.

Part 2 Products

2.1. MATERIALS

.1 Provide "U" type support Strut.

Part 3 Execution

3.1. INSTALLATION

.1 The Contractor to supply anchor bolts and base diagrams of equipment showing exact location for anchor bolts.

.2 It shall be the responsibility of the electrical division to supply the Contractor with anchor bolts and base diagrams of equipment showing exact location of anchor bolts.

.3 All drilling for hangers, rod inserts and work of similar nature shall be done by this Division.

.4 Auxiliary structural members shall be provided under the electrical section concerned where conduits or equipment must be suspended between the joists or beams of the structure, or where required to replace individual hanger to allow for installation on new services. Submit details for review as requested.

.5 Depending on type of structure, hangers shall be either clamped to steel beams or joists, or attached to approve concrete inserts.

.6 Approved type expansion shields and bolts may be used for conduit up to 100 mm diameter where the presetting of concrete inserts is not practical. Submit Shop Drawings.

.7 Suspension from metal deck shall not be allowed unless specifically accepted by the Departmental Representative. Drawings of the proposed method of suspension must be submitted for review.

.8 Hangers, hanger rods and inserts in all parking and ramp areas shall meet the requirements of CAN/CSA-S413-07 and shall be of corrosion-resistant material or have an effective, durable corrosion resistant coating. Submit samples for approval.

.9 Suspending one hanger from another shall not be permitted.

.10 All hangers, supports, brackets and other devices used outside the building wall shall be galvanized. If galvanized components cannot be used submit samples of proposed substituted for review before installation.

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. REFERENCES

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

Part 2 Products

2.1. OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 Square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2. SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 75 mm x 50 mm x 38 mm or as indicated. 100 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

.2 Provide cast FS aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles connected to rigid conduit.

.3 Provide electro-galvanized steel utility boxes for surface mounted boxes connected to surface-mounted EMT conduit, minimum size 100 mm x 54 mm x 48 mm.

.4 Square or octagonal outlet boxes for lighting fixture outlets.

.5 Square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.3. MASONRY BOXES

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

2.4. 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. OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

.1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 75 mm x 50 mm x 63.5 mm with two double clamps to take non-metallic sheathed cables.

2.6. FITTINGS - GENERAL

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 31.75 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1. INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

.2 Section 26 05 32 – OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1.2. REFERENCES

.1 Canadian Standards Association (CSA).

- .1 CAN/CSA C22.2 No.18- Outlet Boxes, Conduit Boxes, and Fittings.
- .2 CSA C22.2 No.45- Rigid Metal Conduit.
- .3 CSA C22.2 No.56- Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- .4 CSA C22.2 No.83- Electrical Metallic Tubing.
- .5 CSA C22.2 No.211.2- Rigid PVC (Un-plasticized) Conduit.
- .6 CAN/CSA C22.2 No.227.3- Flexible Nonmetallic Tubing.
- .7 CSA C22.2 No.227.1 - Electrical Non-Metallic Tubing.

Part 2 Products

2.1. CONDUITS

.1 Rigid metal conduit: to CSA C22.2 No.45, galvanized steel or aluminum threaded.

.2 Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.

.3 Electrical metallic tubing (EMT): to CSA C22.2 No.83, with couplings.

.4 Rigid PVC conduit: to CSA C22.2 No.211.2.

.5 Flexible metal conduit: to CSA C22.2 No.56, steel or liquid-tight flexible metal.

.6 Electrical non-metallic tubing (ENT): to CSA C 22.2 No. 227, with couplings.

2.2. CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits NPS 2 and smaller. Two hole steel straps for conduits larger than NPS 2.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1 m oc.

.4 Hot dipped galvanized threaded rods, 6 mm diameter minimum, to support suspended channels.

2.3. CONDUIT FITTINGS

.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.

.2 Factory "ells" where 90 bends are required for 27mm and larger conduits when a hydraulic bender is not used.

.3 Connectors, couplings and straps for EMT conduit are to be set-screw steel type. In a sprinklered environment, provide watertight fittings and "O" rings on all vertical conduit runs or when conduit is terminated at any piece of electrical equipment.

.4 Provide plastic bushings for all connectors, rigid nipples and rigid conduit 35mm or larger.

2.4. EXPANSION FITTINGS FOR RIGID CONDUIT

.1 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.

2.5. FISH CORD

.1 Fish cord to be made of polypropylene.

Part 3 Execution

3.1. INSTALLATION

.1 All conduits on project to be surface mounted. No conduits in cast in-place concrete or in slab conduits will be allowed unless written consent is received from the Departmental Representative and Owner. Only once approved by the Departmental Representative and Owner do the clauses contained within this section and the respective sections relating to conduits in cast in-place concrete or in slab conduits apply.

.2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.3 Conceal conduits except in mechanical and electrical service rooms or in unfinished areas. Conduits to have their own support system and are to be supported independently of the ceiling grid or ceiling support system.

.4 Where vertically runs conduit passes through a slab, Contractor to provide a 100mm high concrete pad with the pad extending 100mm on all sides of the conduit.

.5 Use electrical metallic tubing (EMT) conduit except where specified otherwise.

.6 Use epoxy coated conduit in corrosive areas.

.7 Use rigid galvanized steel threaded conduit where conduit is subject to mechanical injury.

.8 Use rigid PVC conduit underground or in corrosive areas, where indicated.

.9 Use flexible metal conduit for connection to motors or vibrating equipment in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.

.10 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations. Use only liquid tight fittings when using liquid tight flexible metal conduit. Liquid tight flexible metal conduits to have a jacket with an FT6 rating when used in plenums otherwise provide a minimum FT4 rating.

.11 Install conduit sealing fittings in hazardous areas. Fill with compound.

.12 Minimum conduit size for lighting and power circuits: NPS 21mm .

.13 Install EMT conduit from a raised floor branch circuit panel to outlet boxes located in sub floor.

.14 Install EMT conduit from a raised floor branch circuit panel to junction box in sub-floor. Run flexible metal conduit from junction box to outlet boxes for equipment connections in sub-floor.

.15 Bend conduit cold. Replace conduit if kinked or flattened more than 0.1 of its original diameter.

.16 Mechanically bend steel conduit over 19 mm dia.

.17 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.18 Install fish cord in empty conduits.

.19 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.20 Dry conduits out before installing wire.

.21 All cutting and patching of masonry/concrete floors, walls, and roof for electrical services shall be by this Division. Obtain approval from Departmental Representative before cutting any structural walls or floors. Cutting and drilling shall only be at times allowed by the Landlord. Check and verify the location of existing mechanical and electrical services in walls and below the floor slab in all areas requiring core drilling and cutting. Protect all tenant areas where core drilling occurs. Carefully chip top and bottom of slab to expose rebars to minimize cutting of rebars when core drilling. Provide x-ray study before drilling or cutting where required by the Landlord and/or Departmental Representative.

.22 Provide sleeves for all new conduits passing through floor and roof slabs, beams, concrete walls and slab to slab partitions, etc.

.23 Prior to installation of any wire or cable in the ducts, pull through each duct a flexible mandrel not less than 300 mm long and size for the internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Notify the Departmental Representative no less than 48 hours prior to the event, so that the Departmental Representative may witness.

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 mounted channels.

.5 Do not pass conduits through structural members, except as indicated.

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

.7 Conduits must not be used to support other conduits.

3.3. CONDUITS IN CAST-IN-PLACE CONCRETE

.1 Locate to suit reinforcing steel. Install in centre one third of slab.

.2 Protect conduits from damage where they stub out of concrete.

.3 Install sleeves where conduits pass through slab or wall.

.4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.

.5 Do not place conduits is slabs in which slab thickness is less than 4 times conduit diameter.

.6 Encase conduits completely in concrete with minimum 25 mm concrete cover.

.7 Organize conduits in slab to minimize cross-overs.

3.4. CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

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

3.5. CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

.2 For all non-PVC conduits run underground, provide waterproof joints with heavy coat of bituminous paint.

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. DEFINITIONS

.1 Priority Two (P2) Buildings: buildings in which life safety is paramount concern. It is not necessary that P2 buildings remain operative during or after an earthquake.

.2 SRS: acronym for Seismic Restraint System.

1.3. LIMITATIONS

.1 Only one trade to be responsible for all seismic restraint systems for all electrical systems and equipment.

1.4. GENERAL DESCRIPTION

.1 This section covers design, supply and installation of complete SRS for all systems.

.2 SRS to be fully integrated into, compatible with:

.1 Noise and vibration controls specified elsewhere in this project specification.

.3 Systems, equipment not required to be operational during and after seismic event.

.4 During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position.

.5 Design to be by Professional Engineer specializing in design of SRS and registered in Province of Ontario.

1.5. REFERENCES

.1 CAN/CSA-G40.21-04, Structural Quality Steels.

.2 CAN/CSA C22.2 No. 250.0-00 , Luminaires

1.6. SUBMITTALS

.1 Submit Shop Drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.

.2 Submittals to include:

.1 Full details of design criteria.

