Part 1 General

1.1 RELATED REQUIREMENTS

.1 Division 01.

.2 Division 04.

.3 Division 05.

.4 Division 07

.5 Division 09.

.6 Division 21.

.7 Division 22.

.8 Division 23.

.9 26 05 20 Wire and Box Connectors (0-1000V).

.10 26 05 21 Wires and Cables (0-1000V).

.11 26 05 28 Grounding – Secondary.

.12 26 05 29 Hangers and Supports for Electrical Systems.

.13 26 05 31 Splitters Junction, Pull Boxes and Cabinets.

.14 26 05 32 Outlet Boxes, Conduit Boxes and Fittings.

.15 26 05 34 Conduits, Conduit Fastenings and Conduit Fittings.

.16 26 09 23.01 Metering and Switchgear Instruments.

.17 26 12 16.01 Dry Type Transformers Up to 600V Primary.

.18 26 24 13 Generator Paralleling Switchgear.

.19 26 24 16.01 Panelboards – Breaker type.

.20 26 28 13.01 Fuses – Low Voltage

.21 26 28 16 Power Circuit Breakers.

.22 26 28 16.02 Moulded Case Circuit Breakers.

.23 26 28 20 Ground Fault Circuit Interrupters – Class A.

.24 26 32 13 Power Generation – Diesel.

.25 26 36 23 Automatic Load Transfer Equipment.

.26 26 50 00 Lighting.

.27 26 99 99 Commissioning.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1-12, Canadian Electrical Code, Part 1 (23nd Edition), Safety Standard for Electrical Installations.

.2 Abbreviations for electrical terms: to CSA Z85.

.3 CSA Electrical Bulletins in force at the time of tender submission, while not identified and specified by number in this division, are to be considered as forming part of the related CSA Part II standard and must be complied with.

.2 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 CONTRACT DRAWINGS

.1 No omissions in the drawings or specifications are intended and the Contractor shall give due consideration to this matter. Any work or material referred to in the drawings and not in the specifications, or vice versa, shall be furnished and performed as though fully covered in both. This shall apply particularly to the drawings where descriptions are sufficiently detailed so as to require little or no mention in the specifications. Items indicated on floor plans and not on riser diagrams, or vice versa, shall be considered fully covered by both.

.2 Runs of conduit and outlet locations indicated on the drawings are diagrammatic and exact locations must be determined by the Contractor as the work proceeds, with due regard to the structure and the work of other trades. The Departmental Representative reserves the right to alter locations of conduit and outlets up to 3000 mm without extra cost, provided that the Contractor is advised prior to roughing in. The Contractor shall make any changes dictated by structural requirements, or conflicts with other trades, without charge.

.3 Any error or omission shall be referred to the Departmental Representative whose decision shall be final.

.4 Building dimensions shall not be scaled from the electrical drawings but shall be obtained from the site if Architectural and/or Structural drawings are not available. Any discrepancy between the drawings and the building shall be questioned before proceeding with the installation.

1.4 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

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

.1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.5 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit for review updated single line electrical diagrams, drawing 600 x 600 mm, minimum size, under Plexiglas and locate as indicated.

.1 In generators service room.

.3 Shop drawings:

.1 The Contractor shall prepare shop drawings showing in detail the design and construction of all equipment, panels, cabinets, transformers, etc. Six (6) copies of all such drawings shall be submitted to the Departmental Representative for review, and the work shall not be executed until such review has been obtained.

.2 All shop drawings, other than standard manufacturers' dimensions and data sheets, shall bear the stamp of a registered professional Engineer who shall be fully responsible for the Engineering content of such drawings.

.3 Prior to submission the Contractor shall carefully check all shop drawings to ensure that they comply with the drawings and specifications in both intent and detail. No consideration will be given to shop drawings submitted without this approval and review from the Contractor. Appendix A at the end of this section must be completed and signed and must accompany all shop drawing submissions. Submissions not accompanied by Appendix A will be returned for re-submission.

.4 The Departmental Representative’s review of these drawings is general and is not intended to serve as a check and shall not release the Contractor from responsibility for errors or from the necessity of checking the drawings himself, or of furnishing the materials and performing the work as required by the plans and specifications.

.5 High quality electronic “PDF” copies of shop drawings are acceptable.

.4 Quality Control:

.1 Provide CSA certified equipment and material.

.2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction for special approval before delivery to site.

.3 Submit test results of installed electrical systems and instrumentation.

.4 Permits and fees: in accordance with General Conditions of contract.

.5 Submit, upon completion of Work, load balance report as described in PART 3 - Load Balance.

.6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.

.5 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.6 QUALITY ASSURANCE

.1 Qualifications: electrical work to be carried out by qualified, licensed electricians or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.

.1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.

.2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

1.7 SYSTEM STARTUP

.1 At the conclusion of the job, the Contractor shall review and demonstrate to the Departmental Representative, all electrical equipment and their respective functions and operation. Such demonstration shall be provided for such reasonable periods of time as the complexity of the job warrants, and as approved by the Departmental Representative. Such review and demonstration shall be made by an authorized representative of the Contractor, who shall be fully knowledgeable of the project, its installation and operation. Three bound maintenance and operational manuals shall be reviewed and left with the Departmental Representative. These manuals shall be custom written for materials and systems supplied for this project. Generic information may accompany the manuals but must only be supplemental information. These manuals shall include, but not be limited to, approved copies of all shop drawings, guarantees, manufacturers maintenance instructions, diagrams, and parts lists, all packaging and installation instructions, and all operating instructions. Where manufacturers' literature is not available, or appropriate, the Contractor shall provide same in written form. Refer also to Section 01 78 00. Prior to final inspection, submit these manuals to the Departmental Representative for review.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant will aspects of its care and operation.

.4 Phase 1 and Phase 2 electrical phasing procedures are associated with this project (all included under this contract). Carry all associated cost for re-testing, re-commissioning and fuel as required.

1.8 MINIMUM STANDARDS

.1 All work shall be performed in accordance with Canadian Electrical Code, and National Building Code, as minimum standards. These standards together with all Local or Municipal Rules, Regulations, and Ordinances shall be considered as the Latest Approved Editions at the time of Tender Closing. In no instance, shall the standard established by the drawings and specifications, be reduced by any codes.

1.9 PERMITS, FEES AND INSPECTION

.1 The Contractor shall obtain all inspections and permits required by all laws, ordinances, rules, and regulations by public authority having jurisdiction in this district, and shall obtain certificates of such inspections and shall pay all charges in connection therewith. The final certificate of inspection shall be obtained before final payment for work shall be considered due.

.2 In no instance shall the standard established by the drawings and specification be reduced by any codes, etc..

1.10 SUPERVISION

.1 The Contractor shall provide supervision and sufficiently qualified foreman to ensure that the job proceeds in a proper and efficient manner. If in the opinion of the Departmental Representative, such personnel are not competent to carry out their work, the Contractor shall replace these men immediately upon written request of the Departmental Representative.

1.11 OTHER TRADES

.1 The Contractor shall co-operate and investigate with other trades to make maximum use of the spaces and avoid conflict with pipes, ducts, equipment radiation, etc. Shop drawings shall be prepared by the Contractor indicating the route of main conduits and ducts which shall be submitted to the Departmental Representative for review.

.2 The Contractor shall co-operate with other Contractors on the site and carry out the work, in such a way, as not to hinder or hold-up the work of other trades.

.3 The Contractor shall consult with other Contractors and other Sub-contractors, where their respective installations conflict and shall re-route conduits, ducts, outlets, equipments, etc., as required, subject to the approval of the Departmental Representative.

.4 The Contractor shall obtain from the Mechanical contractor and other trades complete detailed wiring diagrams of equipment requiring connections and shall be responsible for pointing out any discrepancies or the reason why they cannot be adhered to.

1.12 GUARANTEE

.1 The Contractor shall guarantee all work, under this Division, free from defects, for a period of one (1) year, after final acceptance of the entire project. The Contractor shall make good

all defects, other than normal wear and tear, during the life of the guarantee. Notwithstanding the above, longer guarantees may be required for specific installations or equipments, as indicated in other sections of the specifications.

.2 Guarantees shall be submitted in writing, bound where more than one is required, and submitted to the Departmental Representative for review. Each guarantee shall include:

.1 Project name and address.

.2 Guarantee time period (commencement date shall be the date as shown on the project final certificate of completion, unless otherwise indicated).

.3 Clear and concise definition of what is guaranteed.

.4 Signatures of company officers of the Contractor and/or manufacturers, as applicable.

1.13 RECORD DRAWINGS

.1 One (1) set of white prints will be provided for record drawing purposes. Maintain project "as-built" record drawings and accurately record significant deviations from the Contract Documents, caused by site condition or Contract change. Mark changes on white prints in "RED".

.2 Prior to start of testing, balancing and adjusting, finalize production of as-built drawings.

.3 Testing, balancing and adjusting to be performed using as-built drawings.

.4 Turn over the as built drawings to the Departmental Representative at the completion of the project.

1.14 RENOVATION WORK

.1 Co-ordinate the removal or shutdown of existing services with the Departmental Representative. Indicate intent to remove, disconnect, or shutdown services in writing, and receive an affirmative written reply, prior to the start of such work. Refer to general notes on the drawings for additional requirements.

.2 Remove all equipment and services indicated on the drawings or made redundant by renovation. If doubt exists, with reference to the removal of same items, obtain clarification from the Departmental Representative before proceeding. All equipment removed shall be brought to the attention of the Departmental Representative, who shall take possession of such items. If the Departmental Representative deems such equipment redundant, the Contractor shall remove and dispose of such items at his own cost.

.3 Maintain services to, and reconnect all equipment and apparatus to remain, should such services be disrupted during the renovation work.

.4 Renovation must be accomplished with the BIO Campus Buildings in full operation. In the event that it is necessary to temporarily relocate existing equipment to accommodate the work, or allow it to proceed in an orderly fashion, temporary services must be provided as a part of the work.

.5 Where circuitry to an existing panelboard has been changed, revise the existing directory accordingly. In the absence of a directory, provide one and detail the new and/or revised circuitry.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

.1 Contract materials shall be new and C.S.A. approved for their specific use.

.2 For the purposes of uniformity similar materials shall be of one manufacturer (i.e. all panels and switchgear; breakers, all motor control equipment; all light fixtures in as much as is possible; etc.)

.3 To avoid the possibility of the work being delayed, the Contractor shall order all materials as soon as possible, and he shall report at once to the Departmental Representative any delays in the delivery of materials which would hold up the completion of the job.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

.2 All power and control wiring associated with the mechanical systems of this project shall be performed by the electrical contractor but only to the limits of what is actually shown on the electrical drawings.

.3 The Contractor shall obtain from the mechanical and other trades complete detailed wiring diagrams of equipment requiring connections and shall be responsible for pointing out any discrepancies or the reason why they cannot be adhered to.

.4 Prior to rough in of electrical services, co-ordinate location of all mechanical equipment with the Mechanical Contractor.

2.3 WIRING TERMINATIONS

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

2.4 EQUIPMENT IDENTIFICATION

.1 All electrical equipment are to be provided with “lamicoid” nameplates as further described herein. Care is to be taken to ensure that all plates are affixed true and level, and plumb in all instances.

.2 Nameplates are to be affixed to all “metal” surfaces with steel type “pop-rivets”.

.3 Nameplates are to be affixed to other types of surfaces with contact type cement.

.4 Contact type cement is to be applied (buttered) to complete rear side of plate, as opposed to several locations or areas on same

.5 Lamicoid nameplates installed on distribution panelboards, motor control centres, splitter troughs, transformers, etc. shall indicate the following:

.1 Designated name of equipment.

.2 Amperage of overcurrent protection device.

.3 Voltages, number of phases and wires.

.4 Designation of power source

.1 Example:

PANEL 101 – 150AMPS
120/208V–3PH–4W
FED FROM MAIN SWITCHBOARD

.6 Lamicoid nameplates installed on combination starters, magnetic starters, manual starters, and all various system controls, control panels, disconnect switches, etc. shall contain the following information.

.1 Designated name of equipment.

.2 Designated name of power source.

.3 Branch circuit breaker number(s) where possible.

.4 Voltage(s).

.1 Examples:

EXHAUST FAN NO. 1
PANEL H – 120V
CCT. NO.17

SUPPLY FAN NO. 1
M.C.C. NO.1
600V–3PH

.7 Lamicoid nameplates installed on fusible type disconnect switches are to also indicate maximum designated/designed fuse size.

.8 Lamicoid nameplates are to be installed on all junction and/or pull boxes sized 150 mm x 150 mm and larger indicating name of system, designated panel name and electrical characteristics where applicable.

.9 Lamicoid nameplates are to be installed adjacent to each overcurrent devices located in switchboards, CDP panels, etc.. They need only indicate designated name and/or number of equipment they feed. Unused O.C. devices are to be identified as spare(s).

.10 Install an additional "lamicoid" nameplate on all, or any piece of electrical equipment, or apparatus (i.e.: main switchboard, CDP panels, panelboards, motor control centres, etc.) that may contain overcurrent devices, i.e. circuit breakers and/or fuses, that have been designed for, and incorporate interrupting capacity sized "larger" than 10 kaIC.

.1 Example:

Minimum interrupting capacity of breakers installed in this panel to be not less than 20 kAC.

Minimum interrupting capacity of fuses installed in this MCC to be not less than 20 kAIC.

.11 Allow for an "average" of forty letters for each lamicoid nameplate.

.1 Lamicoid 3 mm thick plastic engraving sheet, black letters, white face, for all electrical systems except fire alarm systems which shall have white letters on red face.

.2 1.5 mm thick nameplates above receptacles as previously indicated, with top left and right corners to be rounded off.

.3 Lettering on lamicoid nameplates shall not "start" or "end" nearer than 8 mm from either, or both ends of said plates. Size of lettering, including overall lengths of various plates shall be as indicated in the following chart.

.4 Sizes as follows:

NAMEPLATE SIZES

Size 1	10 mm x 50 mm	1 line	5 mm high letters
Size 2	13 mm x 75 mm	1 line	6 mm high letters
Size 3	16 mm x 75 mm	2 lines	5 mm high letters
Size 4	19 mm x 90 mm	1 line	10 mm high letters
Size 5	37½ mm x 90 mm	2 lines	13 mm high letters
Size 6	25 mm x 100 mm	1 line	13 mm high letters
Size 7	37½ mm x 100 mm	2 lines	6 mm high letters
Size 8	50 mm x 150 mm	2 lines	13 mm high letters

.12 Labelling of all branch circuit phase and neutral conductors to be done on both ends of all circuit conductors plus in "all" junction and/or pull boxes located in between. Use write-on,

self-laminating labels sized as necessary. To be installed in a "flagged" manner around individual conductor(s).

.13 Coverplates for junction and/or pull boxes located above finish ceilings and housing branch circuits are to have each branch circuit number neatly identified on coverplate. Felt marker-pen may be used for this purpose.

.14 All of the following conductors are to have their insulation colours identified as indicated:

Phase A	Red
Phase B	Black
Phase C	Blue
Neutral	White/Grey
Bond	Green
Ground	Green
Isolated Ground	Green c/w Yellow Strip

.1 Colour code conductor insulation and others as per the following:

.1 All sizes of phase conductors up to and including #2 AWG.

.2 All sizes of neutral, bond and/or ground conductors, up to and including #3/0 AWG.

.2 Approved coloured tapes in lieu of insulation colouring may be used to identify conductors that exceed sizes as indicated in items .14.1.1 and .14.1.2 above, and is to take place on both ends of runs for a minimum of 300 mm from where terminations take place.

.15 Some examples of electrical apparatus that could have (identical types) of removable covers, and will require to have their lamicoid nameplates installed on wall(s) adjacent to control, rather than directly to their covers are the following.

.1 Magnetic starters.

.2 Manual TOL switches

.3 Magnetic contactors.

.4 Relays.

.16 All various pieces of mechanical equipment are to be identified with identical information as indicated on electrical equipment nameplate feeding same mechanical equipment.

.17 Both plates are to be supplied and installed by the electrical contractor in the absence of any mechanical trade identification.

.18 Bonding conductors require labelling on both ends of runs where they are "dedicated" solely to the designated branch circuit they accompany. Identify with same number(s) being used to identify accompanying branch circuit phase and neutral conductor.

.19 All junction and/or pull boxes, condulet fittings (and covers), etc., complete with their respective coverplates are to be colour coded as per the following. Boxes are to be coloured both inside and outside, where "one" colour only is required. Boxes are to be coloured on inside only where "two" colours are required. Metal coverplates are to have both colours

applied diagonally where “two” colours are required. Complete plate is to be painted where one colour only is required.

.20 Schedules shall be installed on the back of each door for panels, neatly arranged and mounted in frame under transparent cover. Schedules shall show system voltage, which outlets are on each circuit and any special information necessary. Schedules shall be typewritten and of a permanent nature.

2.5 WIRING IDENTIFICATION

.1 Identify wiring on both ends of phase conductors of feeders and branch circuit wiring by circuit number at all panelboards, pull and junction boxes, outlet and equipment connections, and all devices. Labels shall be Panduit PLD-1 or PLD-2 as required. Labels to be installed in such a manner as to present white area with information in "flagged" position. Wrap around conductor in "U" fashion and have it adhere to itself. Identify neutrals and bond wires indicating which circuits with which they are used.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1.

.4 The individual conductors and conductor pairs used in the various communications cables shall be colour coded. Maintain the colour coding scheme for each system throughout.