.2 Working drawings, materials lists, schematics full specifications for all components of each SRS to be provided.

.3 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables).

.4 Separate Shop Drawings for each SRS and devices for each system, equipment.

.5 Identification of location of each device.

.6 Schedules of types of SRS equipment and devices.

.7 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.

.8 Installation procedures and instructions.

1.7. DESIGN FACTORS

.1 Za = 40.

.2 Zv = 2.0.

.3 V = 0.1.

.4 I = 1.0.

.5 F = 1.3.

.6 R = 1.3.

.7 Cp = 1.0.

Part 2 Products

2.1. SRS MANUFACTURER

.1 SRS to be from one manufacturer regularly engaged in production of same.

2.2. GENERAL

.1 SRS to provide gentle and steady cushioning action and avoid high impact loads.

.2 SRS to restrain seismic forces in all directions.

.3 Fasteners and attachment points to resist same load as seismic restraints.

.4 SRS of Conduit systems to be compatible with:

- .1 Expansion, anchoring and guiding requirements.
- .2 Equipment vibration isolation and equipment SRS.

.5 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.

.6 Attachments to RC structure:

- .1 Use high strength mechanical expansion anchors.
- .2 Drilled or power driven anchors not permitted.

.7 Seismic control measures not to interfere with integrity of firestopping.

2.3. SRS FOR STATIC EQUIPMENT, SYSTEMS

.1 Floor-mounted equipment, systems:

- .1 Anchor equipment to equipment supports.
- .2 Anchor equipment supports to structure.
- .3 Use size of bolts scheduled in approved Shop Drawings.

.2 Suspended equipment, systems:

- .1 Use one or combination of following methods:
  - .1 Install tight to structure.
  - .2 Cross-brace in all directions.
  - .3 Brace back to structure.
  - .4 Slack cable restraint system.
    - .1 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
    - .2 Hanger rods to withstand compressive loading and buckling.

2.4. SRS FOR VIBRATION ISOLATED EQUIPMENT

.1 Floor mounted equipment, systems:

.1 Use one or combination of following methods:

.1 Vibration isolators with built-in snubbers.

.2 Vibration isolators and separate snubbers.

.3 Built-up snubber system approved by Engineer, consisting of structural elements and elastomeric layer.

.2 SRS to resist complete isolator unloading.

.3 SRS not to jeopardize noise and vibration isolation systems. Provide 4 mm – 8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.

.4 Cushioning action to be gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.

.2 Suspended equipment, systems:

.1 Use one or combination of following methods:

.1 Slack cable restraint system.

.2 Brace back to structure via vibration isolators and snubbers.

2.5. SLACK CABLE RESTRAINT SYSTEM (SCS)

.1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.

.2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.

.3 Hanger rods to withstand compressive loading and buckling.

Part 3 Execution

3.1. INSTALLATION

.1 Attachment point and fasteners:

.1 To withstand same maximum load that seismic restraint is to resist and in all directions.

.2 Slack Cable Systems (SCS):

.1 Connect to suspended equipment so that axial projection of wire passes through center of gravity of equipment.

.2 Use appropriate grommets, shackles, and other hardware to ensure alignment of restraints and to avoid bending of cables at connections points.

.3 Conduit systems: provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.

.4 Small conduits may be rigidly secured to larger pipes for restraint purposes, but not reverse.

.5 Orient restraint wires on ceiling hung equipment at approximately 90° to each other (in plan), tie back to structure at maximum of 45° to structure.

.6 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.

.7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.

.3 Install SRS at least 25 mm from all other equipment, systems, and services.

.4 Co-ordinate connections with all disciplines.

3.2. SEISMIC

.1 Conduit:

.1 All conduits greater than 64 mm in diameter.

.2 All conduits suspended by individual hangers 300 mm or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 300 mm limit is exceeded by any hanger in the run, seismic bracing is required for the run.

.3 The 300 mm exemption applies for trapeze supported systems if the top of each item supported by trapeze qualifies. Structural connections must be a non-friction connection (no "C" clamps).

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

Part 2 Products

2.1. EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates and labels as follows:

.1 Nameplates:

.1 Lamacoid 3 mm thick plastic engraved sheet, black or red face, white core, mechanically attached with self tapping screws.

.2 White letters 20 mm high for major switchboards, panelboards and power transformers.

.3 White letters 12 mm high for terminal boxes, junction boxes, grid boxes, splitter boxes, disconnect switches starters and contactors.

.4 Allow for an average of twenty-five (25) letters per nameplate.

.5 Identification to be in English.

.6 Black nameplates for normal power.

Sample:

SWITCHBOARD AA
1200A, 13.8kV, 3 PH, 3W
FED FROM TRANSFORMER

.2 Labels:

.1 Embossed plastic labels with 6 mm high letters unless specified otherwise, for internal components, such as relays, fuses, terminal blocks.

.2 Wording on nameplates to be approved by Departmental Representative prior to manufacture.

.3 Identification to be in English.

.4 Nameplates for terminal cabinets, grid boxes pull boxes, and junction boxes are to indicate the system and/or voltage characteristics.

.5 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.6 Transformers: indicate capacity, primary and secondary voltages.

.2 Equipment identification to be permanently fastened to the respective equipment with rivets.

2.2. WIRING IDENTIFICATION

.1 Identify wiring with permanent legible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code: to CSA C22.1-1998.

.4 Use colour coded wires in communication cables and control wiring, matched throughout system.

2.3. CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Colour
up to 250 V Normal Power	Green
up to 600 V Normal Power	Blue
Medium Voltage	Large independent label clearly identifying the voltage
Telephone/Data	White
Controls	Purple

2.4. RECEPTACLE IDENTIFICATION

.1 All receptacles are to be labelled with the respective circuit numbers with a printed label, similar to a Brady label, with 12mm characters. Circuit number to include full circuit number including panel board identification.

.2 Label to be placed on wall above cover plate or on cover plate. Location of label to be consistent throughout project.

2.5. WIRING TERMINATION

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

.2 Lugs, terminals, screws used for termination of multiple wires must be rated for their intended use.

2.6. MANUFACTURERS AND CSA LABELS

.1 Visible and legible after equipment is installed.

2.7. WARNING SIGNS

.1 Provide warning signs, as specified, and/or to meet the requirements of the Inspection Authorities.

2.8. FUSE SIZE LABELLING

.1 Contractor to install a label on all equipment with fuses to identify the fuse sizes that are installed in the respective equipment.

.2 Contractor to also install a label on all equipment with fuses to identify the maximum allowable fuse size based on the size of the respective feeders.

Part 3 Execution

3.1. NOT USED

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS and Section 01 00 10 – General Instructions.

1.2. SUMMARY

.1 The electrical power system studies for the project shall be performed by an approved electrical power systems contractor. The type and content of each study is specified in the following articles.

.2 The extent of the power systems studies shall include MV equipment shown on drawings.

.3 Contractor to label and re-label with the appropriate Client approved label all equipment that is new or the calculated values have changed from what is currently shown.

1.3. SUBMITTALS

.1 Completed electrical power system studies shall be bound and submitted to the Departmental Representative. The study must be stamped and signed by a P. Eng.

.2 Contractor providing electrical power systems study to allow for revisions/adjustments passed on review and actual transformer impedances.

.3 Provide a minimum of three (3) bound coloured copies to Departmental Representative for review. Modify studies based on comments received and continue to re-issue until a final version is agreed upon.

.4 Provide a copy of the working electronic file on a CD along with each of the final copies of the studies. Identify what software was used to complete the studies. The information contained within the project file remains the property of the crown and can be used by the for future system modifications.

.5 Provide samples of the proposed arc flash labels for approval.

Part 2 Products

2.1. ELECTRICAL POWER SYSTEM STUDIES

.1 Short-Circuit Analysis:

.1 Calculation of maximum rms symmetrical three-phase short-circuits and single-line to ground fault current at each significant location in the electrical system shall be made using a digital computer.

.2 Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.

.3 A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.

.4 The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

.5 Include a computer printout identifying the maximum available short-circuit current in rms symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.

.6 The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.

.7 A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for the improvements to the system.

.8 The contractor shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.

.9 Any inadequacies shall be called to the attention of the Departmental Representative and recommendations made for improvements as soon as they are identified.

.2 Protective Device Time-Current Coordination Analysis

.1 The time-current coordination analysis shall be performed with the aid of a digital computer and will include the determination of settings, ratings, or types for the over-current protective devices supplied.

.2 A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected over-current devices and other pertinent system parameters.

.3 Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

.4 The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable over-current protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.

.5 A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.

.6 A discussion section which evaluates the degree of system protection and service continuity with over-current devices, along with recommendations as required for increasing system protection or device coordination.

.7 Significant deficiencies in protection and/or coordination shall be called to the attention of the Departmental Representative and recommendations made for improvements as soon as they are identified.

.3 Power Factor Correction Study

.1 A Power Factor Correction Study shall be performed to determine the appropriate level of compensation needed to achieve the desired power factor.

.2 Impacts on harmonic and transient concerns shall be evaluated in order to determine the optimum size and configuration of the equipment.