2.6 CONDUIT AND CABLE IDENTIFICATION

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

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

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

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green

2.7 HOUSEKEEPING PADS

.1 Supply and install concrete housekeeping pads for all free standing, floor mounted, electrical equipment. Housekeeping pads to be 100mm thick, complete with 10M dowels at 457mm c/c around the perimeter, drilled and grouted into the slab (minimum embedment 100 mm. Concrete to be 211kg/cm^2 in accordance with CAN3-A23.1-M90. Reinforce with one layer 6 x 6 4/4 WWF. Pads to be nominally 150mm larger in all dimensions than the equipment being supported, and have chamfered edges.

.2 Adjust existing housekeeping pad(s) dimensions to suit new equipment layout when required.

Part 3 Execution

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

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

3.3 MOTOR AND EQUIPMENT CONNECTIONS

.1 Provide final connections to all motors, equipments, controls, etc. indicated on the drawing. These motors, equipment, controls, etc. shall include those supplied under other sections of this specification, as well as Owner supplied items (if applicable). Ensure that equipment will operate properly (e.g. proper rotation) and report any instance of defective equipment to the Departmental Representative.

3.4 CO-ORDINATION OF PROTECTIVE DEVICES

.1 This contractor shall provide a complete study for:

.1 Co-ordination fault study with suggested overcurrent (phase and ground fault) settings in accordance to IEEE standards.

.2 Short circuit and arc flash studies to determine short circuit current level and comply with CSA C22.1-15, CSA Z462, NFPA, and IEEE requirements.

.2 The study shall be prepared and submitted to the departmental representative for review. All costs associated with the study shall be included in the tender price. Professional Engineer licensed to practice in Nova Scotia shall stamp the Short Circuit, Co-ordination and Arc Flash Study.

.3 Co-ordination study shall be reviewed by Department Representative before ordering the generator, ATS, switchgear, and distribution panels to site.

.4 Allow for two updates of calculation after the first review.

.5 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

.6 Determined the Flash Protection Boundary and Personal Protective Equipment (PPE) to be used by maintenance personnel.

.7 Mark the distribution equipment with lamicoid nameplates for Arc Flash identifying the level of PPE to be work when performing maintenance on the building electrical equipment.

.8 Provide all required warning label(s) and signage for electrical equipment within the generator service room.

3.5 CUTTING AND PATCHING

.1 Cutting and patching shall be the responsibility of this Contractor and shall be performed by a skilled tradesperson.

.2 Make every effort to minimize cutting and patching by providing dimensions, locations and other data for bases, sleeves, boxes, etc., to be built in as construction proceeds. Set sleeves and mark openings in concrete forms and masonry before placing concrete and masonry.

3.6 FIELD QUALITY CONTROL

.1 Conduct following tests:

.1 Power distribution system including phasing, voltage, grounding and load balancing.

.2 Insulation resistance testing:

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.2 Check resistance to ground before energizing.

.3 Test all wiring included in the Contract, to ensure there are no shorts or grounded conductors and that insulation values are as required by the Canadian Electrical Code

.4 The Departmental Representative reserves the right to use any piece of electrical equipment, device, or material installed under this Contract for such reasonable lengths of time and at such times as he may require to make a complete and thorough test of the same, before the final completion and acceptance of the work

.5 The following wiring methods detailed below are designed to enhance the ability to perform capacitive leakage tests; these methods are to be strictly followed and tests performed under this Contract

.1 All circuit conductors are to be individually tie wrapped to their corresponding labelled neutral conductor in all panelboards, pull boxes and junction boxes. Enough slack conductor length should be left to enable the ability to clamp the ground detector around the individually tie wrapped circuit conductor and its corresponding labelled neutral. This wiring method is to be neat and of good workmanship quality

.2 The main switchgear, CDP's, panelboards, MCC's, etc. are to have their respective feeder phase and neutral conductors tie wrapped together and enough slack conductor length to enable the ability to clamp the ground detector around each set of feeders. This wiring method is to be neat and of good workmanship quality.

.3 After all electrical wiring has been completed by the Electrical Sub-Contractor, he is to test the grounded electrical distribution system to ensure there are not ground shorts, and capacitive leakage in the system is within acceptable limits

.4 All feeders or branch circuits, which do not have neutral conductors, are to have their respective phase conductors tie wrapped together in accordance with the methods described previously.

.6 Submit properly prepared and bound reports of all tests indicating:

.1 The date and time of the test.

.2 The name or names of those who conducted the test.

.3 The purpose of the test.

.4 The results of the test.

.5 Any applicable code limits or bounds.

.7 Such tests shall not be construed as evidence of acceptance of any part of the Contract, and it is agreed and understood that no claim for damage will be made for any injury or breakage to any part or parts of the above, due to the aforementioned tests, where caused by weakness or inaccuracy of parts, or by defective materials or workmanship of any kind whatsoever.

.8 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.9 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.7 COMMISSIONING

.1 Refer to Section 26 99 99 for requirements.

3.8 CLEANING

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

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

.3 On completion of this project, the Contractor shall remove all debris and leave the site neat and tidy. Equipment shall be checked for proper fitting and alignment, adjusted, cleaned, repainted where necessary, and left in first class condition.

END OF SECTION

APPENDIX A **Job Number: 15-291**

Shop Drawing Submittal Form

General Contractor:	
Phone Number:	Fax No:

Electrical Contractor:	
Phone Number:	Fax No:

Electrical Contractor Project Representative:	
Phone Number:	Fax No:

Shop Drawing Items:
Number of Shop Drawing Copies:
Supplier of Shop Drawings:
Manufacturer of Shop Drawings:
Specification Section and Items:

Drawing Reference:

Specified Options Indicated □ ***Yes*** □ ***No***

Items are in Conformance with Plans and Specifications Confirmed by Contractor.
□ ***Yes*** □ ***No***

(If No, explain):

Contractor's Signature:

Date:

Part 1 General

1.1 RELATED SECTIONS

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

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-C22.2 No.18-98(R2003), Outlet Boxes, Conduit Boxes and Fittings.

.2 CAN/CSA-C22.2 No.65-03(R2008), Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

.1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

.3 National Electrical Manufacturers Association (NEMA).

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 See Section 01 74 21 Construction Waste Demolition Management.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.

.4 Divert unused wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

Part 2 Products

2.1 MATERIALS

.1 For branch circuit wiring #10 AWG and smaller, use spring type pressure wire connectors with current carrying parts of copper, or copper alloy, and insulating cap, all to fit copper conductors as required. Standard of acceptable quality: Ideal "wing nuts".

.2 Joints for all other wiring shall be made using T & B colour keyed compression type connectors, 54000 series, and T & B series compression tools. Insulation shall consist of a first layer of compound type tape followed by a layer of Scotch #33 vinyl tape

Part 3 Execution

3.1 INSTALLATION

.1 Remove insulation carefully from ends of conductors and:

- .1 Install spring type wire connectors for branch circuit and control wiring #10 AWG and smaller. Plier tighten all wire nut joints and connections.
- .2 Install pressure type wire connectors for branch circuit wiring larger than #10 AWG. Insulating tapes to overlap successive wraps by a minimum of 50%.
- .3 The splicing of feeders conductors is not acceptable.

.2 All connections shall be made electrically and mechanically secure. The sizes of connectors shall be according to manufacturer's recommendations for each wire size and combination of wires.

END OF SECTION

PART 1 - General

1.1 RELATED SECTIONS

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

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

1.2 REFERENCES

.1 CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.

.2 CAN/CSA-C22.2 No. 131-M89(R1994), Type TECK 90 Cable.

1.3 ACTION AND INFORMATION SUBMITTALS

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

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 See Section 01 74 21 Construction Demolition Waste Management.

.2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - Products

2.1 GENERAL

.1 Wire and cable shall conform fully to the latest specifications of the Canadian Standards Association (C.S.A.), Electrical and Electronic Manufacturers Association Of Canada (EEMAC), the Insulated Power Cable Engineers Association (IPCEA), and the American Society of Testing Materials (ASTM).

2.2 BUILDING WIRES

.1 Wiring on circuits exceeding 50 volts to ground shall be of soft drawn stranded copper of 98% conductivity and of full size and AWG gauge. Insulation shall be cross-linked polyethylene RW-90 rated 600 volts. Wiring shall be continuously colour coded as follows:

.1 Phase A Red

.2 Phase B Black

.3 Phase C Blue

.4 Neutral – White/Grey

.5 Ground Green

.6 Where extra colors are required for three way switches, etc., they shall be yellow.

.2 Conductors pertaining to the wiring of thermostats, motorized valves, damper actuators, and electric pneumatic relays shall be stranded copper conductor of 95% conductivity and of full size and AWG gauge. Insulation shall be thermoplastic "TW" rated 600 volts. Colour code shall be orange and brown. Minimum size shall be No. 18 AWG.

.3 Colour coding shall be by insulation colour as follows: Phase conductors on sizes up to and including No. 2 AWG. Neutral, ground and bond conductors on sizes up to and including No. 3/0 AWG. Approved coloured tape, in lieu of coloured insulation, may be used for phase conductors sized No. 1 AWG and larger, neutral, ground and bond conductors sized No. 4/0 AWG and larger.

.4 ACM alloy conductors may be utilized for feeders 100A or above, size as indicated, with 600V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE.

2.3 TECK CABLE

.1 Cable: to CAN/CSA-C22.2 No. 131.

.2 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.3 Insulation:

.1 Type: Chemically cross-linked thermosetting polyethylene rated type RW90, 600V.

.4 Inner jacket: polyvinyl chloride material.

.5 FT6 rated.

.6 Armour: interlocking aluminum.

.7 Overall covering: thermoplastic polyvinyl chloride material.

.8 Fastenings:

.1 One hole steel straps to secure surface cables 53 mm and smaller. Two hole steel straps for cables larger than 53 mm.

.2 Channel type supports for two or more cables at 1800 mm centers.

.3 Threaded rods: 12 mm diameter to support suspended channels.

.9 Connectors:

.1 Watertight approved for TECK cable.

2.4 CONTROL CABLES

.1 Type LVT: Soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.

PART 3 - Execution

3.1 GENERAL

.1 The Contractor shall run all circuits so that the voltage drop, in no case exceeds 3% of the line volts. The neutral wire, wherever it is run shall be continuous with no fuses, switches, or breaks of any kind.

.2 The minimum conductor size for all 15-amp branch circuits is to be #12 AWG. For 15 amp 120 volt branch circuits, the following table shall be followed:

Branch Circuit One-Way Length from Panel to Load (Including Vertical Drops)	Phase Wire Size	Dedicated Neutral Wire Size	Shared Neutral Wire Size	Bond Wire Size
Up to 24.38 m	#12 AWG	#12 AWG	#10 AWG	#12 AWG
24.68 m to 38.1 m	#10 AWG	#10 AWG	#8 AWG	#12 AWG
38.4 m to 56.38 m	#8 AWG	#8 AWG	#6 AWG	#10 AWG

.3 Oversized #10 AWG branch circuit wiring conductors to be extended to outlet box of device they feed. Oversized #8 or #6 AWG branch circuit wiring conductors to be extended from panelboard to junction box located on wall or in ceiling space directly above outlet or device they feed. A #8 or #6 AWG wire can be reduced to #10 AWG for vertical portion of drop only.

.4 All “stranded” conductors are to be “twisted together” prior to any types of terminations taking place, but not necessarily limited to, some of the following areas:

.1 Receptacles.
.2 Light switches.
.3 Neutral terminal strips.
.4 Bonding terminal strips.
.5 Circuit breakers.
.6 Disconnect switches.
.7 Magnetic and manual starters.
.8 Magnetic contactors.
.9 Relays.
.10 Terminating lugs, etc.

3.2 INSTALLATION OF BUILDING WIRES

.1 Where pulling wires and cables, the use of an approved lubricant only will be permitted. No wires or cables shall be pulled in conduits until such conduits are free from moisture and in no case shall wires be pulled until approval of the Departmental Representative is obtained.

.2 All various types of cables are to be installed parallel or perpendicular to building lines and shall be adequately secured to the building structure at not more than 60" intervals or as otherwise indicated, in such a manner as to ensure they are protected from potential types of mechanical damage occurring. Install independent supports for cabling in ceiling spaces, and do not use those of other trades. Do not secure cables to mechanical systems piping or ducts, suspended ceiling support wires, etc.. The laying of “unsupported” cables of any types whatsoever directly atop ceiling grid system is strictly prohibited.

.3 Install and secure surface cables directly to underside of metal decking and/or ceiling slab where installed in any concealed ceiling spaces.

.4 Cables are “always” to be installed as high as possible to underside of structure.

.1 Where cables are installed in same direction as steel joists, they are also to be secured as high as possible to underside of metal decking and/or structure. Do not install cables in the upper portions of any Q-Decking.

.5 The grouping together of cables to form a “bundle” for securing purposes is acceptable provided that the following procedures are adhered to.

.1 In addition to securing cables at 1500mm intervals to structure, multiple or bundled groups of cables (including low voltage types), shall be tye-wrapped together at mid-point between each structure support, or every 760mm. Secure to structure at 1500mm intervals, and secure together (between structure supports) at 1500mm intervals.

.6 After all wiring devices have been installed, the Contractor shall test all systems to make sure there are no grounds, leaks, or shorts. Such tests shall be performed to the satisfaction of both the inspection authority having jurisdiction and the Departmental Representative.

.7 Perform megger tests in accordance with Section 26 05 01 Common Work Results – Electrical.

3.3 INSTALLATION OF TECK CABLES 0 -1000V

.1 Install cables.

.1 Group cables wherever possible on channels.

.2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors (0-1000V).

.3 Perform megger tests in accordance with Section 26 05 01 Common Work Results – Electrical.

3.4 INSTALLATION OF CONTROL CABLES

.1 The installation of "surface" wiring on walls or in open (non-enclosed) type ceilings, shall be Type EMT conduit complete with associated steel type connectors and couplings.

.2 EMT conduit is to be extended to within 610 mm of "all" various control devices associated with the operation of any given piece of mechanical equipment.

.3 Unless specifically indicated otherwise, liquid tight, flexible metal type conduit complete with steel type connector and steel locknut may be used for the "final" 610 mm connection between the end of the EMT conduit and the applicable control device.

.4 EMT or PVC type conduit "wall stubs" complete with flush installed device box shall be installed in all masonry or concrete partitions where, and as may be required, where plenum rated cabling is used.

.5 EMT connectors complete with nylon insulated throat or threaded type bushing shall be installed on end of EMT stub above "finish" type ceilings, etc., where plenum rated cabling is used.

.6 All EMT conduit stubs are to be "bonded" to ground as per CEC.

.7 Ground control cable shield.

.8 Perform megger tests in accordance with Section 26 05 01 Common Work Results – Electrical.

3.5 STRANDED CONDUCTORS

.1 All stranded conductors prior to terminating under device bolts such as circuit breakers, switches, receptacles, etc., are to be twisted together so as to form a single conductor to ensure a reliable mechanical connection.

3.6 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 Common Work Results – Electrical.

.2 Complete static verification, start-up and functional performance testing by a manufacturer's qualified representative. Pay for all associated costs.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

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

1.2 REFERENCES

.1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE):

.1 ANSI/IEEE 837-02, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

1.3 ACTION AND INFORMATION SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer packaging materials in accordance with Section 01 74 21 – Construction Demolition Waste Management.

Part 2 Products

2.1 EQUIPMENT

.1 Grounding equipment shall be to CSA C22.2 No. 41.

.2 Clamps for grounding of conductors to be sized as required to make for an electrically conductive connection to water piping.

.3 Insulated bonding conductors: green, copper conductors, size as indicated.

.4 Insulated bonding conductors: green, copper conductors, size as indicated.

.5 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

.6 Ground plates to be copper clad steel, present not less than 0.2 square metres of surface area to soil, 6 mm thick.

.7 All ground plate clamps and fittings to be bronze or brass, CSA approved.

.8 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:

.1 Grounding and bonding bushings.
.2 Protective type clamps.
.3 Bolted type conductor connectors.
.4 Compression welded type conductor connectors.
.5 Bonding jumpers, straps.
.6 Pressure wire connectors.

Part 3 Execution

3.1 INSTALLATION GENERAL

.1 All equipment and exposed non-current-carrying metal, conduits and parts shall be permanently and effectually grounded to meet minimum requirements of the Canadian Electrical Code, and as indicated on the drawings and further specified. Standards set either by drawings or specifications which are above those covered by the CEC shall not be reduced under any circumstances.

.2 Install complete permanent, continuous grounding system including, conductors, connectors, accessories. Where EMT is used, run bond wire in conduit.

.3 Install connectors in accordance with manufacturer's instructions.

.4 Protect exposed grounding conductors from mechanical injury.

.5 Make buried connections, and connections to conductive water main, electrodes, using permanent inspectable wrought copper compression connectors to ANSI/IEEE 837.

.6 Use mechanical connectors for bonding connections to equipment provided with lugs.

.7 Soldered joints not permitted.

.8 Connect building structural steel and metal siding to ground.

.9 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.10 The branch circuit bonding conductor shall be secured (wrapped around unbroken) to the bonding screw of each outlet/device box before connecting to other bonding conductors and/or providing a pigtail lead for device terminations.

.11 All bond conductors shall be twisted together with a screw-on type wire connector, and then placed in the rear of the outlet box in such a manner as to minimize obstruction.

3.2 SYSTEM AND CIRCUIT GROUNDING

.1 Install system and circuit grounding connections to neutral of secondary 347/600V system and 120/208V system.

.2 The ground conductor shall run unbroken from the ground plates to the generators ground points.

3.3 EQUIPMENT BONDING

.1 Install bonding connections to typical equipment included in, but not necessarily limited to following list:

- .1 All panel ground busses.
- .2 Transformers.
- .3 Frames of motors.
- .4 Motor control centres.
- .5 Starters.
- .6 Control panels.
- .7 Structural steel.
- .8 Wall mounted ground busses.
- .9 The metallic piping.

.2 Generally, minimum bonding shall be provided by the metallic conduit/outlet box system and by the bond wires in cables. Additional insulated bond conductors, sized as per the drawings, shall be provided as follows:

- .1 In all EMT feeders that supply panelboards, CDP panels, FDP panles, MCCs, switchgear, generators, and transformers – all sized as per CEC Table 16A.
- .2 A separate green bond conductor sized as per Table 16A of the CEC shall be installed in each EMT conduit run for branch circuit wiring, with the exception that the minimum size bonding conductor shall be 12 AWG.
- .3 A separate green bond conductor sized as per Table 16A of the CEC shall be installed in non-metallic conduit systems (i.e. – rigid PVC), with the exception that the minimum size bonding conductor shall be 12 AWG.

.3 Where bond conductors terminate at ground busses in switchgear or panelboards, the connection shall be made with a compression lug, which shall be secured to the bus with nut, bolt and two Belleville washers. Size of bolts shall be to suit lug and shall be properly torqued and marked. One-hole short barrel (single crimp) lugs shall be used for wire sizes up to and including number 6 AWG. Two-hole long barrel (dual crimp) lugs shall be used for wire sizes number 4 AWG and larger.

3.4 GROUNDING BUS

.1 Where bond conductors terminate at existing ground wall mounted busses, the connection shall be made with a two-hole compression lug, which shall be secured to the bus with nut, bolt and two Belleville washers. Size of bolts shall be to suit lug and shall be properly torqued and marked. One-hole short barrel (single crimp) lugs shall be used for wire sizes up to and including number 6 AWG. Two-hole long barrel (dual crimp) lugs shall be used for wire sizes number 4 AWG and larger

.2 Ground items of electrical equipment in communication equipment in communication equipment room to ground bus with individual bare stranded copper connections.

3.5 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Perform ground continuity and resistance tests using a ground resistance tester appropriate to site conditions and to approval of local authority having jurisdiction over installation. The maximum resistance shall be 10 ohms. Submit a ground resistance report to the Departmental Representative for review.

.3 Perform tests and submit the report before energizing the electrical system.

END OF SECTION

PART 1 - General

1.1 RELATED SECTIONS

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

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 See Section 01 74 21 Construction Demolition Waste Management.

.2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - Products

2.1 SUPPORT CHANNELS

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

.2 All strut to be galvanized.

.3 All threaded hanger rods to be minimum 10mm diameter, larger if required, made from mild steel.

.4 In concrete use cast in threaded inserts wherever possible. Should additional inserts be required use a "red head" type of insert capable of carrying at least 227 kg.

.5 Supports for all conduit work shall be one hole steel pipe straps; unistrut, or equal, with necessary fittings, approved for their respective use.

.6 All pull and junction boxes, wireways, and multiple conduits shall be supported by a steel channel support system with all components, hangers, wall supports, cable clamps, etc., specifically manufactured and approved for their application.

.7 Fastening devices for cabinets, boxes, supports etc., shall be nut and bolt, expansion shields, wedge anchors, or toggle bolts, size and number to suit the application or as detailed on the drawings. Toggle bolts may not be used in plasterboard construction.

.8 Fastening devices for outlet boxes shall be nut and bolt, expansion shields, wedge anchors or clips, size and number to suit the application or as detailed on the drawings.

.9 Where outlet boxes are set in drywall construction, a piece of steel stud shall be secured to either side of the outlet box or use quick-mount box supports, or side box supports.

PART 3 - Execution

3.1 INSTALLATION

.1 Secure all equipment in a manner so as not to distort or cause undue stress on any components.

.2 Secure equipment to masonry, tile and plaster surfaces with lead anchors or nylon shields.

.3 Secure equipment to poured concrete with expandable inserts.

.4 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts. Toggle bolts shall not be used to secure equipment to plasterboard, drywall, or acoustic tile surfaces.

.5 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

.6 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.7 Fasten exposed conduit or cables to building construction or support system using straps.

- .1 One-hole steel straps to secure surface conduits and cables 53mm and smaller.
- .2 Two-hole steel straps for conduits and cables larger than 53mm
- .3 Beam clamps to secure conduit to exposed steel work.

.8 Suspended support systems:

- .1 Support individual cable or conduit runs with 10mm dia threaded rods and spring clips.
- .2 Support 2 or more cables or conduits on channels supported by 10mm dia threaded rod hangers where direct fastening to building construction is impractical.

.9 For surface mounting of two or more conduits use channels at 1500mm on centre spacing.

.10 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.11 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.12 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Departmental Representative.

.14 Do not support any electrical conduits, wire or equipment from ceiling system support cables.

.15 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

.16 In addition to the C.E.C. conduit support requirements, all suspended conduit runs containing horizontal or vertical elbows shall have one additional support installed not greater than 300mm from the midpoint of the 90° bend.

END OF SECTION

PART 1 - General

1.1 RELATED SECTIONS

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

1.2 ACTION AND INFORMATION SUBMITTALS

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

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1-15, Canadian Electrical Code, Part 1, 23nd Edition.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 See Section 01 74 21 Construction Demolition Waste Management.

.2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - Products

2.1 JUNCTION AND PULL BOXES

.1 Pull and junction boxes, where larger than standard boxes shall be the equivalent to Type "C" or "D" boxes sized according to C.E.C. Sections 12 3000 to 12 3038. Use Type "D" for boxes up to 300mm x 300mm and Type "C" for boxes 300mm x 300mm or larger.

.2 Pull boxes and junction boxes installed outdoors shall be CSA type 4X.

.3 Pull boxes in other indoor area shall be of sheet metal construction with all welded steel corners and screw on flat covers for surface mounting.

.4 All flush installed boxes shall be Type “D”. Covers for flush mounted pull boxes shall extend a minimum of 25 mm all around.

.5 Concealed junction boxes (within ceiling space) shall not be smaller than 100 mm square.

.6 All junction boxes containing more than three circuits shall be complete with terminal strips for phase conductors, neutral and bonds.

2.2 CABINETS

.1 Cabinets shall be steel, fabricated to C.S.A. & EEMAC Standards with baked enamel finish. Cabinet shall be EEMAC Standard Types "C", "D", or "T" as indicated on the drawings. Type "T" cabinets shall be complete with hinged door, lock, two keys, and handle, and be lined with 21mm plywood.

.2 Cabinets installed outdoors shall be CSA type 4X.

PART 3 - Execution

3.1 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations and secure them adequately to the building structure. Pull boxes installed in the middle of conduit runs without backing are not acceptable.

.2 The location of junction and/or pull boxes in suspended ceiling spaces, i.e. - dry wall, T-Bar, etc., is not to be greater than 760mm above the finished ceiling and must be easily accessible.

.3 All suspended junction, pull and outlet boxes shall be supported with minimum size 10mm threaded rods, nuts and flat washers. Threaded rods shall be secured to boxes with one flat washer and nut installed on both sides of box. One rod required for all boxes sized up to and including 119mm square. Two rods required for boxes larger than 119mm square, up to and including 203mm square. A minimum of four rods required for all boxes larger than 203mm square.

.4 Mount cabinets with top not higher than 2000mm above finished floor.

.5 Install terminal blocks as indicated in cabinets.

.6 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30m of conduit run between pull boxes.

3.2 IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Install size 2 identification labels indicating system name, voltage, phase and circuit numbers where applicable.

END OF SECTION

PART 1 - General

1.1 RELATED SECTIONS

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

1.2 REFERENCES

.1 CSA C22.1-2015, Canadian Electrical Code, Part 1.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 See Section 01 74 21 Construction Demolition Waste Management.

.2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

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

.2 103 mm square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 347 V outlet boxes for 347 V switching devices.

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

2.2 GALVANIZED STEEL OUTLET BOXES

.1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 91mm x 53mm x 41mm or as indicated. 103mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

.2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 103mm x 54mm x 53mm.

.3 103mm square or octagonal outlet boxes for lighting fixture outlets.

.4 103mm square outlet boxes with extension and plaster rings for flush mounting devices in finished walls.

.5 Surface outlet boxes installed below 2438 mm shall be hot dipped galvanized cast "FS", or "FD" series boxes with metal coverplates.

2.3 CONDUIT BOXES

.1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

.2 PVC FS boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

2.4 FITTINGS - GENERAL

.1 Bushing and connectors with nylon insulated throats.

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

.3 Conduit outlet bodies for conduit up to 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 and cable connections. Reducing washers are not allowed.

.5 At each local switch, convenience outlet, receptacle, ceiling or wall fixture, continuous row of fixtures, or system unit (i.e. fire alarm, etc.) provide and install a standard pressed steel outlet box unless specifically noted otherwise. All outlet boxes shall be galvanized inside and out and set flush with finished surfaces. They shall be rigidly and securely set. Boxes shall not be mounted back to back, but separated by a minimum of 300mm, to prevent noise transmission.

.6 In centering outlets, the Contractor is cautioned to allow for radiation, pipes, ducts, etc., and for the variation in arrangement and thickness of finishes, etc.. His failure to comply with this will not relieve him from the cost of necessary alterations.

.7 The Contractor shall allow for the relocation of an outlet up to 3000mm from where shown, provided he has been notified so prior to rough-in of the same.

.8 All suspended boxes are to be supported with minimum size 12mm threaded rod(s).

.9 All flexible conduit fixture feeds shall originate from the side of the outlet box and not from the box cover.

.10 Flush installed boxes being used as a junction or pull box that requires a blank metal coverplate, is to have an appropriate sized, one or two gang "plaster ring" installed on same. This permits the use of a standard, one or two gang (blank) finish metal coverplate to be used, and avoids the necessity of acquiring an oversized, custom made coverplate.

.11 When installing flush boxes in metal drywall partitions, always screw a short piece of metal stud (same width as partition) to non-supported side of box.

.12 Concealed boxes installed above drywall ceilings or behind walls, are to have their locations identified on room sides of access opening frames with properly colour coded identification discs.

.13 Condulet fittings (LB, LL, LR, etc.) and their respective covers/plates are to be painted, and where concealed, have their locations identified with appropriate colour coded, 21mm, self-adhering discs, applied to T-bar splines and/or access opening frames, in similar manner as for concealed junction and/or pull boxes, etc..

.14 Tile type extension rings are not to be used on boxes that have not been "flush" installed. They are not intended, not acceptable for "surface" type application.

3.2 IDENTIFICATION

.1 All outlet boxes shall be colour coded as per the colour coding legend for conduits and cables. Refer to Specification Section 26 05 01. Outlet boxes are to be coloured only on the inside.

END OF SECTION

PART 1 - General

1.1 RELATED SECTIONS

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

1.2 REFERENCES

.1 Canadian Standards Association (CSA)

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

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 See Section 01 74 21 Construction Demolition Waste Management.

.2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - Products

2.1 CONDUITS

.1 Rigid steel threaded conduit shall conform to C.S.A. C22.2 No. 45 galvanized, sized as indicated.

.2 Thinwall Type "EMT" conduit shall conform to C.S.A. C22.2 No. 83, galvanized, sized as indicated.

.3 Flexible galvanized steel liquid tight conduit shall conform to C.S.A. C22.2 No. 56, sized as indicated.

.4 Rigid PVC conduit shall conform to C.S.A. C22.2 No. 211.2, sized as indicated.

.5 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3, sized as indicated.

2.2 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 53mm and smaller. Two hole steel straps for conduits larger than 53mm.

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

.3 Channel type supports for two or more conduits at 1500mm on centers.

.4 Threaded rods, 12mm diameter, 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 degree bends are required for 27mm and larger conduits.

.3 Couplings for thinwall Type "EMT" shall be set screw type, zinc with matching locknuts (except where specified below for watertight couplings).

.4 Connectors for thinwall Type "EMT" shall be set screw type, zinc with matching locknuts (except where specified below for watertight connectors).

.1 Connectors 32mm and larger shall be complete with threaded plastic bushings. Connectors less than 32mm shall be complete with insulated throats.

.5 Utilize watertight connectors and couplings for exposed horizontal runs of EMT where conduits are installed below sprinkler lines.

.6 Utilize watertight connectors and couplings for exposed vertical runs of EMT.

.7 Couplings and connectors for P.V.C. rigid conduit shall be C.S.A. Approved for their respective use. All P.V.C. fittings shall be solvent weld type. Push-fit type fittings are not acceptable.

.8 Connectors for flexible conduit, armoured cable shall be set screw galvanized steel. Units shall be equal to T&B #3110 series, steel, and be complete with case hardened locknuts.

.9 Connectors for liquid tight flexible conduit shall be watertight, compression type galvanized steel or aluminum. Locknuts shall be case hardened. Dry type connectors may be used in dry indoor areas not exposed to liquids or moisture, if approved for use.

2.4 FISH CORD

.1 Polypropylene.

PART 3 - Execution

3.1 INSTALLATION

.1 All conduit installed in outdoor shall be PVC.

.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.

.4 Rigid PVC or Galvanized rigid steel threaded conduit shall be used in all poured concrete construction. Thinwall Type "EMT" shall be used for all branch circuit wiring and all systems installed exposed on ceilings and walls unless noted otherwise. Bends, offsets, or elbows made on the job for steel conduits shall be made so that the conduit is not injured or flattened.

.5 All branch circuit wiring run in thinwall Type EMT conduit shall be complete with a No. 12 AWG minimum green insulated bonding conductor, increasing as required by Table 16A of the C.E.C..

.6 P.V.C. conduits sized 27 mm in diameter and larger shall be installed in trenches not less than 300mm in depth from underside of concrete floor slab to bottom of trench. Conduits shall be placed on a 152 mm bed of sand and have a second 152 mm of sand placed on top (completely around) of conduits prior to backfilling.

.7 All concealed and exposed conduit shall be kept parallel to building lines and run "on the square". All conduits shall be installed to avoid proximity to steam and hot water pipes by 150 mm. Conduits shall run through ceiling spaces and down in walls. No conduit shall run in or under floor slabs unless specifically indicated.

.8 All conduits shall be securely held in place by means of approved supports and in accordance with C.E.C. Sections 12-1010, 12-1114 and 12-1404. All EMT conduit straps shall be steel. Cast straps are not acceptable. EMT conduit shall be installed as a complete system and shall be securely fastened in place within 914 mm of each outlet box, junction box, cabinet, couplings or fittings and the spacing between supports as follows:

.1 Less than 1500mm for 16mm and 21 EMT;

.2 Less than 2286mm for 27mm and 35mm EMT;

.3 Less than 3048mm for 41mm EMT or larger.

.9 Code approved P.V.C. rigid conduit shall be used for underground circuits and where otherwise specifically noted. Conduit shall be joined with approved connectors and P.V.C. solvent cement. The proper size bonding conductor, as per the C.E.C., shall installed in all P.V.C. conduits.

.10 No branch circuit wiring shall run in concrete slabs. Conduit stubs in concrete shall be protected from damage during construction. Conduit openings shall be sealed with plugs or caps to prevent entrance of foreign materials. Where conduits pass through a waterproof

membrane an oversize sleeve shall be installed and caulking applied to maintain the waterproof properties of the membrane. A cold cure mastic shall then be applied between sleeve and conduit.

.11 Flexible conduit, not smaller than 10mm I.D., or flexible armoured cable with separate grounding conductor, and complete with insulating anti shorts, shall be used between lighting fixtures and their respective junction boxes, and where rigid or "EMT" conduit cannot be used, such as in cabinet work.

.12 Liquid tight flexible conduit, not smaller than 10mm I.D., shall be used for connections to all transformers, motors and equipments, in both wet and dry areas.

.13 Upon installation of all conduits, terminate in boxes, cabinets, and fittings, or install suitable plugs or caps, to prevent the entrance of foreign materials. Conduits shall be swabbed out using a drag, consisting of tight fitting rubber washers and shall be dry before conductors are pulled in.

.14 All conduit subject to corrosive elements shall be treated with corrosion resistant compounds.

.15 Conduit shall not pass through structural members without the permission of the Departmental Representative.

.16 A sufficient number of fittings shall be used to permit easy pulling of wires. Conduits shall be continuous, and shall be made electrically and mechanically secure throughout.

.17 Conduits shall not run directly between outlets on the opposite sides of a common partition, in order to prevent sound transmission.

.18 It is strictly prohibited to install or otherwise “conceal” any types of rigid or flexible conduits, cables, etc. “within” the uppermost, or top portions of metal type Q-Deck “flutes”, regardless of their intended use(s).

.1 All or any types of wiring associated with metal type decking is to be “surface” installed on underside, or room side of same.

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

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

.21 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.22 Mechanically bend steel conduit over 21mm diameter.

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

.24 Install fish cord in empty conduits.

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

.26 Dry conduits out before installing wire.

3.2 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1500mm clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended or surface channels.

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

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

3.3 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

3.4 COUPLINGS AND CONNECTORS

.1 Threaded couplings shall be used for all rigid steel threaded conduit joints. All joints in or below concrete slabs shall be thoroughly red leaded and screwed tight. No exposed threads shall be left, i.e., running thread couplings are not approved.

.2 Rigid steel threaded conduit shall connect to boxes and cabinets with the use of two, case hardened steel locknuts and insulated bushing. Painted area at locknut connections shall be scraped clean, and locknuts screwed tight to ensure ground continuity.

.3 Thinwall Type "EMT" couplings shall be securely tightened.