.3 The study shall make appropriate recommendations in order to provide proper operation of the electrical system.

.4 The study shall be based on load data collected from onsite measurements and from previous utility bills in order to characterize the power factor of the system over a period of time and under varying load conditions.

.5 System loading tables shall be provided which include power factor data and estimated levels of power factor compensation provided.

.6 Evaluation of system operation using the estimated levels of compensation will be provided with consideration to harmonic and transient concerns.

.7 Final levels of compensation will be determined and used as the base case condition for the harmonic and transient studies.

.8 All conclusions, recommendations, and equipment specifications as a result of the Power Factor Correction Study will be summarized in the final report.

.4 Arc Flash/Incident Energy Study

.1 An Arc Flash/Incident Energy Study shall be performed to determine the incident energy and arc flash protection boundary at each piece of electrical equipment and to identify the level of PPE required by people working on that respective equipment.

.2 All equipment rated at 208V fed from a transformer less than 125kVA are not required to be included in the study. Equipment not included in the study is to receive a common arc-flash label that does not include equipment specific data.

.3 The study shall take into account all the information set forth in the short circuit study and the coordination study. Contractor to use the minimum and maximum fault currents provided by the utility to determine the worst incident energy levels. Provide two columns in your arc flash summary sheet identifying the current at both fault levels. Contractor to revisit the coordination study and revise coordination to provide the minimum incident energy levels as possible. Provide recommendations to reduce the incident energy levels even further at the risk of affecting the coordination to allow Departmental Representative to review options and provide feedback.

.4 Calculate the arc flash hazard, incident energy level and the flash protection boundary as per IEEE 1584. PPE level recommendations as per NFPA 70E.

.5 All electrical equipment to be identified with the incident energy, flash protection boundary and level of PPE required.

.6 Purpose made labels to be provided on all electrical equipment. All equipment where levels where not calculated are to be provided with a standard warning label. Label samples to be submitted for review by Departmental Representative.

Part 3 Execution

3.1. GENERAL

.1 Contractor to include for all on site surveys and investigations in order obtain all the relevant information to complete all the studies.

.2 The relays and equipment will be set up on site by the Technical Start-Up Services Contractor. Coordinate with this Contractor to ensure information is relayed accordingly.

.3 Review work on site to ensure equipment has been set up as per the coordination study. Have the Technical Services Start-up Contractor test systems at random to ensure the coordination study has been adhered to.

.4 Submit a report and a letter reporting that the coordination study information has been followed.

.5 Contractor to revise fuse sizes as identified in the report and modify the drawings to represent as-built conditions.

3.2. LABELLING

.1 Install arc flash labels on all equipment. Coordinate with the electrical contractor.

3.3. TRAINING

.1 Provide a one day of in-depth training on arc-flash safety detailing the industry and code requirements including the details of the specific project for the department representatives.

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

Part 2 Products

2.1. MATERIALS

.1 Sleeves passing through masonry walls shall be Schedule 40 steel pipe.

.2 Sleeves passing through floors in finished areas and concealed spaces may be sheet metal or factory fabricated reusable type.

.3 Where a housekeeping pad cannot be installed, sleeves passing through floors with waterproof membrane shall have a flashing collar, 50 mm wide at the membrane level. Flashing collar shall be continuously welded to sleeve. Sleeves shall extend 50 mm above the finished floor and shall be Schedule 40 steel pipe.

.4 Where conduits pass through exterior foundation walls 6 mm thick steel sleeve of inside diameter not less the 75 mm greater than the outside diameter of the pipe shall be used and shall be complete with anchor collar. A reinforced concrete bridge shall be installed between the wall and the adjacent undisturbed soil.

.5 Provide adequate bracing for support of sleeves during concrete and masonry work.

Part 3 Execution

3.1. INSTALLATION

.1 Arrange for all chases and formed openings in walls and floors as required. These chases and openings shall not be larger than necessary to accommodate the equipment and services. Advise on these requirements well in advance, before the concrete is poured and the walls are built. All necessary sleeves and inserts shall be supplied by the electrical contractor.

.2 Chases and openings not located in accordance with the above provisions shall be made at the expense of the electrical contractor. Cutting of structural members shall not be permitted without specified written acceptance of the Departmental Representative.

.3 Provide sleeves for all service penetrations through walls, partitions, floor slabs, plenums and similar barriers. At non-rated barriers fill the annular space between the service and the sleeve with fire rated insulation as specified for rated separations and caulk around the edges with a minimum 12 mm thick of fire rated compound or acoustic non-setting mastic.

.4 Through all fire or smoke separations, after testing, the annular space between conduit sleeves shall be fire stopped.

.5 Where holes are to be installed in existing structure, contractor is to core drill the holes required. Contractor is required to scan all areas prior to coring and confirm layout with structural engineer prior to completing work. When installing sleeves in existing structures, sleeves shall be provided as specified complete with a combination puddle/anchor flange bolted to the floor. Seal watertight between the flange and the floor.

.6 All sleeves are to extend 100mm above finished floor to accommodate a 100mm concrete pad. Contractor to pour the concrete pad with the pad extending 100mm on all sides of the sleeve.

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

.2 Include for all cutting and patching for all Electrical services.

Part 2 Products

2.1. MATERIALS

.1 All services and materials used for the cutting and patching shall meet all requirements specified in Section 01 73 00, and shall be carried out by experienced workers.

Part 3 Execution

3.1. INSTALLATION

.1 Cut all openings no larger than is required for the services. Core drill for individual services.

.2 Obtain approval from Departmental Representative before cutting or core drilling any openings or holes.

.3 Patch all openings after services have been installed to match the surrounding finishes.

.4 In existing areas all cutting, except for core drilling for individual services or where specifically noted, is part of this division work.

.5 The cost of cutting, patching and finishing is included in this division contract.

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

.2 Section 26 05 73 – ELECTRICAL POWER SYSTEM STUDIES.

.3 Section 26 05 14 – POWER CABLE AND OVERHEAD CONDUCTORS

.4 Section 26 05 26 – GROUNDING AND BONDING

.5 Section 26 13 13 – METAL CLAD SWITCHGEAR

.6 Section 26 27 02 – SURGE PROTECTION DEVICE

1.2. REFERENCE

.1 ANSI/NETA MTS-2007 - Standard For Maintenance Testing Specifications For Electrical Power Distribution Equipment And Systems

1.3. OVERVIEW

.1 As part of this project, start up services will be performed on the electrical distribution and control equipment as specified. This specification is intended as a part of the electrical portion of this project.

.2 The start-up service company must follow jobsite electrical safety requirements, installation standards and electrical testing standards.

.3 Documentation of all procedures performed shall be provided. 3 copies shall be provided and forwarded to the Departmental representative. Written documentation must contain recorded test values of all electrical tests performed per the individual product specification.

.4 Start-up service scheduling must be available through a 24 hour, toll free national dispatch system.

.5 The start-up service company shall be present during energization of the distribution equipment. Jobsite and equipment access must be provided by the electrical contractor.

.6 The contractor shall supply a power source, specified by the start-up service company, for on-site test equipment.

.7 The contractor is to attend all factory witness testing required within the respective specification sections. The contractor is responsible to cover all their costs and include them in their bid.

.8 The contractor is to set-up and tests all devices as defined in the reports produced under specification Section 26 05 73 – ELECTRICAL POWER SYSTEM STUDIES.

Part 2 Products

2.1. GENERAL

.1 Conduct the following tests, at time suitable to Manufacturer representative, with Departmental representative present as witness.

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

2.2. INSPECTION AND TEST PROCEDURES

.1 Perform all testing identified in the ANSI/NETA MTS-2007 standard in addition to the following tests.

.2 Switchgear and Switchboard Assemblies

.1 Visual and Mechanical Inspection

.1 Assemblies shall be inspected for physical damage.

.2 Bussing compartment inspection shall include the following:

.1 Check tightness of accessible bolted bus joints by torque wrench method.

.2 Check insulators for cracks and contamination.

.3 All electrical, key, and mechanical interlock systems shall be verified for correct operation.

.4 Closure shall be attempted on locked open devices. Opening/withdrawal attempt shall be made on locked closed devices.

.5 Mechanical operations of circuit breaker in cell shall be checked and auxiliary devices activated.

.6 Drawout trays, contact alignment, ease of operation, proper grounding, and interlocks shall be checked.

.7 Circuit breaker cell shall be inspected for contamination, physical damage, loose hardware, shutter mechanism, control plug, guide rail, floor nameplates, ground bus, auxiliary contacts, and linkages.

.8 Circuit breaker shall be inspected for contamination, physical damage, main finger/stab penetration and secondary connections.

.2 Electrical Tests

.1 Insulation resistance of each bus section shall be measured phase-to-phase and phase-to-ground.

.2 Over potential test shall be performed for each bus section, phase-to-phase and phase-to-ground for medium voltage equipment,

.3 Electrical operation of the circuit breaker shall be checked in the test and connected position.

.4 The control power source shall be checked.

.5 The circuit breaker control scheme shall be tested.