.4 Connectors for thinwall Type "EMT", liquid tight and flexible conduit or cable shall terminate at boxes and cabinets with one case hardened locknut. Painted area shall be scraped clean, and locknut screwed tight to ensure ground continuity.

.5 Couplings and connectors for rigid P.V.C. shall be cleaned with solvent and joined with cement C.S.A. approved for the purpose.

3.5 CONDUIT FITTINGS

.1 Install conduit fittings where required. Secure conduit in fittings and secure conduit to structure within 300mm of fitting.

.2 Colour code coverplates, ceiling splines and access covers in accordance with Section 26 05 01.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

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

.2 Section 26 24 13 Generator Paralleling Switchgear.

.3 Section 26 99 99 Commissioning.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI C39.1-1981, Requirements, Electrical Analog Indicating Instruments.

.2 CSA International

.1 CAN3-C17-M84(R2008), Alternating - Current Electricity Metering.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for metering and switchgear instruments and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Include meter, instrument, outline dimensions, panel drilling dimensions and installation cutout template.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect metering and switchgear instruments from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan and Waste Reduction Workplan in accordance with Section 01 74 21 – Construction Demolition Waste Management.

Part 2 Products

2.1 METER

.1 Owner metering shall be provided integral to the switchgear. Utility grade PT's and CT's will be provided by switchgear manufacturer.

.2 Current transformers shall be epoxy moulded compact construction for bus bar connections. Quantities and ratings shall be as indicated on the drawings.

.3 Owner's metering system shall be a microprocessor-based unit with non-volatile memory and programmable CT and PT ratios. Unit shall be powered directly from the 600V AC line. The main meter unit shall have:

.1 Amperes, phases A, B and C.

.2 Volts, phases A-B, B-C, C-A, A-N, B-N, and C-N.

.3 Watts.

.4 Vars.

.5 VA.

.6 Watt-hours.

.7 Var-hours.

.8 VA-hours.

.9 Power factor.

.10 Frequency.

.4 Provide meter complete with BACnet card and Ethernet card.

2.2 MANUFACTURER

.1 Acceptable manufacturer: Powerlogic PM8000 series. No alternates will be accepted.

2.3 SHOP INSTALLATION

.1 Install meters and instrument transformers in separate compartment of switchgear. Meter display and operator control functions to be front accessible.

.2 Install instruments on switchgear.

.3 Ensure adequate spacing between current transformers installed on each phase.

.4 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources, and electrical supplies.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metering and switchgear instruments installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Departmental Representative.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 METERING INSTALLATION

.1 Install meters and instruments in location free from vibration and shock.

.2 Make connections in accordance with diagrams.

.3 If applicable, ensure power factor corrective equipment connected on load side of meter.

.4 Connect meter and instrument transformer to ground.

.5 Owners metering shall be supplied, installed and tested as part of the switchgear package.

.6 Connect meter to BACnet network as indicated on the drawing. Allow to update existing BACnet network to integrate the new added meter.

.7 Connect meter to Ethernet network as indicated on drawing. Electrical contractor is responsible to update existing BIO Campus ION network software to integrate the new meter.

.8 Provide meter test switch and install as indicated on the drawings.

3.3 FIELD QUALITY CONTROL

.1 Conduct tests in accordance with Section 26 05 01 - Common Work Results - Electrical and in accordance with manufacturer's recommendations.

.2 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.

.3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.

.4 Perform tests to obtain correct calibration.

.5 Do not dismantle meters and instruments.

.6 Complete static verification, start-up and functional performance testing by a manufacturer’s qualified representative. Pay of all associated cost.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 21 – Construction Demolition Waste Management.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by metering and switchboard instrument installation.

END OF SECTION

Part 1 General

1.1 RELATED SECTION

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

.2 Section 26 99 99 Commissioning.

1.2 REFERENCES

.1 CSA International:

.1 CAN/CSA-C22.2 No.47-M90(R2007), Air-Cooled Transformers (Dry Type).

.2 CSA C9-02(R2007), Dry-Type Transformers.

.3 CAN/CSA-C802.2-06, Minimum Efficiency Values for Dry Type Transformers.

.2 National Electrical Manufacturers Association (NEMA).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for dry type transformers and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit voltage regulation/tap tests.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 See Section 01 74 21 Construction Demolition Waste Management.

.2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for dry type transformers for incorporation into manual.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect dry type transformers from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DESIGN DESCRIPTION

.1 Design 1.

.1 Type: ANN.

.2 3 phase, 600V input, 120/208V output, 60 Hz, size as indicated on the drawings.

.3 Voltage taps: standard.

.4 Insulation: Class H, 150degrees C temperature rise.

.5 Basic Impulse Level (BIL): standard.

.6 Hipot: standard.

.7 Average sound level: standard.

.8 Impedance at 17 degrees C: standard.

.9 Mounting: floor.

.10 Finish: in accordance with Section 26 05 01 - Common Work Results - Electrical.

.11 Copper windings.

.12 Winding configuration to be as noted on drawings.

.13 K-Rated Transformers K-4.

.14 Voltage Regulation to be 4% or better.

.15 Transformer to be equipped with dual spade transformer lugs, secured to transformer chassis for grounding.

2.2 ENCLOSURE

.1 Enclosure to be fabricated from sheet steel, complete with removable metal front panel. Enclosures and ventilation grilles shall be drip-proof as a minimum in accordance with C.E.C. 26-008.

.2 Install transformer on housekeeping pad in accordance with Section 26 05 01.

.3 Transformers shall be mounted on vibration isolators to reduce noise transmission. These isolators shall be located between the enclosure and the housekeeping pad and shall be in addition to isolators located between the core and coil assembly and the enclosure.

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Label size: 7.

Part 3 Execution

3.1 INSTALLATION

.1 Mount dry type transformers on floor.

.2 Ensure adequate clearance around transformer for ventilation.

.3 Install transformers in level upright position.

.4 Remove shipping supports only after transformer is installed and just before putting into service.

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

.6 Make primary and secondary connections in accordance with wiring diagram.

.7 Energize transformers after installation is complete.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 Common Work Results - Electrical.

.2 Complete static verification, start-up and functional performance testing by a manufacturer's qualified representative. Pay for all associated costs.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 Construction Demolition Waste Management.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by dry type transformers installation.

END OF SECTION

Part 1 GENERAL

1.1 RELATED REQUIREMENTS

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

.2 Section 26 09 23.01 Metering and Switchgear Instruments.

.3 Section 26 28 16.02 Moulded Case Circuit Breakers.

.4 Section 26 28 16 Power Circuit Breakers.

.5 Section 26 32 13 Power Generation Diesel.

.6 Section 26 36 23 Automatic Load Transfer Equipment.

.7 Section 26 99 99 Commissioning.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International):

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

.2 Electrical Equipment Manufacturers Advisory Council (EEMAC):

.1 EEMAC 2Y-1-58, Light Grey Colour for Interior Panels.

.3 American National Standards Institute (ANSI):

.1 ANSI-C37.13 – Low Voltage Power Circuit Breakers.

.2 ANSI-C37.17 – Trip Devices.

.3 ANSI-C37.20.1 – Switchgear Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit shop drawings with single line diagram of entire Switchgear assembly.

.3 Provide operation and maintenance data for generator paralleling switchgear for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.4 Include operating information required for start-up, synchronizing and shut down of generating units.

1.4 HEALTH AND SAFETY

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 WARRANTY

.1 Manufacturer shall warrant the equipment for a minimum of eighteen months from date of shipment subject to terms and conditions of manufacturer’s current warranty publication.

.2 Manufacturer shall have an established network of factory-direct service technicians capable of servicing the equipment.

.3 Manufacturer's field service representatives shall be on call and available for immediate dispatch 24 hours a day, 365 days a year. All field service personnel shall be factory trained, by the manufacturer, and certified in the maintenance and repair of the specified equipment.

Part 2 Products

2.1 GENERAL

.1 Provide indoor generator paralleling switchgear including digital control and distribution system to automatically start and parallel Generator 1 and Generator 2. Each generator is rated 1000 kW, 347/600V, 3ph, P.F. 0.8.

.2 Switchgear maximum dimension shall be 3860 mm (width) x 2324 mm (height) x 1524 mm (depth).

.3 Switchgear shall include 4 modules sections as follows:

.1 Section 1 and Section 2: dedicated to all related paralleling control and distribution including and not limited to: Generator 1 control, Generator 2 control, master control, and generators circuit breakers, etc.

.2 Section 3: power distribution and metering.

.3 Section 4: space for future distribution.

.4 Provide new circuit breaker as shown on electrical drawing. Re-locate existing circuit breaker and re-install in distribution Section 3 as shown on Electrical Drawing E-102. Provide new mounting brackets for all re-located circuit breakers and refer to Electrical Drawing E-101 for existing circuit breakers model number.

.5 Circuit breakers in Section 3 shall be installed on the same order shown on Drawing E-102 to allow for re-terminating existing cable **(splicing existing cable is not accepted)**.

.6 Switchgear shall provide new paralleling control to existing and new ATS(s). Refer to Electrical Drawing E-101 for existing ATS(s) model number.

2.2 SWITCHGEAR ENCLOSURE

.1 The enclosure shall be CSA Type 2 rated (or higher), free-standing and floor supported, with front and rear access. An adequate number of anchor bolts shall be designed to place the base in direct contact with the foundation when bolted. All doors shall be formed of 11 gauge steel, and be provided with sufficient hinges to support the door and components. Doors must swing open more than 90 degrees. Front doors shall be supplied with a lockable handle. Rear doors shall be supplied on all bussed sections. All door locks shall be keyed alike, with one key supplied for each lock. All panel covers shall be formed type, and secured with screws as necessary.

.2 Main bus shall be silver plated copper. Main bus shall be rated for 2500 ampere and have a minimum bracing level of not less than 50 kAic RMS symmetrical.

.3 Control wiring shall be CSA rated for 600 volt. Current transformer circuit termination shall be ring tongue type and include shorting terminal blocks.

.4 Control wires shall be numbered every 203 mm or less and visible next to the terminals. Wiring shall be permanently marked with wire termination designations. These designations shall include the device and connection point where the wire is terminated. All control wire markings shall be printed directly on the wire insulation and be permanent. Current transformer wire shall be 12 gauge.

.5 Low level signal circuits shall be separated and provided with shielded wire to minimize electromagnetic interference. Shielded wire shall be grounded at one point. Ethernet cabling shall be unshielded Category 5 or higher.

.6 Wiring between each section shall not be spliced, and shall be free of abrasions and tool marks. Connections between cubicles shall use labelled connection plugs. Wire shall be placed in wire duct or harnessed, and shall be supported to prevent sagging or breakage from weight or vibration. Inter-cubicle wiring harnesses shall be contained in overhead steel wire troughs. Communication cables and current transformer circuits shall be hard wired.

.7 All wiring to hinged doors shall be run through door terminal blocks or connection plugs. **Terminal blocks shall be provided for all external connections and placed in an accessible area not exposed to hazardous bus or cables, if possible.** Current transformer circuits shall be connected through shorting terminal blocks.

.8 Components:

.1 Synchroscope: Synchroscope shall consist of industrial switchboard type metres, 114.3 mm square, 1% accuracy.

.2 Current Transformers: Current transformers shall be furnished with VA burden ratings suitable to supply the metering and protective devices without affecting accuracy.

.3 Potential Transformers: Three wye-wye connected potential transformers shall be provided in turns ratio and VA burden rating to be compatible with the controls and voltage sensing as applied. Transformers shall have integrally mounted primary and secondary fuses.

.4 Alarm and Status Indication: Visual and audible alarm and status indication lights, including spares, shall be provided. Visual alarms shall be reset only after the fault condition has been corrected. The audible alarm shall include a silencing circuit which after activation shall permit audible annunciation of subsequent failures. Lamp test shall be an integral feature of this indicator. Each illuminated indicator tile shall be 24 mm x 24 mm.

.5 Control Fuses: Fuses shall be mounted in locations where they are readily accessible. Pull-out type fuses shall be provided for all primary circuits and shall be of the current limiting type.

.9 Electromagnetic Control Relays: All electromagnetic control relays shall be suitable and adequately rated for their intended service in the control system. All relays for control circuit duty shall be plug-in type with retaining clips and transparent plastic covers. Relays shall be clearly marked for control voltage. When possible, all relays shall have light-emitting diodes to indicate that the coil is energized.

2.3 ACCEPTABLE MANUFACTURER

.1 The equipment described shall be manufactured by ASCO Power Technologies (4000 Series) Any alternates to this bid shall only be considered if a complete written description of the proposed system along with any variances to the specification, are received ten days prior to bid due date. Any variances not specifically enumerated prior to bidding shall be considered non-responsive. Alternate manufacturers must be approved in writing.

.2 Paralleling control systems mounted on the generator skid are not accepted.

2.4 GENERATOR POWER CONTROL SECTION

.1 Each generator section shall contain over-current protection, controls, relays, and auxiliary devices associated with its respective engine generator set. It shall include the following:

.1 For each generator set, low voltage power circuit breaker shall be provided to provide over-current protection and paralleling functions. Refer to Section 26 28 16 Power Circuit Breakers and electrical drawing for requirements.

.2 Generator Control System:

.1 Paralleling controls for each generator shall include a programmable logic controller and a Woodward DSLC-2 digital synchronizer and load controller designed for use on three-phase AC generators and mounted in the switchgear. The controls shall combine a synchronizer (with voltage matching capability), load sensor, load control, dead bus closing system interlock, VAR, power factor, and process control. The load sharing network and VAR sharing network shall be completely integrated in the switchgear.

.2 The controls shall sense true RMS power and provide soft loading and unloading functions on the main bus.

.3 DC-to-DC converter(s) shall be in each generator control section to provide a constant 24V DC power. The generator section DC-to-DC converter shall supplement the Dc-to-DC converter in the master control section. Control power shall be sourced from generator set batteries and sustain adequate control voltage during an engine crank. The converters shall provide power for up to 75% rated load if the source voltage drops to 12 volts. Source voltage shall not exceed 32 volts.

.4 Generator controls shall include the following functions, components, devices, and indicators.

.1 Reverse Power Protection (Device 32R).

.2 Generator Voltage Monitoring and Frequency Monitoring:

.1 Generator controls shall monitor voltage and frequency to ensure the generator is not connected to the bus until frequency is at least 59 hertz and 90% rated voltage.

.3 Automatic Synchronizer:

.1 The synchronizer shall include a differential voltage detector, differential frequency detector and differential phase detector. Analog voltage bias signal shall be provided for frequency matching and phase angle control. Synchronizer shall issue a

breaker close signal when frequency, phase and voltage conditions are met.

.2 The differential voltage detector shall compare the voltage of the oncoming generator to the paralleling bus. If the voltage is not within the factory set difference of plus or minus 5% (adjustable from 0 to plus or minus 10%), the voltage detector shall inhibit the circuit breaker from closing. When the oncoming generator voltage is within the preset acceptable limit, the inhibit shall be removed.

.3 The differential frequency detector shall compare the frequency of the oncoming engine generator set to the paralleling bus. If the frequency is not within the preset acceptable difference of plus or minus 0.5 Hz (adjustable from 0 to plus or minus 0.5 Hz), the frequency detector shall inhibit the circuit breaker from closing. When the oncoming engine generator frequency is within the acceptable limit, the inhibit shall be removed.

.4 The differential phase detector shall compare the phase angle of the oncoming engine generator set to the paralleling bus. If the phase angle is not within the preset acceptable difference of plus or minus 0.05 Hz (adjustable from plus/minus 0.02 to 0.25 Hz), the phase detector shall inhibit the circuit breaker from closing. When the oncoming engine generator phase angle is within the acceptable limit, the inhibit shall be removed.

.4 Multiple Circuit Interlock:

.1 Generator controls shall provide for first-up, first-on operation of the generator set. This device shall positively prevent more than one set from being simultaneously connected to a dead bus. Upon initiation of the connection of the first set to the bus, this circuit shall shift the control of the remaining sets to automatic or manual synchronizing at the operator's discretion.

.5 Input/output module shall be supplied by generators suppliers and installed/terminated by switchgear supplier. The following is a list of alarms and shutdowns input and output signals and shall be confirmed during shop drawing review phase:

.1 Low fuel level.

.2 High fuel level.

.3 Low battery voltage.

.4 Ventilation failure.

.5 Low coolant temperature.

.6 Engine coolant level.

.7 Battery failure.

.8 Generator run status.

.9 Generator control not in auto.

.10 Unexpected engine shutdown.

.11 Engine overcrank.

.12 Engine overspeed.

.13 Engine high temperature.

.14 Engine low lube oil pressure.

.15 Short circuit.

.16 AC over voltage.

.17 Engine stop.

.18 Engine failure to start.

.6 Contractor shall provide Modbus to BACnet converter complete with all required wiring, conduit and interconnection. Connect to BIO Campus existing BACnet system. Modbus mapping shall monitor the following:

.1 Parallel circuit breaker withdrawn.

.2 Local gen breaker open.

.3 Parallel circuit breaker closed.

.4 24V DC control voltage failure.

.5 DC-DC converter failure

.6 Local gen controls not in auto.

.7 Common shutdown.

.3 Engine Starting Control:

.1 The engine starting control shall be in a dedicated programmable logic controller and shall automatically start, protect and monitor each engine generator set. The controller shall be provided with power supply, CPU and required I/O modules. Engine start control shall additionally be hard wired so that the engine can be automatically or manually started if the controller is not available. The programmable logic controller shall be dedicated for control exclusively of the engine and generator set and shall be independent of the Master PLC. Distributed I/O systems which rely on a master controller shall not be acceptable.

.2 Engine Start/Stop Operation: The automatic engine control logic shall initiate operation of the engine upon receipt of a signal from a contact that closes for engine run, and opens for engine stop.

.3 Five Position Engine Control Selector Switch:

.1 Lockout/Reset: When placed in this position, the engine shall not be capable of starting and/or running. If the engine was shut down due to the operation of a protective device, the shutdown malfunction shall be reset when the switch is moved to this position. If the engine is running when the switch is moved to this position, it shall immediately shut down.

.2 Off/Cool-down: When placed in this position, the engine shall shut down after soft unloading from the bus (provided another source is connected to the bus) and a cool-down period.

.3 Automatic: When placed is this position, the engine control shall be in readiness for fully automatic operation upon receipt of a start signal.

.4 Test Off-line: When placed in this position, the engine shall start and run as if a start signal were received except it shall not be connected to the bus. If a start signal is received, normal automatic functions shall

resume. When returned to the Automatic position, the engine shall shut down.

.5 Test On-line: When placed in this position, the engine shall start, run and connect to the bus. When returned to the Automatic position, the circuit breaker shall open, provided no automatic start signal is present, and the engine shall run for its cool-down period before shutting down.

.4 Four Position Synchronizing Mode Selector Switch:

.1 Permissive: In this position, the governor controls are deactivated. However, the synchronizer shall operate as a passive synch check relay and signal the closing of the generator breaker when both sources are in phase.

.2 Check: In this position, the synchronizer is fully operational except it cannot close the generator breaker. The phase=lock feature holds the generator output in synchronism with the bus.

.3 Off: In this position, the synchronizer is turned off to allow for manual paralleling at the Master Cubicle.

.4 Run: In this position, the synchronizer is in the fully operational, automatic mode.

.5 Engine Cool-down Time Delay: The cool-down time delay shall be adjustable from 1 to 10 minutes (factory set at 5 minutes) and automatically bypassed for malfunction and manual shutdown of the engine generator set.

.6 Failure to Synchronize Time Delay: The failure to synchronize time delay shall be fixed at 60 seconds. It shall provide audible and visual indication, but it shall not terminate synchronizing attempts not shut down the engine.

.4 Alarm and Status Indication:

.1

Function	**Colour**
Lamp Test (Push Button)	
Parallel CB Open	Green
Parallel CB Closed	Red
Auto Start	Green
Engine Running	Green
PLC Stopped	Red
Control Voltage Failure	Red
Controls Not In Auto	Red
PowerQuest Override	Amber
Gen Common Shutdown	Red
DC Converter Failure	Red
DSLC-2 Self Test Failed	Red

.5 Generator Control Station:

.1

Function	**Selections**
Generator Control Switch	Lockout/Reset
	Off/Cool-down
	Automatic
	Test Off-line
	Test On-line
Synchronizing Mode Switch	Permissive

	Check
	Off/Cool-down
	Run
Emergency Stop Push Button	---
Alarm Rest Push Button	---
Voltage Control Switch	Lower
	Off
	Raise
Speed Control	Lower
	Off
	Raise

2.5 MASTER CONTROL SELECTION

.1 The master control selection shall contain a programmable logic control capable of storing necessary control sequence algorithms, variable operation set-points, time delays, and alarming levels. Distributed I/O stations shall include modular input and output cards for discrete and analog signals necessary to provide the integrated system operations specified below.

.1 Priority Load Control:

.1 Discrete output modules shall be provided to control the necessary priority load blocks. The number of load blocks shall equal the number of engine generator sets, and shall be sized such that the connectable load of each block is not greater than the kilowatt rating of the generator set connected. As the generators are connected to the bus, the controller shall signal for the connection of the load blocks in an ascending sequential priority with the highest priority load requiring emergency power being connected first. Priority failure pass-along logic shall initiate the connection of low priority loads to the first generator on-line it start signals have not been received from high priority transfer switches or other devices.

.2 Load shedding shall be done on a last-on, first-off basis. The generator bus shall have a solid-state frequency monitor, with integral time delay to initiate load shedding upon a reduction of bus frequency to 58 Hz or less, for a period of three seconds or more. Upon sensing a bus underfrequency, the system shall automatically shed the lowest priority load connected at the time occurrence. This shed circuit shall override any manual load-add operation, and shall lock out the manual load-add circuitry. It shall provide an audible alarm annunciation of bus underfrequency load shed.

.3 Provide means to reset the bus underfrequency signal.

.4 Provide a “load shed bypass/reset” push-button, for manual supervised operation over the load-shed, load-add control logic. One push-button shall be provided for each priority block except first priority. Logic shall be provided in the event that a bus overload occurs resulting in a reduction in bus frequency; the bypassed priority load shall be shed automatically through override logic control.

.2 Power Management Applications:

.1 Master controls applications shall include Load Bus Optimization and Generator Load Demand.

.2 Load Bus Optimization shall control individually prioritized and separately controlled distribution loads via power transfer switches and/or electrically operated circuit breakers. Loads shall be added or removed from a bus segment according to the available headroom on the bus.

.3 Generator Load Demand shall control individually prioritized and separately controlled engine-generator sets. Engine-generator sets shall be added or removed from a bus segment according to dynamic measurements of power consumption and engine-generator efficiency set-points.

.3 Manual Paralleling Controls:

.1 A Synchroscope selector switch shall be provided to select any generator for manual paralleling operation. The positioning of the selector switch shall simultaneously connect the synch-check relay, Synchroscope, and "manual paralleling" push-button to the selected generator.

A solid-state sync check relay shall be furnished for manual paralleling, to sense and compare the phase angle difference between the oncoming generator and the bus. This relay shall lockout the manual paralleling push-button until the oncoming generator is within 15 degrees of synchronism.

.2 Operation shall be arranged so the operator shall depress and hold the manual paralleling push-button. When the relative phase angle reduces to 15 degrees and going towards zero degrees, the sync check relay's output contact shall initiate the closing of the respective oncoming generator breaker.

.3 The manual paralleling interface controls and metering shall be grouped in a central location on the front of the master control section. This shall allow for paralleling multiple generators from one location within the switchgear. Manual paralleling controls and sync check relay shall be hardwired and shall not rely on touch screens or programmable logic controllers to perform manual paralleling functions.

.4 DC Control Power Selector – Best Battery System:

.1 Control power for the system logic shall be derived from the engine starting batteries and/or an optional station battery system. The control logic shall be powered through a suitable means that shall permit continuity of power until the last battery is no longer available. The controls shall be powered from any battery or combination of batteries and prevent feedback to a failing battery. The transition of control logic power from any battery combination to any other battery combination shall be accomplished without disruption in the power flow.

.2 DC-to-DC converters shall provide a constant 24VDC power to the master and generator controllers during starting and cranking of all engine generator sets "simultaneously".

.3 Additionally, the best battery system shall provide power to each generator paralleling circuit breaker trip coil if the generator battery power to its cubicle is lost.

.5 System Test Switch:

.1 Provide a system no-load test switch to initiate a complete automatic system operation by simulating the closure of the remote engine start signal.

.6 Alarm and Status Indication:

Function	**Colour**
Lamp Test (Push Button)	---
Emergency Mode	Amber
I/O Comm Failure	Red
Bus Under Frequency	Red
ATS Control Fuse Blown	Red
PLC 1 Stopped	Red
PLC 2 Stopped**	Red
Control Voltage Failure	Red
DC Converter Failure	Red

** Only with redundancy option.

.7 Main Audible Alarm:

.1 Provide a main audible alarm. The alarm horn shall be the DC vibration type, subsequent malfunctions to resound the alarm if the horn had been previously silenced.

.8 Paralleling Bus Metering / Instrumentation:

.1 Synchroscope and Synchroscope Plant Selector Switch with positions for each generator.

.2 Bus Under/Over-Voltage Relay.

.3 Bus Under/Over-Frequency Relay.

.9 Master Control Station:

Function	**Colour**
Bus Alarm Push Button	---
Alarm Silence Push Button	Red
Manual Parallel Push Button	Green

.10 Master Controller:

.1 GE RX3i with CPU, power supply, I/O, and communications.

.2 The controller shall have the capability to interface to distributed I/O racks.

2.6 OPERATOR INTERFACE TERMINALS

.1 The monitoring and control interface shall be ASCO PowerQuest 4000 HMI.

.2 The monitoring and control interface shall include programmable 15” colour touch screen units and shall interface with Programmable Logic Controllers, Synchronizer/Load Controllers (PCS 4000 DSLC-2) and Transfer Switches. The automatic operation of the

system shall not be impeded by the unavailability, disconnection or failure of any single or all colour touch screens.

.3 The default screen shall consist of a one-line overview of the system that includes:

.1 Dynamically updated and colour-coded (according to status) one-line representing power flow and sources, and emergency power system elements such as engine-generator sets, circuit breakers included in the scope of delivery (including breaker position and alarms), and transfer switches (including transfer switch position, source availability, and bypass position if available).

.2 Communication status of PLCs.

.3 Dynamically updated and colour-coded interconnect lines representing power flow and source.

.4 ATS summary screen shall be accessible via menu button.

.5 The current main bus KW value.

.4 Additional screens shall include:

.1 Generator status shall include dynamically updated colour indications and signal nomenclature.

.2 Generator control shall include fully functional engine control switch and synchronizing mode switch.

.3 Generator metering screens shall include dynamically updated values.

.4 Synchronizer/Load Share controller screens shall include dynamically updated parameters that are available from the controller such as metering status (voltages, currents, power measurements) and synchronization status (frequencies, voltages, synchroscope).

.5 Transfer Switch screens shall include details of selected transfer switches including present state and position, source availability, transfer/retransfer controls (password protected), bypass status, pickup/dropout settings, time delay settings, and metering data.

.6 A load management screen which shall dynamically indicate the current load demand status and provide operator controls to change settings (password protected). Each generator shall be represented and include “pick up” and “drop out” information and parameters (user-defined time delays, current timer status, and actual power) to manage loading of all engine-generator sets.

.7 A bus optimization screen which shall dynamically indicate application status (enabled/disabled), most recent step load added, next available step load information, headroom, and priority load shed controls.

.8 A generator priority screen for load demand.

.9 A load priority screen for assigning unique priorities and tag names to each transfer switch and/or electrically operated circuit breaker for distribution loads. Parameters for each load shall include and step add time delay. Transfer switches shall include (when available) engine start signal, load shed signal, and HOA (Hand-Off-Auto) mode.

.10 An alarm summary screen with a current listing of all active alarms and file archival.

.11 An alarm history screen with file archival.

.12 A communication status screen shall be dynamically updated and include redundant PLC status information and indicate which redundant PLC is currently in control.

.13 Historical trending of up to 4 parameters: voltage, frequency, real power (KW) and reactive power (KVAR).

.5 The following discrete status and alarms shall be displayed (when available):

.1	Warnings	Low Oil Pressure Pre-Alarm High Water Temperature Pre-Alarm Low Coolant Level Battery Charger Failure Low Battery Voltage High Battery Voltage Engine Battery Common Alarm Day Tank 1 Low Fuel Day Tank 1 High Fuel Day Tank 2 Low Fuel Day Tank 2 High Fuel Day Tank Ruptured Basin Low Water Temperature Common Alarm Ground Fault Alarm 24VDC Control Voltage failed Fail To Synchronize Circuit Breaker Open Failure DC-DC Converter Failure
.2	Monitored Shutdown Conditions	Local Gen Controls Not In Auto Day Tank Low Fuel Critical Low Oil Pressure Shutdown High Water Temperature Shutdown Overspeed Shutdown Reverse Power Shutdown Parallel Circuit Breaker Tripped Overcrank Shutdown Common Shutdown Paralleling Gear Emergency Stop Remove Emergency Stop Reverse KVAR Shutdown Controls Not In Auto Circuit Breaker Close Failure Local Gen Breaker Open Shutdown
.3	Status	Parallel CB Not Connected Auto Start Present ECS Reset Required Local Gen CB Open Local Gen CB Closed Paralleling Gen CB Open Paralleling Gen CB Closed Generator Running

.6 Security features shall include definition of at least three distinct security levels (monitor, control, manage) and a unique user name and password for each individual. Each individual account shall also be assigned to a security level thereby defining the scope of their access and control. If an individual is logged in to the system with no activity for 15 minutes, the individual shall be automatically logged out.

.7 On loss of screen communication, the operator must be able to take control at any time; systems that utilize "instant auto" features shall be excluded.

.8 Screens shall be turned off (power standby mode) after 30 minutes of inactivity to protect the LCD monitor; a single touch of the screen shall turn the screen back on.

2.7 DISTRIBUTION SECTIONS

.1 Emergency distribution sections shall be provided with number and size of distribution circuit breakers as shown on the project drawings.

.2 All relocated and new circuit breakers shall be installed on emergency distribution section as shown on the drawing. Refer to electrical drawing for circuit breaker mounting order to accommodate re-terminating existing feeders.

.3 Distribution sections shall be provided with main bus of the same ampacity as the generator switchgear sections. Bus shall be 3 phase, 4 wire, copper, rated 2500A. Neutral bus shall be 100 % rated.

.4 New circuit breakers and re-located circuit shall be from the manufacturer.

2.8 SEQUENCE OF OPERATION

.1 The Digital Paralleling Control System is designed to start and parallel all engine generator sets "Generator 1" and "Generator 2", upon receipt of a signal from 6 automatic transfer switches that emergency power is required.

.2 Normal Mode: Whenever the individual engine generator control switches are placed in their automatic position, the engine generator system is on standby in readiness for automatic starting and synchronization in the event of a power failure signal or system test.

.3 Emergency Mode:

.1 In the event of a power failure, all generators automatically start and come up to speed. The first generator set to achieve 90% of nominal voltage and frequency shall be connected to the bus. Master interlock permit the connection of only one engine generator to the dead generator bus in the event of simultaneous generator relay operation. Upon sensing the availability of emergency power, the priority-1 load block will be allowed to transfer their loads to the emergency bus, either through direct control or through a "permissive signal" to the automatic transfer switches. Second synchronizer will automatically adjust the frequency of the on-coming generator to synchronize with the bus. When synchronism is achieved, the on-coming generator is paralleled to the bus. When the second generator's circuit breaker is closed the priority-2 load block will be allowed to transfer their loads to the emergency bus. As each generator parallels to the bus, another block of load is allowed to be added, until all generators and all loads are online. Both gensets will start sharing the load equally.

.2 Upon sensing that normal utility power has been restored to acceptable limits, a sequence shall begin to transfer the load back to the utility source. The re-transfer shall be initiated after the retransfer to utility time delay has expired (adjustable at each ATS from 0 minute to 30 minutes) allowing an open transition transfer return to utility. After all the transfer switches have re-transferred their loads to the normal source, the generator circuit breakers are simultaneously opened and the engine generators run for an adjustable no-load cool-down period of zero to thirty minutes; factory set at 5-minutes. The controls are released and the generators are placed in readiness for the next power failure.

.3 If a generator fails while operating in the automatic mode, it is disconnected from the bus and shutdown. Audible and visual alarms will be activated to indicate the condition.

.4 A push-button permits override of the load-shed circuits for supervised operation (one for each priority except priority 1). Loads that have been block shed can be manually re-added using the priority-# Load Shed Bypass/Reset push-button located on the Master control section Touch Screen.

.5 In the future if more load is added to the system (total more than 1MW), the lowest priority feeder loads (as programmed by the operator via the Touch Screen) are signaled to shed so as to leave one block of load online (less than 1MW) per generator.

.6 Priority loads shall be as follows:

.1 ATS 1 Fish LAB.

.2 ATS 3 Ellis LAB.

.3 ATS 6 (new ATS for the heating load).

.4 ATS 4 and ATS 5 Coast Guard Building.

.5 ATS 2 Energy Centre.

.7 For now “Generator 1” and “Generator 2” will provide 100% redundancy for BIO emergency system in BIO campus. New added “ATS 6” shall include load shedding contacts connected to the switchgear load management system and ready for load shedding sequence to allow for future step shedding.

.8 The Digital Paralleling Control System shall be capable to provide load management up to 12 ATS.

.4 Generator No Load Test: A system test switch shall be provided in the master control Touch Screen to limit access to authorized persons only. Operation of this switch will initiate an automatic system operation as if an ATS Accessory 7 (engine start signal) from any of the automatic transfer switches had operated. However, unless a normal source outage occurs during this mode of operation, the transfer switches will not transfer its load to the emergency bus. To terminate this test, the system test switch is reset to initiate a normal system shutdown sequence.

.5 Single Engine Test: Each engine can be started for test purposes by placing its generator control switch to the test off-line position. In this mode, the generator circuit breaker will remain open. Should a normal source outage occur during this mode of operation, the breaker will close and the remaining units will be started. Upon restoration of normal power, the system will revert to single engine test mode until the switch is returned to the AUTOMATIC position. For on-line test, placing of the generator control switch to the

test on-line position will present a similar operation except that the generator breaker will close when the generator achieves nominal voltage and frequency.

.6 ATS Hand – Off – Auto (H-O-A) Controls:

.1 The system shall be capable of H-O-A control for the ATSs provided the ATSs are equipped with the load shed relay ("Acc 30B" signal). During Emergency Mode any ATS can be individually added to the bus or shed via these controls. The operator can select the ATS to be added by placing it in the HAND position. When placed in the HAND position, the load shed relay ("Acc 30B" signal) at the ATS will be energized (if not already energized via normal load control), allowing the ATS to transfer to Emergency. If the operator inadvertently adds too much load, causing a Bus Underfrequency condition, all HAND switches will be reset back to AUTO and the system will revert to Normal load control.