.6 A phasing check shall be made on double-ended and/or emergency source switchgear at tie points to ensure correct bus phasing.

.3 Test Values

.1 Bolt torque levels are checked in accordance with manufacturer's specifications.

.2 Insulation resistance testing is to be performed in accordance with the manufacturer's recommendations.

.3 Power Circuit Breakers

.1 Visual and Mechanical Inspection.

.1 Check mechanical operation.

.2 Cell fit and element alignments are checked.

.3 Bolt torque levels are checked in accordance with CSA Standards or manufacturer's specifications.

.4 Check arc chutes for foreign matter, cracks and secure installation.

.5 Clean primary contact surfaces and lubricate if required.

.2 Electrical Tests

.1 Contact resistance is measured.

.2 Insulation resistance is checked at 1000 VDC for one (1) minute from pole to pole and from each pole to ground and across open contacts of each phase.

.3 Minimum long-time pick-up current is determined when possible; delay time is determined at 300% of pick-up by secondary injection.

.4 Short-time pick-up and time delay is determined by secondary injection.

.5 Instantaneous pick-up current is determined by secondary injection.

.6 Ground-fault pick-up current and delay is determined by secondary injection.

.7 Trip unit reset characteristics are verified.

.8 Final settings are made in accordance with Manufacturer representative prescribed settings.

.9 Auxiliary devices, such as under voltage relays, blown main fuse detector, shunt close, shunt trip, spring charging motor and auxiliary contacts are activated to ensure operation as applicable.

.10 All functions of the trip units will be tested with test kits.

.11 Secondary Current Injection shall be performed on the power circuits.

.4 Air Switches-Low and Medium Voltage

.1 Visual and Mechanical Inspection

.1 Inspect the switch for physical damage, proper installation, anchorage, and grounding.

.2 Inspect interior insulation arc chutes and interphase barriers.

.3 Perform mechanical operator tests. Clean and lubricate as necessary.

.4 Check blade alignment and arc interrupter operation.

.5 Check fuse linkage and element for proper holder and current rating. Record fuse data.

.6 Check key interlock for safe operation and proper key distribution.

.2 Electrical Tests

.1 Over potential test voltages are applied phase-to-phase and phase-to-ground.

.2 Contact resistance is measured across each switch blade and fuse line, measured in micro-ohms.

.3 Perform insulation resistance test on each phase-to-ground and from phase-to-phase.

.5 Protective Relays

.1 Visual and Mechanical Inspection

.1 Inspect relays for physical damage, presence of foreign material and moisture.

.2 Check conditions of spiral spring, disc clearance and corrosion (if present). Inspect cover glass interior and relay components.

.3 Check for mechanical freedom of movement, proper travel and alignment, and tightness of mounting hardware and tap screws.

.2 Electrical Tests

.1 This test is only performed on wiring to non-solid state relays

.2 The following tests are performed at settings specified by the Manufacturer representative:

.1 Pickup parameters on each operating element.

.2 Timing at three (3) points on the time dial curve.

.3 Pickup target and seal in units.

.4 Operation of restraint, directional, and other elements are checked as required.

.3 Phase angle and magnitude contribution tests are performed on all differential and directional type relays after energization to vectorially prove proper polarity and connection.

.6 Instrument Transformers

.1 Visual and Mechanical Inspection

.1 Inspect for physical damage and compliance with single-line diagram.

.2 Check mechanical clearance and proper operation of all disconnecting and grounding devices.

.3 Verify proper operation of grounding or shorting devices.

.2 Electrical Tests

.1 Current transformer ratio is measured by primary current injection, or voltage method.

.2 Potential transformer ratio is measured.

.3 Insulation resistance is measured primary to ground, secondary to ground, and primary to secondary.

.4 Secondary wiring connections are verified by secondary current injection.

.5 Transformer polarity markings are verified.

.7 Grounding Systems

.1 Visual and Mechanical Inspection.

.1 Inspect ground system for compliance with plans and specifications.

.2 Electrical Tests.

.1 The fall of potential test is performed per IEEE Standard No. 81, Section 9.04 on the main ground electrode or system.

.2 The two (2) point method test is performed per IEEE Standard No. 8`, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and/or derived neutral points.

.8 Ground Fault Systems (NEC 230-95)

.1 Visual and Mechanical Inspection.

.1 Monitor panels (if present) shall be manually operated for both trip test and no trip test.

.2 Electrical Tests.

.1 System neutral insulation resistance is measured to insure no shunt ground paths exist. The neutral ground disconnect link is removed, neutral insulation resistance measured and the link replaced.

.2 The relay pickup current is determined by primary injection at the sensor and the circuit interrupting device operated.

.3 The relay timing is tested by injecting one hundred fifty percent (150%) and three hundred percent (300%) of pickup current into sensor. Total trip time is electrically monitored.

.4 Zone interlock systems are tested by simultaneous sensor current injection and monitoring zone blocking function.

.5 Verify that system will operate at 57% rated control voltage (if applicable).

.3 Test Parameters.

.1 System neutral insulation resistance will be a minimum of preferably one (1) megohm or greater.

.2 Relay pickup current will be within ten percent (10%) of device dial or fixed setting, and in no case greater than twelve hundred (1200) amperes.

.3 Relay timing will be in accordance with published time-current characteristic curves, but in no case longer than one (1) second.

.9 Metering and Instrumentation.

.1 Visual and Mechanical Inspection.

.1 Verify meter connections in accordance with single-line meter and relay diagram.

.2 Inspect for physical damage.

.2 Electrical Tests.

.1 Ammeter accuracy is checked using current injection.

.2 Voltmeter accuracy checked.

.10 Cables-Medium Voltage

.1 Visual and Mechanical Inspection

.1 Inspect exposed cable section for tracking corona or physical damage.

.2 Inspect shield grounding, cable support, and termination.

.3 Apply grounds upon completion to drain all absorbed potential to zero volts.

.2 Pre-acceptance tests:

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 10000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.3 Verify phasing of cabling.

.3 Acceptance Tests:

.1 Electrical Tests (New continuous cable i.e. Not spliced to old cable)

.1 A dc hi-potential to be applied in at least five (5) equal increments until maximum test voltage is reached. DC leakage current to be recorded at each step after a constant stabilization time, consistent with system charging current delay.

.2 Perform shield continuity test.

.3 Terminations to be corona suppressed by guard ring, field reduction sphere or other suitable methods.

.4 Each conductor to be individually tested with all other conductors grounded. All shields are to be grounded.

.5 Perform dc hi-potential test using step voltage method. Maximum test voltage shall be in accordance to the ICEA and manufacturer's recommended levels.

.2 Existing Cables

.1 Existing cables insulation resistance to be tested using a 10kV megger before cables are cut into for splicing and again after splicing of new cables is complete prior to re-energization.

2.3. INFRARED SCANNING

.1 Two months after the occupancy of the building by the Contractor is to infrared scan all new equipment installed.

.2 Contractor to re-scan the entire electrical distribution system up to and including all panelboards two months prior to the completion of the warranty period.

.3 Contractor to use current infrared detection technology.

.4 Contractor is to provide a complete report, identifying areas of concern. Contractor to provide copies of all infrared video taken on DVDs to the Departmental Representative for their records.

.5 Electrical Contractor is to repair any loose connection/terminations or replace any faulty equipment under warranty.

2.4. REPORTS

.1 Provide Departmental Representative with list of test results showing location at which each test was made, circuit tested and result of each test.

.2 Technical Start-up Contractor shall submit to the Departmental Representative a report, in addition to the test reports, summarizing their acceptance that all tests were completed to the satisfaction of the Technical Start-up Contractor following each factory witness test and each on-site test. Append all factory test repots as an appendix to this report.

.3 Manufacturer is responsible to cover all costs incurred due to failure of equipment during factory testing, including but not limited to, additional travel and accommodation expenses and extra time to witness tests.

.4 Assemble all testing results into a common binder and organize based on specification sections. Include all manufacturer testing results. Submit 3 copies of this manual along with the Operation and Maintenance manuals.

Part 3 Execution

3.1. NOT USED

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS and Section 01 00 10 – General Instructions.

1.2. SYSTEM DESCRIPTION

.1 Furnish and install a complete Power & Energy Monitoring System (PMS) as described in this specification. The system is defined to include, but not be limited to, remote devices for monitoring, device communication interface hardware, inter-communication wiring and ancillary equipment .The manufacturer shall demonstrate the system is not a prototype and that similar systems have been field installed and successfully operated for at least five years.

.2 The PMS shall interconnect all meters, electronic trip units, transformer temperature monitors, motor protection devices, and digital relays, included within the new power equipment and the existing devices shown on the drawings that have the capability to communicate through the network.

.3 The PMS shall utilize Ethernet as the high-speed backbone network that supports view of all the information through a web-based interface.

1.3. REFERENCES

.1 All Power Meters and Circuit Monitors shall be UL 508 Listed; CSA approved, and have CE marking. They shall also have certified revenue accuracy as per ANSI C12.16.

.2 The system shall comply with the applicable portions of NEMA standards. In addition, the control unit shall comply with FCC Emission Standards specified in Part 15, Sub-part J for Class A application.

1.4. SUBMITTALS

.1 Indicate electrical characteristics and connection requirements. When the power equipment manufacturer installs PMS components, the power equipment shop drawings shall clearly identify the components, the internal connections, and all contractor connections.

.2 The PMS drawings shall show all PMS components including necessary component dimensions; type, size, and weight, as well as, a single line diagram indicating external wiring requirements. Drawings shall identify terminal blocks used for interconnections and wire type to be used.

.3 Product Data: Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.

1.5. QUALITY

.1 Power monitoring components included within the power equipment lineups shall be factory installed, wired and tested prior to shipment to the job site.

Part 2 Products

2.1. ADVANCED METER

.1 The Advanced Meter shall be installed as part of a power monitoring system as indicated on the drawings.

.2 The Advanced Meter shall communicate using MODBUS protocol over serial or TCP networks.

.3 The Advanced Meter shall be compatible with and configurable for use with embedded HTML pages installed in Ethernet cards or gateways as part of the overall power monitoring and system network.

.4 The advanced meter shall be installed on the feeder circuits on the main switchgear as indicated and for the distribution panels as indicated on the drawings.

2.2. POWER QUALITY METER

.1 The Power Quality Meter shall be installed as part of a power monitoring system as indicated on the drawings.

.2 The Power Quality Meter shall communicate using MODBUS protocol over serial or TCP networks.

.3 The Power Quality Meter shall be compatible with and configurable for use with embedded HTML pages installed in Ethernet cards or gateways as part of the overall power monitoring system network.

.4 Power quality meter shall be installed on the main breakers of normal switchboard/switchgear.

2.3. ETHERNET CONNECTIVITY AND WEB ENABLING

.1 Basic Ethernet Card

.1 The basic ethernet card shall have an embedded web server inside the unit, capable of serving HTML pages with dynamic meter data displays.

.2 It shall connect to the Ethernet backbone via standard RJ-45 port for connection of unshielded twisted pair cable (UTP) or LC fiber optic connection for multimode fiber (100BaseFX).

.3 It shall support all meters and other MODBUS devices through one 2 wires or 4-wires RS-485 communication port via standard daisy-chain connections. The RS-485 serial port shall operate up to 38.4k baud.

.4 It shall be fully TCP/IP compliant thereby allowing the power monitoring software access to power monitoring information from anywhere on the local area network (LAN) or via the Wide Area Network (WAN).

.5 It shall derive control power directly from the power quality meter.

.2 Advanced Ethernet Gateway

.1 Advanced Ethernet Gateway shall have an embedded web server inside the unit, capable of serving HTML pages with dynamic meter data displays and logging data.

.2 It shall be capable of accepting HTML files PDF files, ActiveX CRG, GIF, JPG graphics, MS Office files (doc, xls, ppt, etc.).

.3 It shall feature one 10/100 Mbit UTP port.

.4 It shall feature 16 MB of internal memory.

.5 It shall support all meters and other MODBUS devices through one 2-wire or 4-wire RS-485 communication port via standard daisy-chain connections.

.6 It shall feature one RS-485 serial port and a second port configurable for RS-232 or RS-485 (support for 2-wire or 4-wire).

.7 It shall be assigned a single IP address, and provide high speed Ethernet support for up to 192 devices.

.8 It shall be compatible with Ethernet TCP/IP networks and allows users to access power monitoring information from any location on a local area network (LAN) or a wide area network (WAN).

.9 It shall also be possible via the Ethernet port to upgrade the firmware of the Ethernet communication card in the field to accommodate new system features.

2.4. EMBEDDED WEB PAGES

.1 Embedded WEB Pages shall be provided for any Basic Ethernet Cards or Advanced Ethernet Gateways and for the devices connected to them. Where applicable to certain device types, the WEB pages shall include the following:

.1 Energy and Power Summary with Trending and Period Comparisons.

.2 Power Quality Summary with Trending and Comparisons.

.3 Harmonics and Power Flow Summary.

.4 Voltage Disturbance, Transient, and Flicker Summaries.

.5 Alarm Summary with Trending and Period Comparisons.

.6 ITIC/SEMI and Motor Derating Curves.

.7 Real-time Trending with Forecasting.

.8 Real Time Energy Cost Summary Worksheet.

.9 EN50160 and IEEE519 Power Quality Index Tables, Trends and Summary Alarms.

2.5. COMMUNICATIONS TO THE BUILDING AUTOMATION SYSTEM

.1 Provide gateway to communicate to building automation system using Modbus RTU protocol to access metering data by building automation vendor.

Part 3 Execution

3.1. ETHERNET GATEWAYS

.1 Contractor interconnection wiring requirements shall be clearly identified on the PMS system drawings.

.2 Advanced Ethernet gateways are to be used when meters and other components on the system do not contain internal memory.

.3 Provide adequate internal memory to store historic data for a minimum of 30 days for all meters.

3.2. SYSTEM START-UP AND TRAINING

.1 On-site start-up and training of the PMS shall be included in the project bid.

.2 Start-up shall include a complete working demonstration of the PMS with simulation of possible operating conditions that may be encountered.

.3 Training shall include any documentation and hands-on exercises necessary to enable electrical operations personnel to assume full operating responsibility for the PMS after completion of the training period.

.4 The project bid shall include 2 days start-up assistance and 2 days training to include 3 separate trips.

3.3. DESIGN SERVICES

.1 The power monitoring system vendor shall make all alterations and changes needed to make the system perform as needed at each location. These changes may include:

.1 Custom enclosures and panels.

.2 Modifications to existing switchgear and equipment, including installation.

.3 Communication interface installation and configuration.

.4 Communication network design.

.2 The power monitoring system vendor to provide development, integration, and installation services required to complete and turn over a fully functional system. This shall include, but not limited to:

.1 All technical coordination, installation, integration and testing of all components.

.2 Detailed system design, including a full design of the proposed web interface in conjunction with Departmental Representative.

.3 System drawings.

3.4. INSTALLATION

.1 PMS components, including meters, electronic trip units, transformer temperature monitors, motor protection devices, and digital relays, included within the power equipment lineups shall be factory installed, wired and tested prior to shipment to the job site.

.2 All control power, CT, PT and data communications wire shall be factory wired and harnessed within the equipment enclosure.

.3 Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.

3.5. WIRING

.1 The electrical contractor shall install all wiring required to externally connect equipment lineups, external meters and any other wiring as required by the PMS vendor including all RS 485 communications network loops and Ethernet communications wiring to meters.

.2 All wiring external to equipment is to be run in conduit.

END OF SECTION

Part 1 General

1.1. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS and Section 01 00 10 – General Instructions.

1.2. REFERENCES

.1 Ontario Electrical Safety Code.

.2 Local Utility Standard for Customer Owned Substations.

.3 CSA C22.2 No. 31-M89.

.4 Seismic compliance: UBC Zone 4 and CBC Title 24.

.5 ANSI/IEEE C37.20.2 - Standard for Metal-Clad Switchgear.

.6 ANSI/IEEE C37.04 and .06 - Standard ratings and preferred ratings for Indoor AC Medium-Voltage Circuit Breakers used in Metal-Clad Switchgear.

.7 ANSI/IEEE C37.11 - Requirements for electrical control for AC High-Voltage Circuit Breakers rated on a symmetrical current basis or a total current basis.

.8 ANSI/IEEE C37.09 - Standard Design and Production Testing.

.9 ANSI Z55.1 - Gray Finishes for Industrial Apparatus and Equipment.

.10 ANSI/IEEE C57.13 - Requirements for Instrument Transformers.

.11 NEMA SG4 - Alternating Current High Voltage Circuit Breakers.

.12 NEMA SG5 - Power Switchgear Assemblies.

1.3. SUBMITTALS

.1 Submit Shop Drawings as follows::

- .1 Outline dimensions
- .2 Enclosure construction
- .3 Shipping splits
- .4 Lifting and supporting points
- .5 Front view elevation
- .6 Floor plan
- .7 Top view
- .8 Single line diagram
- .9 Nameplate schedule

.10 Component list

.11 Conduit entry/exit locations

.12 Assembly ratings including: short-circuit rating, voltage, continuous current, basic impulse level for equipment over 600 volts

.13 Major component ratings including: Voltage, Continuous current, Interrupting ratings

.14 Cable terminal sizes

.15 Product data sheets

.16 Automatic transfer scheme drawing and sequence of operations

.17 Wiring diagrams

.18 Certified production test reports

.19 Installation information including equipment anchorage provisions

.20 Seismic certification

1.4. QUALITY ASSURANCE

.1 Manufacturer: Company specializing in medium voltage metal-clad switchgear with at least fifteen years in business. The manufacturer of the switchgear must be the same as the manufacturer of the circuit breaker.

.2 Provide Seismic qualified equipment as follows:

.1 The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of current NBC and OBC. Equipment certification acceptance criteria shall be based upon the ability for the equipment to be returned to service immediately after a seismic event within the above requirements without the need for repairs.