.2 When the ATS is placed back into the AUTO position, the ATS will function per normal load control. Any switch that does not have an Acc 30B picked up by normal load control (i.e. the switch is in Load Shed) will be immediately transferred back to Normal.

.3 When an ATS first calls for an engine start, the system will immediately begin emergency mode. Any ATS left in the HAND position will be returned to AUTO and normal load control will commence.

.4 If an ATS is placed in the OFF position, it will NEVER transfer to emergency. Any ATS left in the OFF position will not automatically return to AUTO at the start of emergency mode. An ATS left in the OFF position can only be taken out of OFF via the HOA switch. If the system is running in emergency mode, placing an ATS in the OFF position will immediately shed it from the emergency source.

2.9 MASTER PLC

.1 The Master PLC shall be a fully-functioning PLC that includes and executes the actual sequences of operation from the PCS system.

2.10 CONFIGURATION STATION

.1 The Configuration Station shall include application software simulating devices and system components including breakers, synchronizers, switchgear control stations, transfer switches, utility feeds and generators. The Configuration Station shall also provide ways to set up scenarios including device and component failures and system events in order to test operator knowledge, capabilities and responsiveness.

2.11 ACCESSORIES

.1 In addition to circuit breaker accessories, shown in Sections 26 28 16 and 26 28 16.02 the following shall be provided:

.1 A portable circuit breaker lifting device shall be provided.

.2 A portable circuit breaker test kit shall be provided.

2.12 FINISHES

.1 Apply finishes in accordance with Section 26 05 01 Common Work Results – Electrical.

2.13 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 Common Work Results – Electrical.

2.14 WITNESS TEST

.1 An inspection and witness test of the switchgear prior to shipment shall be scheduled in advance with the factory.

.2 Metal enclosures shop finished by cleaning, priming inside and out with rust resistant primer and finished with at least two coats of enamel.

.1 Interior surfaces: grey.

.2 Exterior surfaces: grey enamel, minimum thickness 0.05 mm light grey colour to EEMAC 2Y-1.

.3 Supply two tins of spray touch-up enamel as recommended by manufacturer.

Part 3 Execution

3.1 INSTALLATION

.1 The manufacturer of the generator control switchgear shall provide the services of a factory-employed and factory-trained technician to provide installation assistance.

.2 Inspect for obvious shipping damage.

.3 The switchgear is properly installed, anchored and grounded.

.4 Shipping splits have been reinstalled with the splits bolted together, interconnect wiring installed, and bus splice plates installed.

.5 Terminate all power cables.

.6 Install customer control wiring to external equipment including engines, batteries, building management systems, associated motor control, etc..

.7 The engine generator set is installed and ready to run.

.8 Associated motor controls, plumbing, building utilities are complete and operational.

.9 Verify contractor connections and control power availability.

.10 With the engine generator supplier's technical representative controlling the engines, verify that the switchgear and control equipment are fully operational, and perform per the sequence of operation specified. Test equipment (load bank – maximum 5 days) and services as required for the engine generator sets shall be provided by the engine generator set supplier.

.11 With the engine generator supplier's technical representative controlling the engines, demonstrate all functions of the control system, both automatic and manual, to the satisfaction of the Departmental Representative.

.12 Provide plant operators with instruction on the plant operating procedures and major component maintenance after acceptance by the Departmental Representative.

3.2 START-UP AND SYSTEM CHECKOUT

.1 The supplier of the generator paralleling switchgear shall supervise and check out the installation and be present at the start-up of the complete back-up power system. Provide a separate testing report for static verification and start-up verification.

.2 This supplier shall also provide instruction to maintenance personnel, on the operation and maintenance of the generator paralleling switchgear. The manufacturer shall then issue a letter to the Departmental Representative stating whether or not the installation of the generator paralleling switchgear is in accordance with the manufacturers' recommendations. All such costs associated with commission and start-up shall be included in the tender.

3.3 TRAINING

.1 In addition to the commissioning documents, the Contractor shall provide a training session for up to 6 personnel for 2 normal workdays at a jobsite location determined by the Departmental Representative.

.2 The training session shall be conducted by a manufacturer's qualified representative.

3.4 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 Common Work Results – Electrical.

.2 Perform test by a qualified, factory trained, manufacturer's representative.

.3 Include all required costs for all commissioning phases, testing and fuel costs associated with required testing.

.4 The supplier of the generator paralleling switchgear shall supervise and check out the installation and be present at the functional performance testing of the complete back-up power system.

.5 Phase 1 and Phase 2 electrical phasing procedures are associated with this project. Carry all associated costs for re-testing, re-commissioning and fuel as required.

.6 When all commissioning phases are completed, the manufacturer shall issue a letter to the Departmental Representative stating whether or not the installation of the switchgear is in accordance with the Manufacturer's recommendations.

.7 Complete two copies of field testing data sheets. Data sheets shall be signed by supplier's field technician and by the Departmental Representative.

.8 Provide one copy immediately to Departmental Representative. Make additional copies as required and include one copy in each Operating and Maintenance Manual.

END OF SECTION

PART 1 - General

1.1 RELATED SECTIONS

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

.2 Section 26 28 20 – Ground Fault Circuit Interrupters – Class A.

.3 Section 26 28 16.02 – Moulded Case Circuit Breakers.

.4 Section 26 99 99 – Commissioning.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2No.29-11, Panelboards and enclosed Panelboards.

1.3 ACTION AND INFORMATION SUBMITTALS

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

.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity, voltage and phase characteristics, and enclosure dimensions, as well as any special options called for on the drawings.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 See Section 01 74 21 Construction Demolition Waste Management.

.2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - Products

2.1 PANELBOARDS

.1 Panelboards: to CSA C22.2No.29 and product of one manufacturer and same manufacturer as distribution panels.

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 208V and 600V panelboards: bus and breakers rated for symmetrical interrupting capacities as indicated on the drawing or in the co-ordination study.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Two keys for each panelboard and key panelboards alike.

.6 All bussing shall be copper, tin plated, with a full capacity neutral, with an ampere rating as per the drawings.

.7 Mains: suitable for bolt-on breakers.

.8 All panelboard trims and door finishes are to be baked grey enamel.

.9 All enclosures to be CSA Type 1, suitable for surface mounting as indicated on the drawings. All surface mounted tubs to be sprinkler proof in accordance with C.E.C. 26-008.

.10 All panelboard tubs shall be minimum 14 gauge galvanized steel, minimum 508 mm wide.

2.2 CDP PANELS

.1 CDP panels: to CSA C22.2 No.29.

.2 ALL CDP panels to be the product of the same manufacturer as panelboards on the project.

.3 All CDP panels used on 347/600V systems shall have busses and breakers rated for 25,000 Amps (minimum, symmetrical) interrupting capacity or as shown in the co-ordination study.

.4 All CDP panels used on 120/208V systems shall have busses and breakers rated for 25,000 Amps (minimum, symmetrical) interrupting capacity or as indicated.

.5 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification.

.6 CDP Panels: mains, number of circuits, and number and size of branch circuit breakers as indicated on the drawings.

.7 All bussing shall be copper, tin plated, with a full capacity neutral, with an ampere rating as per the drawings.

.8 When connected to “K” rated transformers, 120/208V panelboards shall have a 200% rated neutral.

.9 All mains shall be suitable for bolt on breakers.

.10 All CDP panels trims are to be baked grey enamel.

.11 All enclosures to be CSA Type 1, suitable for surface mounting. All surface mounted tubs to be sprinkler proof in accordance with C.E.C. 26-008.

.12 All CDP panelboard tubs shall be 14 gauge galvanized steel with minimum dimensions of 965 mm wide x 279 mm deep - refer to drawings and panel schedules for minimum width required.

.13 Copper ground bus.

2.3 BREAKERS

.1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Lock-on devices installed as indicated on panel schedules.

2.4 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Nameplate for each panelboard size 4 engraved indicating:

.1 Panel number as per the drawings.
.2 Voltage and phase characteristics of panel.
.3 Amperage of panel.
.4 Where panel is fed from.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved.

.4 A typed directory under transparent cover shall be provided on the inside of each panel showing the location and load connected to each circuit.

PART 3 - Execution

3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Locate distribution panel on housekeeping pad in accordance with Section 26 05 01 Common Work Results - Electrical.

.3 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.

.4 Mount panelboards to height specified in Section 26 05 01 - Common Work Results - Electrical or as indicated.

.5 Connect loads to circuits.

.6 Connect neutral conductors to common neutral bus with respective neutral identified.

.7 Emergency, exit, fire alarm, sprinkler excess pressure pump and bells, and night lighting, circuit breakers shall have locking devices on the handles to prevent unauthorized operation.

.8 Wiring in panelboards shall extend beyond the respective breakers, forming a 150 mm loop before returning to connect to the breaker terminals, so there will be flexibility for reconnecting within the panel. Wiring shall be secured with Ty-wraps or equivalent means to present a neat workmanlike appearance.

.9 Rigidly anchor floor mounted panels to the floor and wall.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 – Common Work Results - Electrical.

.2 Complete static verification, start-up and functional performance testing by a manufacturer's qualified representative. Pay for all associated costs.

END OF SECTION

Panel:	PP5	**Mounting:**	Surface
Location:	Van Steenburgh Building Boiler Room	**Feeder:**	See Single Line Diagram
Type:	Cutler-Hammer P4L4A8-42	**Frame:**	FD, KD
Size:			
Rating:	800A 347/600 V 3Ph. 4W.		

No.	Brk.	Description	Load	Phase	Load	Description	Brk.	No.
1	***			A				2
3	3P/400	Panel PP4		B				4
5	***			C				6
7	***			A			***	8
9	3P/200	MCC VS1		B		Murray Building Penthouse Panel	3P/100	10
11	***			C			***	12
13	***			A			***	14
15	3P/40	30kVA Transformer		B		Vulcan Building Splitter	3P/60	16
17	***			C			***	18
19	***			A				20
21	3P/15	Pump HP-PB-P7		B				22
23	***			C				24
25	***			A				26
27	3P/15	Pump HP-PB-P8		B				28
29	***			C				30
31				A				32
33				B				34
35				C				36
37				A				38
39				B				40
41				C				42

Phase "A" Total kVA	0.00		0.00	**Phase "C" Total kVA**
Phase "B"		0.00	**Total kVA**	

Notes:
* -- Indicates Breaker To Be Complete With Handle Locking Device.

Panel:	PP8			**Mounting:**	Surface			
Location:	Murray Building Penthouse			**Feeder:**	See Single Line Diagram			
Type:	Cutler-Hammer P3aL4A2-42			**Frame:**	FD			
Size:								
Rating:	225A 347/600 V 3Ph. 4W.							
No.	**Brk.**	**Description**	**Load**	**Phase**	**Load**	**Description**	**Brk.**	**No.**
1	***		840	A				2
3	3P/40	Transformer	840	B				4
5	***		840	C				6
7				A				8
9				B				10
11				C				12
13				A				14
15				B				16
17				C				18
19				A				20
21				B				22
23				C				24
25				A				26
27				B				28
29				C				30
31				A				32
33				B				34
35				C				36
37				A				38
39				B				40
41				C				42
		Phase "A" Total kVA	0.84		0.84	**Phase "C" Total kVA**		
		Phase "B"		0.84	**Total kVA**			

Notes:
* -- Indicates Breaker To Be Complete With Handle Locking Device.

Panel:	PP9		**Mounting:**	Surface	
Location:	Murray Building Penthouse		**Feeder:**	See Single Line Diagram	
Type:	Cutler-Hammer P1L4A2-42		**Frame:**	BAB	
Size:					
Rating:	225A 120/208 V 3Ph. 4W.				

No.	Brk.	Description	Load	Phase	Load	Description	Brk.	No.
1	***		280	A	280		***	2
3	3P/15	Pump P7 (Murray Building)	280	B	280	Pump P6 (Murray Building)	3P/15	4
5	***		280	C	280		***	6
7	1P/15	Spare		A	280		***	8
9	1P/15	Spare		B	280	Pump P5 (Murray Building)	3P/15	10
11	1P/15	Spare		C	280		***	12
13				A				14
15				B				16
17				C				18
19				A				20
21				B				22
23				C				24
25				A				26
27				B				28
29				C				30
31				A				32
33				B				34
35				C				36
37				A				38
39				B				40
41				C				42
		Phase "A" Total kVA	0.84		0.84	**Phase "C" Total kVA**		
		Phase "B"		0.84	**Total kVA**			

Notes:
* – Indicates Breaker To Be Complete With Handle Locking Device.

Panel:	1B01			**Mounting:**	Surface			
Location:	Strickland Building Basement			**Feeder:**	See Single Line Diagram			
Type:	Cutler-Hammer P1L4A2-42			**Frame:**	BAB			
Size:								
Rating:	225A 120/208 V 3Ph. 4W.							
No.	**Brk.**	**Description**	**Load**	**Phase**	**Load**	**Description**	**Brk.**	**No.**
1	1P/15	Spare		A	1,920	Pump ST-5	1P/30	2
3	1P/15	Spare		B	400	Mechanical Controls	1P/15	4
5	1P/15	Spare		C	864	Pump ST-3	1P/15	6
7				A				8
9				B				10
11				C				12
13				A				14
15				B				16
17				C				18
19				A				20
21				B				22
23				C				24
25				A				26
27				B				28
29				C				30
31				A				32
33				B				34
35				C				36
37				A				38
39				B				40
41				C				42
		Phase "A" Total kVA	1.92		0.86	**Phase "C" Total kVA**		
		Phase "B"		0.40	**Total kVA**			

Notes:
* -- Indicates Breaker To Be Complete With Handle Locking Device.

Panel:	3B01			**Mounting:**	Surface			
Location:	Strickland Building Basement			**Feeder:**	See Single Line Diagram			
Type:	Cutler-Hammer P3aL4A2-42			**Frame:**	FD			
Size:								
Rating:	225A 347/600 V 3Ph. 4W.							
No.	**Brk.**	**Description**	**Load**	**Phase**	**Load**	**Description**	**Brk.**	**No.**
1	***		840	A	485		***	2
3	3P/40	Transformer	840	B	485	Pump ST-4	3P/15	4
5	***		840	C	485		***	6
7				A	485		***	8
9				B	485	Circulating Pump	3P/15	10
11				C	485		***	12
13				A				14
15				B				16
17				C				18
19				A				20
21				B				22
23				C				24
25				A				26
27				B				28
29				C				30
31				A				32
33				B				34
35				C				36
37				A				38
39				B				40
41				C				42
		Phase "A" Total kVA	1.81		1.81	**Phase "C" Total kVA**		
		Phase "B"		1.81	**Total kVA**			

Notes:
* -- Indicates Breaker To Be Complete With Handle Locking Device.

Part 1 General

1.1 RELATED SECTION

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

1.2 REFERENCES

.1 Canadian Standards Association (CSA)
  .1 CSA C22.2 No.248.8-11, Low Voltage Fuses Part 8: Class J Fuses

1.3 ACTION AND INFORMATION SUBMITTALS

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

1.4 WASTE MANAGEMENT

.1 See Section 01 74 21 Construction Demolition Waste Management.

.2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 FUSES GENERAL

.1 All fuses shall be the product of one manufacturer.

.2 Fuses: to C.S.A. C22.2 No. 106 and to have interrupting capacity of at least 200,000 amps symmetrical.

.3 Fuses shall be of the indicator type.

2.2 FUSES

.1 Class J fuses:
  .1 Up to and including 600 amps, shall be Class J (time delay), plated contacts, rated 600V, current limiting type.

  .2 Standard time delay - hold 500% of current rating for 10 seconds.

Part 3 Execution

3.1 INSTALLATION

.1 Install fuses in mounting devices immediately before energizing circuit.

.2 Ensure correct fuses fitted to physically matched mounting devices.

.3 Ensure correct fuses fitted to assigned electrical circuit.

.4 Fuse sizes shall be as indicated on the drawings. Six (6) spare fuses of each type and rating shall be provided in lockable metal cabinet located in the electrical room.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

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

.2 Section 26 24 13 Generator Paralleling Switchgear.

.3 Section 26 99 99 Commissioning.

1.2 REFERENCES

.1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)

.1 ANSI/IEEE C37.13-2008, Low Voltage AC Power Circuit Breakers Used in Enclosures.

.2 CSA International

.1 CSA C22.2 No. 5-09, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

.2 CSA C22.2, Low Voltage Assemblies

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for power circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 Time-current phase protection co-ordination characteristic curves for breakers.

.2 Interrupting Rating

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for power circuit breakers for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect power circuit breakers nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 POWER CIRCUIT BREAKER

.1 Power circuit breaker: to CSA C22.2 No.5.

.2 Draw out type, 600 V class.

.1 Continuous current rating: 1200 A.

.2 100% service rated.

.3 LSIG.

.4 Trip rating: as indicated.

.5 Interrupting rating: 65 kA, RMS symmetrical without fuses.

.6 Electrically operated.

.7 Carry a CSA label.

.3 Solid-state tripping system consisting of 1 current sensor per pole, 1 solid-state trip unit and self-powered trip actuator. Equipped with long, short, instantaneous, ground fault function and phase overload, short circuit and ground fault indication.

.4 Breakers with normal stored energy, closing mechanism to provide quick-make operation for all ratings.

.5 Circuit breakers shall be electrically operated and equipped with auxiliary contacts, bell alarm contacts, and microprocessor based trip units. Electrically operated breakers shall be complete with 120V AC motor operators. The charging time of the motor shall not exceed 6 seconds.

.6 Breakers with motor charged, stored energy, quick-make, closing mechanism with emergency manual spring charging handle and isolating switch to isolate power supply to spring charging motor.

.7 Breakers with on-off indicator and spring charged/discharged indicator.