.2 The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.

.3 The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil Eng. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.

.4 The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

.5 The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.5. DELIVERY, STORAGE, AND HANDLING

.1 Manufacturer responsible to ship product to site once approval to ship has been given by the technical services start-up contractor.

.2 Contractor to accept equipment on site and inspect for shipping damage.

.3 Contractor to protect equipment from weather and moisture by covering with heavy plastic or canvas and by maintaining heat within enclosure in accordance with manufacturer's instructions.

1.6. EXTRA MATERIALS/ACCESSORIES

.1 For all switchgear with circuit breakers provide one circuit breaker lifting device - portable, floor-supported with a roller base. All four wheels are to be swivelling type to allow the lifting device to me moved in any direction.

.2 Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

.3 The switchgear manufacturer shall furnish accessories for test, inspection, maintenance and operation, including:

.4 One – Maintenance tool for manually charging the breaker closing spring and manually opening the shutter

.5 One – Levering crank for moving the breaker between test and connected positions

.6 One – Test jumper for electrically operating the breaker while out of its compartment

.7 One – Breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails, when applicable

.8 One – Set of rail extensions and rail clamps, when applicable

.9 One – Portable lifting device for lifting the breaker on or off the rails 15 kV only

.10 One – Test cabinet for testing electrically operated breakers outside housing

.11 One – Manual Ground and Test device, 1200/2000 A

.12 One – Electrical Ground and Test device with upper terminals, 1200/2000 A

.13 One – Electrical Ground and Test device with lower terminals, 1200/2000 A

Part 2 Products

2.1. METAL-CLAD SWITCHGEAR ASSEMBLY

.1 The metal-clad switchgear shall consist of an indoor enclosure containing circuit breakers and the necessary accessory components all factory assembled (except for necessary shipping splits) and operationally checked.

.2 The assembly shall be a self-supporting and floor mounted on a level concrete pad. The integrated switchgear assembly shall withstand the effects of closing, carrying and interrupting currents up to the assigned maximum short circuit rating.

.3 System Voltage: 13.8 kV nominal, three-phase grounded, 60 Hz.

.4 Maximum Design Voltage: 15kV.

.5 Impulse Withstand (Basic Impulse Level): 90 kV.

.6 Power Frequency Withstand: 60 kV, 1 minute test.

.7 Main Bus Ampacity: 1200Amps, continuous.

.8 Momentary Current Ratings: Equal to the circuit breaker close and latch rating.

.9 System to be solidly grounded.

.10 Short Circuit Rating: 25kA rms

2.2. COMPONENTS

.1 Stationary Structure

.1 The switchgear shall consist of sections required to achieve design noted on drawings that includes breaker compartments and auxiliary compartments assembled to form a rigid self-supporting completely enclosed structure providing steel barriers between sections.

.2 The sections are divided by metal barriers into the following separate compartments:

.1 Circuit breaker, instrument, main bus, auxiliary device and cable. Each feeder section may have up to two circuit breaker compartments.

.3 Circuit Breaker Compartment

.1 Each circuit breaker compartment shall be designed to house a horizontal draw out metal-clad vacuum circuit breaker. The stationary primary disconnecting contacts are to be silver-plated copper and mounted within porcelain support bushings. The movable contacts and springs shall be mounted on the circuit breaker element for ease of inspection/maintenance.

.2 Entrance to the stationary primary disconnecting contacts shall be automatically covered by metal shutters when the circuit breaker is withdrawn from the connected position to the test or disconnected position or removed from the circuit breaker compartment.

.3 Extend a ground bus into the circuit breaker compartment to automatically ground the breaker frame with high-current spring type grounding contacts located on the breaker chassis when in the test and connected positions.

.4 Guide rails for positioning the circuit breaker and all other necessary hardware are to be an integral part of the circuit breaker compartment.

.5 Blocking devices shall interlock breaker frame sizes to prevent installation of a lower ampere rating or interrupting capacity element into a compartment designed for one of a higher rating.

.6 It shall be possible with indoor switchgear to install a circuit breaker into a bottom compartment without use of a transport truck or lift device.

.4 Cable Compartment/Ground Bus

.1 Two hole long barrel compression type cable lugs shall be furnished for all cable terminations shown on drawings.

.2 The ground bus shall extend through this compartment for the full length of the switchgear.

.3 Auxiliary bus, if needed, and load bus support NEMA Class A-20 standoff insulators shall be epoxy.

.4 Provide insulated ground studs on each phase at each cable connection point.

.5 Main Bus Compartment

.1 The main bus shall be copper with fluidized bed epoxy flame-retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, glass polyester for 15kV class. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Main bus for 15 kV shall be rated 1200 amperes. Insulated copper main bus shall be provided and have provisions for future extension. All bus joints shall be plated, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.

.2 A copper ground bus shall extend the entire length of the switchgear.

.3 Insulated fully rated neutral bus shall extend the entire length of the switchgear

.6 Doors and Panels

.1 Relays, meters, control switches, etc., shall be mounted on a formed front-hinged panel for each circuit breaker compartment.

.2 Front doors to be hinged with securely latching handles.

.3 Rear of each section to be accessed by a hinged door with ability to be locked with a pad lock. Each cable termination section to have separate hinged door. Provide viewing window into each cable termination section.

.7 Wiring/Terminations

.1 The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminals shall be provided. One control circuit cutout device shall be provided in each circuit breaker housing. Switchgear secondary wire shall be #14 AWG, type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

.2 Incoming line and feeder cable lugs of the type and size indicated elsewhere shall be furnished.

.2 Circuit Breakers

.1 The circuit breakers shall be horizontal drawout type, capable of being withdrawn on rails. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper. The main-tie-main breakers to have syncro-check relay (function 25).

.2 Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, removable self-aligning pole unit. The vacuum interrupter pole unit shall be mounted on glass polyester supports for kV class. A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the breaker is removed from its compartment. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.

.3 The secondary contacts shall be silver-plated and shall automatically engage in the breaker operating position, which can be manually engaged in the breaker test position.

.4 Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from stationary structure, and to discharge stored energy mechanisms upon insertion or removal from the stationary structure. The breaker shall be secured positively in the stationary structure between and including the operating and test positions. The breakers shall be electrically operated by 125volt DC.

.5 Each circuit breaker compartment shall be provided with an integral motorized racking device accessory with the following features:

.1 Allow moving the breaker between the connect and disconnect positions from a distance of up to 10 m via a hand held pendant, with the breaker compartment door closed.

.6 Breaker position shall be indicated on the pendant by three LED lights. A blinking light indicates that the circuit breaker is in the motion through the selected position. A solid (non-blinking) light indicates that the circuit breaker has reached and stopped in the selected position. In case normal operation fails, the appropriate error code is displayed on the pendant in a separate 2 character LED display window.

.7 The system shall be designed such that it allows manual racking of the circuit breaker using the levering crank accessory. Manual racking operation shall disable the motorized racking accessory.

.8 It shall be possible to enable/disable operation of the motorized racking accessory via Purchaser's external interlocking/permissive contacts.

.9 125 VDC power for the motorized racking accessory shall be derived from a control power transformer mounted in the switchgear.

.10 Provide a discrete I/O interface module mounted in each circuit breaker control compartment for control of the motorized racking accessory via external hard-wired dry contacts and via push buttons located at a remote control panel. The I/O interface module to provide output terminals for connections of three remote 6 V LEDs for indication of breaker position status at the remote panel. With this I/O interface, the circuit breaker can be moved from disconnect to connect or from connect to disconnect positions from a remote control panel. Whenever the hand held pendant is in use, the pendant becomes the master and will override the customer's remote control signals..

.3 Control Voltage

.1 The circuit breaker control voltage shall be: 125 volts DC -

.2 DC control voltage shall be supplied through an external existing DC power battery cabinet.

.4 Instrument Transformers

.1 Current transformers:

.1 Each breaker compartment shall have provision for front-accessible mounting of up to four current transformers per phase (ANSI standard relay accuracy), two on bus side and two on cable side of circuit breaker.

.2 The current transformer assembly shall be insulated for the full voltage rating of the switchgear.

.3 The current transformers wiring shall be Type SIS #12 AWG.

.4 Relaying and metering accuracy shall conform to ANSI and the local utility Standards.

.5 Provide current transformer shunt mechanism to short out current transformer when being serviced.

.2 Voltage transformers

.1 Voltage transformers are draw out mounted with primary current-limiting fuses and shall have ratio as indicated.

.2 The transformers shall have mechanical rating equal to the momentary rating of the circuit breakers and shall have metering accuracy per ANSI and the local utility standards.

.5 Control Wiring

.1 The switchgear shall be wired with #14 AWG type SIS, rated 600 volt, 90 deg. C. (194 deg. F.), except where larger size wire is specified. The switchgear shall be provided with terminal blocks for outgoing control connections. Wire markers shall be provided for each end of all control wires.

.6 Protective Relays

.1 The switchgear manufacturer shall furnish and install, in the metal-clad switchgear, a microprocessor based protective relay for each breaker along with the quantity, type and rating of other protection relays as indicated on the drawings and described hereafter in this specification.