.8 Interlocks to prevent circuit breaker draw out when in closed position and to prevent closing unless fully engaged or in test position.

.9 The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and CSA listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and rating.

.10 Interrupting capacity of breakers to be met without current limiting fuses.

.1 Include anti-single-phasing coils which act on tripper bar in parallel with current limiting fuses to prevent single phasing.

.2 Co-ordinate time current limiting characteristics of fuses with time current tripping characteristics of circuit breaker.

2.2 TRIP UNITS

.1 Each low voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker.

.2 The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

.3 The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

.4 The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

.5 Trip unit shall have selectable thermal memory for enhanced circuit protection.

.6 Complete system selective co-ordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:

.1 All power circuit breakers shall have adjustments for long delay pickup and time, short time delay and time, and include I2t settings, instantaneous override, ground fault current pickup and time, and include I2t settings.

.7 Voltage phase unbalance and phase loss during current detection.

.8 The trip unit shall provide zone interlocking for the short-time delay and ground fault delay trip functions for improved system co-ordination. The zone interlocking system shall restrain the tripping of an upstream breaker and allow the breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the present time delay. Factory shall wire for zone interlocking for the insulated case circuit breakers within the switchboard.

.9 The trip unit (for the main breaker) shall utilize ARMs Technology (Arc Flash Reduction Maintenance System).

2.3 OPTIONAL FEATURES

.1 Shunt trip 24 VDC.

.2 Auxiliary switches: 6 N.O., 6 N.C.

.3 Alarm switch.

.4 Pilot light.

.5 Control switch.

.6 Key interlock where indicated.

.7 Remote close (120VAC operation).

.8 Over current trip contact.

.9 Adjustable over voltage release.

.10 Reverse load and fault current.

.11 Reverse sequence voltage alarm.

.12 Under frequency.

.13 Over frequency.

.14 Spring release 120 VAC.

.15 Padlocking provision.

.16 Operation counter.

.17 Provide external remote racking unit, one for each breaker.

2.4 MANUFACTURERS

.1 Approved product: Magnum DS MDS 616 c/w Trip Unit 1150 + LSIG.

.2 Restriction of existing assembly:

.1 To ensure the compatibility with existing equipment, power circuit breaker shall be compatible with other existing Cutler Hammer circuit breakers. However, if this Contractor proposes to use alternate manufacturers, the Contractor shall be responsible for the following:

.1 Replace all existing circuit breakers (shown to be re-located) with new equal alternate circuit breakers. All circuit breakers shall be from the same manufacturer and shall comply with the contract documents.

.2 Carry all associated costs for installation, testing, commissioning, and re-commissioning.

.3 Alternates request shall be submitted in writing 10 working days prior to bid closing date.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air circuit breakers installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Departmental Representative.
- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install circuit breakers as indicated.

.2 Adjust circuit breaker settings as per the co-ordination study.

3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 – Common Work Results – Electrical.

.2 Verify power circuit breaker is installed in accordance with contract document and manufacturer recommendation.

.3 Complete static verification, start-up and functional performance testing by a manufacturer’s qualified representative. Pay for all associated cost.

.4 Phase 1 and Phase 2 electrical phasing procedures are associated with this project. Carry all associated costs for re-testing and re-commissioning as required.

3.4 TRAINING

.1 In addition to the commissioning documents, the Contractor shall provide a training session for up to 6 personnel for 1 normal workday at a jobsite location determined by the Departmental Representative.

.2 The training session shall be conducted by a manufacturer’s qualified representative.

.3 The training program shall include instructions on the assembly, protective device settings and other major components.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

- .1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 - General

1.1 RELATED SECTIONS

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

.2 Section 26 24 13 – Generator Paralleling Switchgear.

.3 Section 26 24 17 – Panelboard Breaker Type.

.4 Section 26 28 20 – Ground Fault Equipment Protection.

.5 Section 26 99 99 – Commissioning.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA C22.2 No. 5-09, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

1.3 SUBMITTALS

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

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 See Section 01 74 21 Construction Demolition Waste Management.

.2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - Products

2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters: to CSA C22.2 No. 5

.2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation having de-ionizing arc chambers, be trip free of operating handles on overloads with a definite indication when tripping has taken place, all for manual and automatic operation with temperature compensation for 40°C ambient.

.3 Plug-in moulded case circuit breakers: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.4 Common-trip breakers: with single handle for multi-pole applications; tie handles will not be acceptable

.5 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.6 Circuit breakers with interchangeable trips as indicated.

.7 Circuit breakers to have minimum 10000 A symmetrical RMS interrupting capacity rating or as indicated on the drawings or in the co-ordination study.

2.2 THERMAL MAGNETIC BREAKERS

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

2.3 SOLID STATE TRIP BREAKERS

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

.2 Solid state trip units shall have independently adjustable long time pickup, long time delay, short time pickup, short time delay, instantaneous trip, ground fault pickup, and ground fault delay.

2.4 OPTIONAL FEATURES

.1 Include:

.1 Shunt trip.
.2 On-off locking device.
.3 Handle mechanism to be supplied on all breakers 225amps and greater.
.4 Under-voltage release.
.5 Solid state trip unit.

2.5 MANUFACTURERS

.1 All circuit breakers shall be from the same manufacturers as its respective panelboard, and distribution panel.

.2 Circuit breakers installed at the switchgear shall be from the same manufacturer as the switchgear.

PART 3 - Execution

3.1 INSTALLATION

.1 Circuit breakers shall be securely mounted and tightened down to the bussing as per the manufacturer's recommended torque levels.

.2 Install breakers in quantities as indicated.

.3 Supply and install blank sections for all unused breaker spaces.

.4 Set trip units as per the fault and co-ordination study described in Section 26 05 01 Common Work Results - Electrical.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 – Common Work Results - Electrical.

.2 Verify circuit breakers are installed in accordance with contract documents and manufacturers recommendations.

.3 Complete static verification, start-up and functional performance testing by a manufacturer’s qualified representative. Pay for all associated cost.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

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

.2 Section 26 28 16.02 - Moulded Case Circuit Breakers.

.3 Section 26 28 26 – Power Circuit Breakers.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International):

.1 CAN/CSA-C22.2 No.144-M91(R2001), Ground Fault Circuit Interrupters.

.2 National Electrical Manufacturers Association (NEMA):

.1 NEMA PG 2.2-1999, Application Guide for Ground Fault Protection Devices for Equipment.

1.3 ACTION AND INFORMATION SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit product data and shop drawings.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction Demolition Waste Management.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 MATERIALS

.1 Equipment and components for ground fault circuit interrupters (GFCI): to CAN/CSA-C22.2 No.144 NEMA PG 2.2.

.2 Components comprising ground fault protective system to be of same manufacturer.

2.2 BREAKER TYPE GROUND FAULT INTERRUPTER

.1 Ground fault protection where required by circuit breakers in branch circuit panelboards shall be C.S.A. listed as Class "A" Group "1" with a sensitivity of 5 milliamps or greater. Breakers shall be of the thermal magnetic type incorporating a solid state ground fault sensing circuit and push to test push button. Breakers shall be of the bolt on design, and interchangeable with other panelboard breakers. Interrupting capacity to have minimum 10,000 amperes, R.M.S. symmetrical interrupting capacity rating or as indicated on the drawing or in the co-ordination study.

Part 3 Execution

3.1 INSTALLATION

.1 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

END OF SECTION

Part 1 GENERAL

1.1 RELATED REQUIREMENTS

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

.2 Section 26 24 13 – Generator Paralleling Switchgear.

.3 Section 26 28 16.02 – Moulded Case Circuit Breakers.

.4 Section 26 36 23 – Automatic Load Transfer Equipment.

.5 Section 26 99 99 – Commissioning.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/National Electrical Manufacturers' Association (NEMA)

.1 ANSI/NEMA MG1-1998, Motors and Generators.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-3.6-2000, Regular Sulphur Diesel Fuel.

.3 International Organization for Standardization (ISO)

.1 ISO 3046-1-2002, Reciprocating Internal Combustion Engines - Performance - Part 1: Declarations Of Power, Fuel And Lubricating Oil Consumptions, And Test Methods.

.4 National Electrical Manufacturers Association (NEMA)

1.3 DESCRIPTION

.1 Generating system consists of:

.1 Diesel engine.
.2 Alternator.
.3 Alternator control panel.
.4 Battery charger and battery.
.5 Fuel supply system.
.6 Exhaust system.
.7 Steel mounting base.

.2 System designed to operate as emergency standby unit.

1.4 ACTION AND INFORMATION SUBMITTALS

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

.2 Include:

- .1 Engine: make and model, with performance curves.
- .2 Alternator: make and model.
- .3 Voltage regulator: make, model and type.
- .4 Battery: make, type and capacity.
- .5 Battery charger: make, type and model.
- .6 Alternator control panel: make and type of meters and controls.
- .7 Governor type and model.
- .8 Cooling air requirements in m^3/s.
- .9 Flow diagrams for:
  - .1 Diesel fuel.
  - .2 Cooling air.
- .10 Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, enclosure and total weight.
- .11 Continuous full load output of set at 0.8PF lagging.
- .12 Description of set operation including:
  - .1 Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
  - .2 Manual starting.
  - .3 Automatic shut down and alarm on:
    - .1 Overcranking.
    - .2 Overspeed.
    - .3 High engine temp.
    - .4 Low lube oil pressure.
    - .5 Short circuit.
    - .6 Alternator overvoltage.
    - .7 Lube oil high temperature.
    - .8 Over temperature on alternator.

1.5 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for diesel generator for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Include in Operation and Maintenance Manual instructions for particular unit supplied and not general description of units manufactured by supplier and:

.1 Operation and maintenance instructions for engine, alternator, control panel, , battery charger, battery, fuel system, engine room ventilation system, exhaust system and accessories, to permit effective operation, maintenance and repair.

.2 Technical data:

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

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction Demolition Waste Management, and with the Waste Reduction Workplan.

.2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

1.7 WARRANTY

.1 For work of this Section, five years warranty period or 1500 operating hours, whichever occurs first.

1.8 EXTRA MATERIALS

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Include:

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

Part 2 Products

2.1 GENERAL

.1 This section shall include, but not limited to, the following:

.1 Provision of two interior standby diesel generator systems.

.2 A diesel engine driven generating set to provide standby power for each generator.

.3 An engine start-stop control system mounted on each generating set.

.4 Mounted and loose accessories as specified.

.5 The generator manufacturer shall review the site conditions for overall installation method(s).

.6 The generator manufacturer shall be responsible to remove existing generators and associated equipment as shown on the drawing.

.7 The generator manufacturer shall include for any specialized off load and placement equipment/materials.

.8 Both generators shall operate in parallel mode with new "ASCO Series 4000" paralleling control system. Provide all interconnection control wiring.

.9 The generator manufacturer shall co-ordinate with the generator paralleling switchgear supplier.

.10 This contractor will be responsible for all aspects of supply, delivery, installation, testing, commissioning, re-testing, and re-commissioning.

.2 Generator 1 and Generator 2 emergency power systems shall be built, tested and shipped by one manufacturer, so there is one source of supply. The performance of the generator set series shall be certified by an independent testing laboratory, as to the sets full power rating, stability, voltage, and frequency regulation.

.3 All requirements are typical for Generator 1 and Generator 2.

2.2 DIESEL ENGINE

.1 Diesel engine: to ISO 3046-1.

.1 Engine: standard product of current manufacture, from company regularly engaged in production of such equipment.

.2 Turbo charged and after-cooled, synchronous speed 1800 r/min.

.3 Capacity:

.1 Rated continuous power in kW at rated speed, after adjustment for system losses in auxiliary equipment necessary for engine operation; to be calculated as follows: Rated continuous output = Generator kW divided by Generator efficiency at full load.

.1 Under following site conditions:

.1 Altitude: 305m and less.

.2 Ambient temperature: 25 degrees C and less.

.2 Engine overload capability 100% of continuous output for 1 hour within 12 hours period of continuous operation.

.4 Cooling System:

.1 Liquid cooled: heavy duty industrial radiator mounted on generating set base with engine driven pusher type fan to direct air through radiator from engine side, with ethylene glycol anti-freeze non-sludging above minus 46 degrees C.

.2 To maintain manufacturer's recommended engine temperature range at 10% continuous overload in ambient temperature of 40 degrees C.

.3 Block heater: A 120V or 208V operated in-line circulating coolant heater shall be provided with thermostatic control to keep the coolant temperature at optimum conditions for starting.

.5 Fuel:

.1 Type A fuel oil: to #2 Diesel.

.6 Fuel system: solid injection, mechanical fuel transfer pump, fuel filters and air cleaner, fuel rack solenoid energized when engine running.

.1 Fuel filter system shall consist of duplex water separating fuel filters.

.7 Governor:

.1 Electronic type, electric actuator, speed droop externally adjustable from isochronous to 5%, temperature compensated with steady state speed maintenance capability of 0.2 hertz of nominal.

.8 Lubrication system:

.1 Pressure lubricated by engine driven pump.

.2 Lube oil filter: replaceable, full flow type, removable without disconnecting piping.

.3 Lube oil cooler.

.4 Engine sump drain valve.

.5 Oil level dip-stick.

.9 Starting system:

.1 Positive shift, gear engaging starter 24V dc.

.2 Cranking limiter to provide 6 cranking periods of 10s duration, each separated by 10s rest.

.3 Two sets of lead acid, 24V storage batteries each with sufficient capacity to crank engine for 30 seconds at 0C without using more than 25% of ampere hour capacity. Two sets of starting cables shall be supplied and installed complete with battery selector switches.

.4 Battery charger: constant voltage, solid state, two stage from trickle charge at standby to boost charge after use. Regulation: plus or minus 1% output for plus or minus 10% input variation. Automatic boost for 6h every 30days. Equipped with dc voltmeter, dc ammeter and on-off switch. Minimum charger capacity: shall be at

least 5% of battery ampere hour capacity. Electric power for battery chargers shall be derived from existing electrical panel or as shown on the drawings.

.1 Battery chargers shall be supplied with battery fault contacts. Wire contacts to generator control/annunciator panel.

.2 Two battery charges are required, one for each set of batteries.

.5 Provide 24 DC power from generator batteries to switchgear control complete with 15A circuit breakers.

.10 Vibration isolated engine instrument panel with:

.1 Lube oil pressure gauge.

.2 Lube oil temperature gauge.

.3 Lube oil level gauge.

.4 Coolant temperature gauge.

.5 Coolant level gauge.

.6 Running time meter: non-tamper type.

.11 Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.

.12 Complete removable blanket system to cover all manifolds, turbo and exhaust.

.13 Drip tray.

2.3 ALTERNATOR

.1 Alternator: to ANSI/NEMA MG1.

.2 Rating: 3-Phase, 347/600V, 3 Phase, 4 Wire, 1000 kW, 60Hz, at 0.8PF.

.1 A 100% rated, integral emergency generator circuit breaker is required. Breaker shall be complete with:

.1 LSIG Solid state trip unit with fully adjustable long, short, instantaneous, and ground fault settings,

.2 One normally open and one normally closed auxiliary contact,

.3 24 VDC shunt trip mechanism.

.4 Lockout kit.

.5 18 kAIC interrupting capacity.

.3 Output at 40 degrees C ambient:

.1 100% full load continuously.

.4 Revolving field, brushless, single bearing.

.5 Drip proof.

.6 Amortisseur windings.

.7 Synchronous type.

.8 Dynamically balanced rotor permanently aligned to engine by flexible disc coupling.

.9 Exciter: permanent magnet.

.10 The insulation material shall meet NEMA standards for Class H insulation and be vacuum impregnated with epoxy varnish to be fungus resistant. Temperature rise of the rotor and stator shall not exceed NEMA class F (130 ºC rise by resistance over 40 C ambient).

.11 Voltage regulator: thyristor controlled rectifiers with phase controlled sensing circuit:

.1 Stability: 0.25% maximum voltage variation at any constant load from no load to full load.

.2 Regulation: 1.5% maximum voltage deviation between no-load steady state and full-load steady state.

.3 Transient: 15% maximum voltage dip on one-step application of 0.8PF full load.

.4 Transient: 12% maximum voltage rise on one-step removal of 0.8PF full load.

.5 Transient: 1s maximum voltage recovery time with application or removal of 0.8PF full load.

.6 0-5V DC bias for remote volts control signal for connection to generator switchgear.

.12 Alternator: capable of sustaining 300% rated current for period not less than 10s permitting selective tripping of down line protective devices when short circuit occurs.

2.4 CONTROL PANEL

.1 Totally enclosed, mounting base isolated from diesel generator.

.2 Controller shall be fully compatible with ASCO 4000 Series synchro system. Refer to Appendix A for engine generator controls compatibility information.

.3 Instruments:

.1 Digital 100% solid state circuitry indicating type 2% accuracy, rectangular face, flush panel mounting:

.1 Voltmeter: ac, scale 0 to 600 V.

.2 Ammeter: ac, scale 0 to 800 A.

.3 Wattmeter scale 0 to 800 kW.

.4 Frequency meter: scale 55 to 65Hz.

.5 kWh meter.

.2 Voltmeter selector switch, rotary, panel mounting, four position, labelled "Off-Phase A-Phase B-Phase C".

.3 Ammeter selector switch, rotary, maintained contacts, panel mounting, designed to prevent opening of current circuits, four position labelled "OFF- Phase A-Phase B-Phase C".

.4 Controls:

.1 Engine start button.

.2 Engine emergency stop button.

.3 Remote engine emergency stop button.

.4 The engine controls shall also include a 4-position selector switch with the following positions: OFF/RESET - AUTO - MANUAL - AUTO/COOL DOWN.