.2 Microprocessor-Based Protective Relay:

.1 Overcurrent Protection Relay Microprocessor based multi-function overcurrent protection relay with dual source power supply (self-powered from CTs), ANSI device function 51/50, 51/50N, or 51/50G, and 86.

.2 Distribution Protection Relay
Microprocessor-based multi-function protective relay, ANSI device function 51/50, 51N/50N, 50BF, 25, 32, 46, 55, 67, 27, 59, 59N, 47, 79, 81O,81U and 86. Also includes metering functions.

.3 Transformer Protection Relay
Microprocessor-based multi-function protective relay, ANSI device function 87T, 87GD, and 50/51G for neutral. Also to be included are 51/50 & 51N/50N for primary as well as secondary windings.

.4 Motor Protection Relay
Microprocessor-based multi-function motor protection relay, ANSI device Function 27/47, 49, 50, 51, 46, 50G, 51G, 37, 38, 55, 66, 2/19, 74, 86, and 87.

.5 Generator Protection Relay
Microprocessor-based multi-function generator protection relay, ANSI device functions 51/50, 51/50N, 67, 27, 59, 25, 47, 55, 40, 81 O/U, 67, 32, 24, 87, 49, 46, and 50BF.

.3 One copy of the software to program relays to be provided for each relay in the switchgear.

.7 Metering:

.1 Utility Metering - Where shown on drawings, provide separate barriered-off utility metering compartment or structure complete with hinged sealable door. Bus work shall include provisions for mounting utility company current transformers and potential transformers as required by the utility company.

.2 Customer Metering- Provide power monitor metering for each breaker cell. Provide a separate customer metering compartment with front hinged doors. Include associated instrument transformers.

.3 Provide current transformers for metering as shown on the drawings. Current transformers shall be wired to shorting type terminal blocks.

.4 Provide potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.

.5 Provide Web-Enabled Communications. Where indicated on the drawings, provide a separate compartment with a front facing hinged door as a central point of connection for all internally located communicating devices to an external Ethernet network and allow close monitoring of the power infrastructure with real-time, web-enabled data.

.6 The compartment shall have a lockable, hinged door with a functional through-the-door RJ45 network access port. Power for the components in the compartment shall be supplied by a pre-wired, bus-connected control transformer in the compartment that is fused and has a disconnecting means. The included communications components to be Power Xpert Ethernet Switches.

.8 Voltage Indicators:

.1 A set of flexible LED flashing potential indicators on all cable terminations adjusted to be visible through each viewing window.

.2 Voltage indicators to be rated up to 46kV, with fully insulated components for use in metal clad switchgear.

.3 Voltage indicators to be Model YZ-2 supplied by THIES Electric Distribution Co., Cambridge, ON – 519-621-2524 or approved equal.

.9 Lightning Arrestors:

.1 Arrester component parts: to CAN/CSA-C233.1, and ANSI/IEEE-C62.36.

.2 Arrester to be sized in accordance with the associated electrical code having jurisdiction.

.3 Arrester characteristics:

.1 Distribution arrester.

.2 System highest voltage line to line: 15 kV.

.3 MCOB (maximum continuous operating voltage): 15 kV.

.4 Indoor type.

.5 Housing: polymer.

.4 Provide lighting arrestors at the incoming cells and at the cells feeding transformers.

2.3. AUTOMATIC TRANSFER CONTROL AND REMOTE STATUS

.1 Provide 13.8kV automatic transfer control of main 13.8 kV breakers and remote operation for Hydro Ottawa. Refer to drawings for sequence of operation.

.2 Automatic control scheme to be integrates with Hydro Ottawa RTU system.

.3 Provide remote status of the two mains and tie breakers.

2.4. 44KV PROTECTIVE RELAY CABINET (CELL#11)

.1 Replace existing 44kV outdoor substations CT's and relays and cabinet with new.

.2 New relays to be installed in separate cell cabinet (cell#11).

.3 Provide bus differential and transformer differential protection.

.4 Provide 52-CS for 44kV breakers including one relay per breaker.

2.5. FABRICATION

.1 Construction

.1 Each equipment bay shall be a separately constructed cubicle assembled to form a rigid freestanding unit. Minimum sheet metal thickness shall be 11 gauge steel on all exterior surfaces. Adjacent bays shall be securely bolted together to form an integrated rigid structure. The rear covers shall be removable to assist installation and maintenance of bus and cables. Each individual unit shall be braced to prevent distortion.

.2 The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. Hinged rear doors, complete with provisions for padlocking, shall be provided.

.3 The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell. Provide rails to allow withdrawal of each 15 kV circuit breaker for inspection and maintenance without the use of a separate lifting device.

.2 Large line-ups shall be split to permit normal shipping and handling as well as for ease of rejoining at the job site.

2.6. NAMEPLATES

.1 Provide equipment identification in accordance with Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

.2 Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 4.7625 mm high, minimum. Furnish master nameplate for each switchgear lineup giving information in accordance with IEEE Std C37.20.2-1999. Circuit nameplates shall be provided with circuit designations as shown on purchaser's single-line diagrams.

.3 Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.7. WARNING SIGNS

.1 Provide warning signs in accordance with Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2.8. FACTORY FINISHING

.1 All steel parts, except galvanized, shall be cleaned and iron phosphate (indoor equipment) pre-treatment applied prior to paint application.

.2 Paint color shall be ANSI-61; TGIC polyester powder, applied electrostatically through air. Following paint application, parts shall be baked to produce a hard durable finish. The average thickness of the paint film shall be 2.0 mils. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling.

.3 Adequacy of paint finish to inhibit the buildup of rust on ferrous metal materials shall be tested and evaluated per paragraphs 5.2.8.1-7 of ANSI C37.20.2-1987. Salt spray withstand tests in accordance with ASTM #D-1654 and #B-117 shall be performed on a periodic basis to provide conformance with the corrosion resistance standard of at least 2500 hours minimum (outdoor equipment) or 600 hours minimum (indoor equipment).

2.9. FACTORY TESTING

.1 Testing shall be witnessed by the Technical Service Start-Up Services Contractor.

.2 Include in your bid for the complete cost of two people to attend the factory witness testing for the equipment. Cost to include but not limited to all travel, food and lodging costs.

.3 The metal-clad switchgear shall be fully assembled, inspected and tested at the factory prior to shipment.

.4 Relays to be set-up as per coordination study.

.5 The following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in accordance with the latest version of ANSI standards.

.1 Alignment test with master cell to verify all interfaces and interchangeability.

.2 Circuit breakers operated over the range of minimum to maximum control voltage.

.3 Factory setting of contact gap.

.4 One-minute dielectric test per ANSI standards.

.5 Final inspections and quality checks.

.6 The following production test shall be performed on each breaker housing:

.1 Alignment test with master breaker to verify interfaces.

.2 One-minute dielectric test per ANSI standards on primary and secondary circuits.

.3 Operation of wiring, relays and other devices verified by an operational sequence test.

.4 Final inspection and quality check.

.7 Perform low frequency withstand (Hi-Pot) tests according to ANSI/IEEE C37.20.2, paragraph 5.5.

.8 The manufacturer shall provide three (3) certified copies of factory test reports.

.9 Factory tests as outlined above under 3.02.B shall be witnessed by the Technical Services Contractor, the Departmental Representative.

.1 The manufacturer shall notify the Departmental Representative (2) weeks prior to the date the tests are to be performed.

.2 The manufacturer shall include the cost of transportation and lodging for up to three (2) Departmental Representatives.

Part 3 Execution

3.1. INSTALLATION

.1 Visually inspect switchgear for evidence of damage and ensure that surfaces are ready to receive work.

.2 Visually inspect to confirm that all items and accessories are in accordance with specifications and drawings.

.3 Verify field measurements are as shown on Shop Drawings and instructed by manufacturer.

.4 Verify that required utilities (e.g., control voltage for heater circuits on outdoor switchgear) are available, in proper location, and ready for use.

.5 Install switchgear in a level and upright position on a level concrete floor that is raised from the remainder of the floor by 76.2mm. Slope up outside doors to room. No floor drains are to be located within the room.

.6 The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.

.7 All necessary hardware to secure the assembly in place shall be provided by the contractor.

.8 Install cables, as provided by the switchgear manufacturer, to connect the primary surge arresters.

.9 Bending of high-voltage cables should be avoided or minimized. All necessary bends should meet at least the minimum radii specified by the cable manufacturer.

3.2. FIELD ADJUSTMENTS

.1 The relays shall be set in the field and tested by the technical services start-up contractor as defined in the coordination study.

3.3. FIELD QUALITY CONTROL

.1 Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section for a period of five working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

.2 Manufacturer's Field Start-up and Certification

.1 A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

.2 The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

.3 When the Contractor is ready for final inspection, set-up and testing to begin, the Contractor is to provide in writing that the equipment has been installed and include the manufacturer's certification.

.4 Field inspection, final set-up and testing will be performed by the technical services start-up contractor.

.5 All final testing to be witnessed by Departmental Representative.

.6 Technical services start-up contractor to perform:

.1 Visually inspect all equipment for physical damage.

.2 Perform start-up tests in accordance with manufacturer's instruction manual.

.3 Verify key interlock operation.

.4 Confirm operation of all relays and any inter relay control sequences. Adjust relays and settings and document changes made.

.5 Repeat all factory testing performed on the equipment.

.6 Check insulation of switchgear assembly with 1000 V megger. If values not satisfactory, clean, and dry switchgear and repeat tests until readings acceptable to Consultant.

.7 Check phase rotation of each feeder.

.7 If any test fails, the the Departmental Representative to be notified immediately.

The Contractor shall provide three (3) copies of the Technical services start-up contractor report on the equipment.

3.4. TRAINING

.1 The Contractor shall provide a training session for up to five (5) Operation and Departmental Representative for two normal workdays at a jobsite location determined by the Departmental Representative.

.2 The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, circuit breaker, protective devices, and other major components.

3.5. CLEANING

.1 Once equipment is on site, the Contractor must take appropriate provisions for the equipment to remain clean and dry. If equipment is stored in an un-heated area, temporary heat is to be provided in the enclosures to prevent moisture build-up and corrosion.

.2 Touch-up paint all chips and scratches with manufacturer-supplied paint and leave remaining paint with operation.

.3 Prior to energizing and prior to turning the equipment over to the Departmental Representative, the equipment shall be cleaned thoroughly to ensure there are no traces of construction materials or dust. Contractor to isolate power to the equipment for review by Departmental Representative.

END OF SECTION

Part 1 General

1.1. SUMMARY

.1 The specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy Surge Protective Devices (SPD) formerly called Transient Voltage Surge Suppressors (TVSS). The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B and C environments.

.2 SPDs are designed for repeated limiting of transient voltage surges on 60 Hz Power circuits not exceeding 1000V and designated as follows:

.1 Type 2 – SPDs hard-wired to distribution equipment after the load side of the service equipment overcurrent device.

.2 Type 3 – Plug-in SPDs.

.3 Type 4 – Component SPDs and component assemblies.

1.2. WORK INCLUDED

.1 Conform to Section 26 05 01 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

.2 Section 26 13 13 – METAL CLAD SWITCHGEAR.

1.3. STANDARDS

.1 The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

.1 Institute of Electrical and Electronic Engineers (ANSI/IEEE).

.1 C62.11 Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV), C62.41.1 Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.

.2 C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits.

.3 C62.45 Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits).

.2 Federal Information Processing Standards Publication 94 (FIPS PUB 94) – Guideline on Electrical Power for ADP Installations.

.3 National Fire Protection Association

.1 75 Standard for the Protection of Information Technology Equipment.

.2 780 Standard for the Installation of Lightning Protection Systems).

.4 Canadian Electrical Code (latest edition).

.5 MIL Standard 220B Method of Insertion Loss Measurement.

.6 Underwriters Laboratories UL 1283 and UL 1449 (3rd edition.)

.7 Canadian Standards or (cUL).

1.4. ENVIRONMENTAL REQUIREMENTS

.1 The operating temperature range shall be -25 deg. C. to 60 deg. C. The unit shall be capable of operation up to 3,960 m above sea level.

.2 No appreciable magnetic fields shall be generated.

1.5. SUBMITTALS

.1 Product Data: Provide catalogue sheets and supporting documentation showing:

.1 System voltage.

.2 UL1449 3rd Edition listing.

.3 UL 1449 Voltage Protection Ratings.

.4 UL 1449 I-n rating.

.5 Dimensions showing construction, lifting and support points, and enclosure details.

.6 Per mode and per phase peak surge current ratings.

.7 Modes of discrete suppression circuitry.

.8 Warranty period and replacement terms.

.9 Conductor size, conductor type, and recommended lead length.

.2 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.

.3 List and detail all protection systems such as fuses, disconnecting means and protective features.

.4 Provide verification that the SPD device complies with the required UL1449 latest edition, latest revision, and CSA or cUL approvals.

.5 SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -40dB at 100 kHz.

.6 For retrofit and side-mounting applications, provide electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

.7 Operation and maintenance manuals shall include details for each SPD shipped.

1.6. DELIVERY, STORAGE AND HANDLING

.1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.7. QUALITY ASSURANCE AND WARRANTY

.1 The manufacturer shall provide a 12 month warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

Part 2 Products

2.1. GENERAL

.1 The SPD shall be listed by CSA or cUL to UL's 1283 and UL's 1449 standards (3rd edition, latest revision), and not merely the components or modules. Listing must be verified by a third party approved laboratory.

.2 The SPD shall be CSA or cUL/UL 1449 labelled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD.

.3 Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

.4 Obtain all surge suppression devices from a single manufacturer.

.5 The maximum continuous operating voltage (MCOV) of all components for solidly grounded systems shall not be less than 125% for a 120V system and 120% for 220 and 240V systems, and 125% for 347 and 600V systems. All components for resistance grounded systems shall have an MCOV not less than 125% of the line-to-line voltage.

.6 All SPD's shall be equipped with a comprehensive monitoring system which shall include visual panel display providing information on unit status and phase loss/protection loss.

.7 Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.

.8 The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

.9 Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

.10 The SPD shall protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.

.11 Nominal Discharge Current (In) – All SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 2 and 4) or operating voltage. SPD shall be UL 1449 labelled with this kA I-nominal (I-n) rating.

.12 ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	2500

.13 Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations or distribution equipment rated at 1,000 Amps or more.	300 kA	150 kA
B	Distribution equipment rated less than 1,000 Amps but greater than 400 Amps	200 kA	100 kA
A	Branch Location Panelboards, MCCs, Busway rated at 400 Amps or less	100 kA	50 kA

.14 Internal Fusing - Overcurrent Protection:

.1 Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

.15 SPD shall be separate from or integral to the electrical equipment. Where an Integral SPD is supplied, unit shall be UL 1449 3rd Edition labelled as Type 1 intended for Type 2 applications without need for external or supplemental overcurrent controls.

.16 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability.

2.2. CATEGORY C LOCATIONS

.1 Provide SPD on the service entrance equipment or distribution equipment rated at 1,000 Amps or more.

.2 The SPD shall have an internal audible alarm with mute on front cover.

.3 SPD's for service entrance locations shall have a transient event counter with LCD panel display and reset button on the front cover.

2.3. CATEGORY B LOCATIONS

.1 SPDs for distribution equipment rated less than 1,000 Amps but greater than 400 Amps shall be as indicated on project drawings.

.2 The SPD shall have an internal audible alarm.

2.4. CATEGORY A LOCATIONS

.1 SPDs for the branch location panelboards, MCCs, busway rated at 400 Amps or less shall be as indicated on project drawings and panel schedules.

.2 The SPD shall have an internal audible alarm.

2.5. DATA & SIGNAL LINE PROTECTION (FOR 24V APPLICATIONS)

.1 The unit shall have a data transmission rate up to 10.0 Mbps.

.2 Each conductor shall have less than 2.4 ohm of internal series resistance per wire, and each pair of conductors shall have a peak surge current of no less than 10,000 amps per wire (20,000 amps per pair), 8 x 20 us waveform.

.3 SPD Voltage Protection level shall be less than < 46V.

.4 The response time of the components of the unit shall be less than one nanosecond.

2.6. PHONE LINE PROTECTION

.1 The unit shall be listed under UL 497A, Standard for Secondary Protectors for Communications Circuits.

.2 The unit shall have a data transmission rate up to 16.0Mbps.

.3 Each conductor shall have less than 1 ohm of internal series resistance per wire

.4 Each pair of conductors shall have a peak surge current of no less than 200 amps, 8 x 20 us waveform.

.5 The maximum let-through voltage on an IEC 10 x 700 us impulse (2kV/80A) shall be 260 volts tip-ring, 260 volts tip to ground, and 260 volts ring to ground.

.6 The response time of the components of the unit shall be less than one nanosecond.

2.7. ENCLOSURES

.1 All enclosed equipment shall have CSA Type 1 sprinklerproof enclosure, unless otherwise noted.

.2 For integral mounted SPD unit, it should be mounted in separate compartment with separate removable cover. For remote mounted SPD unit provide separate enclosure mounted as near to the electrical equipment as possible.

Part 3 Execution

3.1. INSTALLATION

.1 Install the SPD with the conductors as short and straight as practically possible. Gently twist conductors together.

.2 Installer may reasonably rearrange breaker locations to ensure short & straightest possible leads to SPDs.

.3 Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. The electrical contractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.

.4 Main service entrance units shall be installed on a breaker, or, where indicated, shall be installed on a non-fused disconnect switch that meets or exceeds the fault current rating of the switchgear. Size of breaker to be confirmed by manufacturer and coordinated with distribution equipment supplier.

.5 Distribution, branch panel, and motor control center units shall be installed on dedicated circuit breakers. Size of breaker to be confirmed by manufacturer and coordinated with distribution equipment supplier.

.6 The installing contractor shall comply with all applicable codes.

END OF SECTION