.5 Operating lights, panel mounted including green pilot lights for breaker on and red pilot lights for breaker off.

.6 Solid state indicator lights for alarm with manually reset NO/NC contacts wired to terminal block for remote annunciation on:

.1 Low fuel level.

.2 High fuel level.

.3 Low battery voltage.

.4 Ventilation failure.

.5 Low coolant temperature.

.6 Engine coolant level.

.7 Battery failure.

.8 Generator run status.

.9 Generator control not in auto.

.10 Unexpected engine shutdown.

.7 Solid state controller for automatic shutdown and alarms with manually reset NO/NC contacts wired to terminal block for remote annunciation on:

.1 Engine overcrank.

.2 Engine overspeed.

.3 Engine high temperature.

.4 Engine low lube oil pressure.

.5 Short circuit.

.6 AC over voltage.

.7 Engine stop.

.8 Engine failure to start.

.8 Lamp test button.

.9 Provide two (2) CANBUS output DIO modules (to be mounted by generator paralleling switchgear supplier into the switchgear) for interconnection between generator and generator controllers.

.10 Provide an annunciator mounted on the generator to display generator system alarm conditions and status indication.

2.5 STEEL MOUNTING BASE

.1 Complete generating set mounted on structural steel base of sufficient strength and rigidity to protect assembly from stress or strain during transportation, installation and under operating conditions on suitable level surface.

.2 Assembly fitted with vibration isolators and control console resiliently mounted.

.1 Spring type isolators with adjustable side snubbers and adjustable for levelling.

.2 Provide they comply, other forms of sound and vibration isolate are acceptable.

.3 Sound insulation pads for installation between isolators and concrete base.

2.6 EXHAUST SYSTEM

.1 Critical grade exhaust silencer with condensate drain, plug and welded couplings. The silencer shall be mounted so that its weight is not supported by the engine nor will exhaust system growth due to thermal expansion be imposed on the engine. Exhaust pipe size shall be sufficient to ensure that exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer.

.2 Heavy-duty flexible exhaust pipe with flanged couplings as required.

.3 Fittings and accessories as required.

.4 Expansion joints: stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion.

2.7 FUEL SYSTEM

.1 Drain and end plug.

.2 Shut-off cock.

.3 Renewable cartridge filter.

.4 Fire valve.

.5 Isolating valves on lines serving auxiliaries.

.6 Day Tank 1, Day Tank 2 and outdoor fuel tank are existing. Provide fuel for commissioning of emergency generation system, once commissioning is completed top up fuel. The electrical contractor will provide the initial fill up of the entire fuel storage system.

2.8 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results – For Electrical.

2.9 FABRICATION

.1 Shop assemble generating unit including:

.1 Base.

.2 Engine and radiator.

.3 Alternator.

.4 Control panel.

.5 Battery and charger.

2.10 MANUFACTRUERS

.1 Approved manufacturers are Caterpillar and Cummins.

.2 Restriction of existing assembly:

.1 To ensure the structural requirement imposed on louver size is met. Refer to mechanical drawing M-101 for maximum ventilation and combustion air values and requirements.

.2 Maximum fuel conception for each generator under 100% load with fan 272.3 L/hour.

.3 Maximum dimensions for each generator: 4233.7 mm long, 2010.4 mm wide, 2355 mm high.

2.11 FINISHES

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

2.12 SOURCE QUALITY CONTROL

.1 Factory test generator set including engine, alternator, control panels, and accessories.

.2 Test procedure:

.1 Prepare blank forms and check sheet with spaces to record data. At top of first sheet record:

.1 Date.

.2 Generator set serial no.

.3 Engine, make, model, serial no.

.4 Alternator, make, model, serial no.

.5 Voltage regulator, make and model.

.6 Rating of generator set, kW, kVA, V, A, r/min, Hz.

.2 Mark check sheet and record data on forms in duplicate as test proceeds.

.3 Tests:

.1 With 100% rated load, operate set for 8 h, taking readings at 30 min intervals, and record following:

.1 Time of reading.

.2 Running time.

.3 Ambient temp in degrees C.

.4 Lube oil pressure in kPa.

.5 Lube oil temp in degrees C.

.6 Engine coolant temp in degrees C.

.7 Exhaust stack temp in degrees C.

.8 Alternator voltage: phase 1, 2, 3.

.9 Alternator current: phase 1, 2, 3.

.10 Power in kW.

.11 Frequency in Hz.

.12 Power Factor.

.13 Battery charger current in A.

.14 Battery voltage.

.15 Alternator cooling air outlet temp.

.2 After completion of 8 hours run, demonstrate following shut down devices and alarms:

.1 Overcranking.

.2 Overspeed.

.3 High engine temp.

.4 Low lube oil pressure.

.5 Short circuit.

.6 Alternator overvoltage.

.7 Low battery voltage, or no battery charge.

.8 Manual remote emergency stop.

.9 High alternator temperature.

.3 Next install continuous strip chart recorders to record frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments to include:

.1 No load to full load to no load.

.2 No load to 70% load to no load.

.3 No load to 20% load to no load.

.4 20% load to 40% load to no load.

.5 40% load to 60% load to no load.

.6 60% load to 80% load to no load.

.4 Demonstrate:

.1 Automatic starting of set and automatic transfer of load on failure of normal power.

.2 Automatic shut down of engine on resumption of normal power.

.3 That battery charger reverts to high rate charge after cranking.

.5 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.

Part 3 Execution

3.1 INSTALLATION

.1 The Supplier of the above diesel generating set shall supervise and check out the installation and be present at the start up of the unit. The Suppliers shall also provide one full day's instruction to Maintenance Personnel, on the operation and maintenance of the unit. He shall then issue a letter to the Departmental Representative stating whether or not the installation is in accordance with the Manufacturers recommendations.

.2 Co-ordinate and include all cost associated with static verification, start-up verification and functional performance testing of the generating units and all related equipment such as the low voltage switchgear, new automatic transfer switches, existing transfer switches.

.3 Phase 1 and phase 2 electrical phasing procedures are associated with this project. Carry all associated cost for retesting, recommissioning and fuel as required.

.4 Locate generating units and install as indicated.

3.2 FIELD QUALITY CONTROL

.1 First Testing: This contractor shall provide a remote load bank, necessary interconnect cabling and fuel to test the Generator 1 and Generator 2 separately under 100% load as outlined below. Load bank shall be made available for a minimum of three business days to allow for generator first testing.

.2 Final Testing: This contractor shall provide two remote load banks (500 kW each), necessary interconnect cablings and fuel to test the emergency power system under 100% loads as outlined below. Connect load banks to existing load banks connection points in generator service room. Load banks shall be made available for a minimum of five business days to allow for generator final testing and commissioning as well as tuning and commissioning of the generator switchgear. All work is to be co-ordinated with paralleling switchgear supplier.

.3 Perform tests in accordance with Section 26 05 01 - Common Work Results – Electrical.

.4 Perform all required re-testing for the emergency power system as required for Phase 1 or Phase 2. Include all associated costs.

.5 Notify Departmental Representative 10 working days in advance of test date.

.6 Provide fuel for testing and leave full tanks (day tank 1, day tank 2 and outdoor tank) on acceptance for each required test.

.7 Demonstrate for Generators 1 and 2:

.1 Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.

.2 Unit start and shut down on "Manual" control

.3 Unit start and transfer on "Test" control.

.4 Unit start on "Engine start" control.

.5 Operation of manual bypass switch.

.6 Operation of automatic alarms and shut down devices.

.8 Run unit on load for minimum period of 8 hours to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling.

.9 At end of test run, check battery voltage to demonstrate battery charger has returned battery to fully charged state.

APPENDIX A

Engine Generator Controls Compatibility Information

The following Governors and Voltage Regulators are suitable to Interface with the ASCO 4000 Series PCS.

Governors	**Voltage Regulators**
Woodward EPG	Basler SSR
Woodward 1724	Basler SR4A
Woodward 2301A	Basler SR8A
Woodward 2301D	Caterpillar DVR
Woodward SG-2D	Caterpillar VR3
FLO-TECH	KATO KCR 360 or 760
Pro-ACT I & II	KATO K65-12B
CSC	KATO K125-10B
Woodward 2301A LSSC	Marathon PM100
701 or 701A	Marathon DVR 2000E
721	Newage MX321/341
723 or 723 Plus	Newage MA325
Caterpillar ADEM	
Detroit Diesel DDEC	
Cummins PCC 3.3	

Note: For other most recent models – please consult ASCO Power Technologies PCS Applications Engineering.

END OF SECTION

PART 1 - General

1.1 RELATED SECTIONS

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

.2 Section 26 23 13 Power Generation – Diesel.

.3 Section 26 24 13 Automatic Paralleling Switchgear.

.4 Section 26 99 99 Commissioning.

1.2 REFERENCES

.1 CSA International

.1 CSA C22.2 No.5-09, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).

.2 CSA C22.2 No.178.1-2007, Automatic Transfer Switches.

.3 CAN/CSA C60044-1-07, Instrument Transformers.

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA ICS 2-1996(R2009), Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.

1.3 SYSTEM DESCRIPTION

.1 Automatic load transfer equipment to:

.1 Monitor voltage on phases of normal power supply.

.2 Initiate cranking of standby generator units on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.

.3 Transfer load from normal supply to standby units when standby units reaches rated frequency and voltage pre-set adjustable limits.

.4 Transfer load from standby units to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.

.5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

.6 Capabilities to display the following status to a low voltage paralleling switchgear:

.1 ATS position.

.2 Normal available.

.3 Bypass position utility.

.4 Bypass position emergency.

.7 Load shedding capability.

1.4 ACTION AND INFORMATION SYBMITTALS

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

.2 Include:

.1 Make, model and type.

.2 Load classification:

.1 Tungsten lamp load: note maximum kW.

.2 Ballast lamp load: note maximum kW.

.3 Motor load: note maximum kW.

.4 Restricted use: resistance and general loads, 0.8pf or higher note maximum kW.

.3 Single line diagram showing controls and relays.

.4 Description of equipment operation including:

.1 Automatic starting and transfer to standby unit and back to normal power.

.2 Test control.

.3 Manual control.

.4 Automatic shutdown.

.5 Dimensional drawings showing dimensions, required clearances and cable entry locations.

.6 Cable lug locations, quantities and sizes.

1.5 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Detailed instructions to permit effective operation, maintenance and repair.

.3 Technical data:

.1 Schematic diagram of components, controls and relays.

.2 Illustrated parts lists with parts catalogue numbers.

.3 Certified copy of factory test results.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 See Section 01 74 21 Construction Demolition Waste Management.

.2 Separate and recycle waste materials.

.3 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.4 Collect and separate for disposal packaging material for recycling.

PART 2 - Products

2.1 MATERIALS

.1 Instrument transformers: to CAN3-C13.

.2 Contactors: to ANSI/NEMA ICS2.

2.2 CONSTRUCTION

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

.2 The automatic load transfer equipment manufacturer shall coordinate the delivery of the Open Transition Automatic Transfer and Two Way Bypass Manual–Isolation Switch (ATS).

.3 The switching panel shall consist of completely enclosed contact assemblies and a separate control logic panel. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.

.4 The transfer switch shall be mechanically interlocked to prevent cross connection of sources when operated either automatically, or manually.

.5 Positive mechanical cable interlocks shall be provided for bypass and isolation switches to prevent cross connection of services.

.6 Transfer switch shall be capable of being operated manually under full rated load conditions. Manual operation shall be accomplished by a permanently attached manual operator, or by integrally mounted push buttons. Removable manual operating handles, and handles that may move in the event of an electrical operation during the manual operation, are not acceptable. Manual operators requiring source or load disconnection prior to manual operation are not acceptable.

.7 The automatic transfer switch shall be 4 poles (overlapping neutral), the neutral shall be fully rated with equal withstand, closing and interrupting ratings to the power poles. Switched neutral poles which are add-on or overlap, or that are not capable of breaking full rated load current are not acceptable.

.8 The automatic transfer switch and the bypass isolation switch sections shall be interconnected with copper bus or cable.

.9 Where indicated on the drawings, the bypass/isolation transfer switches shall be provided with a drawout mechanism to allow easy access for preventive maintenance, testing or inspection. The drawout mechanism shall provide visual indicators as to the position of the switch/breaker during the drawout operation.

2.3 RATING

.1 The transfer switch shall have equal withstand, closing and interrupting ratings of 50 kAic.

.2 The transfer switch shall be 100% equipment rated for continuous duty.

2.4 MICROPROCESSOR LOGIC

.1 The transfer switch shall be controlled by a microprocessor-based controller. The controller shall be hardened against potential problems from transients and surges. Operation of the transfer switch and monitoring of both sources shall be managed by the controller.

.2 The logic control panel shall control the operation of the transfer switch. All sensing and logic shall be controlled by an onboard microprocessor for maximum reliability, minimum maintenance, and built-in serial communications. The logic controller shall be connected to the transfer switch by and interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the control panel to be disconnect from the transfer switch for routine maintenance.

2.5 MICROPROCESSOR CONTROLLER

.1 The microprocessor controller shall include a backlit LCD display, and shall display the following:

.1 Line-to-Line voltages for each source
.2 Line Frequency for each source
.3 Timer countdown for each timer while functioning
.4 Real-Time Clock
.5 Setpoints
.6 Re transfer timer
.7 Generator cool down timer

.2 The microprocessor controller shall include individual LEDs for indicating the following:

.1 Source 1 Available
.2 Source 1 Connected
.3 Source 2 Available
.4 Source 2 Connected

.3 The microprocessor controller shall contain the following features:

.1 Dip switch programming protection.
.2 Set points shall be stored in Non-Volatile memory, and use of an external battery source to maintain operation during “dead” periods shall not be required.

.4 The microprocessor controller shall contain the following Voltage and Frequency features:

.1 The voltage of each phase of the normal source shall be monitored, with dropout adjustable from 50% to 90% of nominal and pickup adjustable from dropout setting +2% to 100% of nominal.

.2 The voltage of each phase of the emergency source shall be monitored, with dropout adjustable from 50% to 90% of nominal and pickup adjustable from dropout setting +2% to 100% of nominal.

.3 The frequency of the emergency source shall be monitored, with dropout adjustable from 90% to 100% of nominal and pickup adjustable from dropout setting +1 Hz to 110% of nominal.

.4 Voltage measurement accuracy shall be +/-2% of nominal input voltage and frequency measurement accuracy shall be +/-0.1 Hz.

.5 The microprocessor controller shall contain the following Time Delay features:

.1 A time delay shall be provided to override a momentary power outage or voltage fluctuation, adjustable 0 to 6 seconds.

.2 A time delay shall be provided on transfer to emergency, adjustable from 0 to 30 minutes.

.3 A time delay shall be provided on retransfer from emergency to normal, adjustable from 0 to 30 minutes. This time delay shall be bypassed if emergency source fails and normal source is available.

.4 A time delay shall be provided after retransfer that allows the generator to run unloaded prior to shutdown, adjustable from 0 to 30 minutes.

.5 All delays shall be field adjustable from the microprocessor-based controller without the use of special tools.

2.6 CONTROLS

.1 Selector switch - four position "Test", "Auto", "Manual", "Engine start".

.1 Test position - Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.

.2 Auto position - Normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.

.3 Engine start position - Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.

.2 Control transformers: dry type with 120V secondary to isolate control circuits from:

.1 Normal power supply.

.2 Emergency power supply.

.3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:

.1 Voltage sensing: 3 phase for normal power and on one phase only for emergency, solid state type, adjustable drop out and pick up, close differential, 2V minimum undervoltage and over voltage protection.

.2 Time delay: normal power to standby, adjustable solid state, 0 to 60s.

.3 Time delay on engine starting to override momentary power outages or dips, adjustable solid state, 0 to 60s delay.

.4 Time delay on retransfer from standby to normal power, adjustable 20s to 10 min.

.5 Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable solid state, 20s intervals to 10 min.

.6 Time delay during transfer to stop transfer action in neutral position to prevent fast transfer, adjustable, 5s intervals to 180s.

.7 Frequency sensing, to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.

.4 Solid state electronic in-phase monitor.

2.7 ACCESSORIES

.1 Selectable 3-phase or 1-phase failure protection on normal supply.

.2 Selectable 3-phase or 1-phase failure protection on emergency supply.

.3 Pilot light indication of transfer switch position and availability of normal emergency voltage sources.

.4 Transfer switch position indicator.

.5 A three position selector switch for engine control:

.1 Off – disables engine.

.2 Auto – automatic operating mode.

.3 Engine Test – signals the engine to start without load transfer to generator.

.6 Engine start contacts.

.7 Three auxiliary relay contacts shall be provided that are energized when power is available on the normal source.

.8 Three auxiliary relay contacts shall be provided that are energized when power is available on the emergency source.

.9 Separate auxiliaries relay contacts for: ATS position, normal available bypass position, utility bypass position emergency, and load shedding.

.10 Exerciser: Provide an engine generator exercising timer that is selectable for either load or no-load transfer.

.11 Pre-Transfer Signal: Provide a pre-transfer signal adjustable from 0-120 seconds for up to 10 devices.

.12 Preferred Source Selector: Transfer switch logic shall have the ability for the user to define a preferred source, selectable between Source 1, Source 2, or None.

.13 Ethernet card.

.14 Modbus RTU and TCP/IP capability.

.15 Integral power meter.

.16 Connectivity module.

.17 Contractor shall provide Modbus to BACnet convertor complete with all required wiring, conduit and interconnection. Connect to BIO existing BACnet system.

2.8 ENCLOSURE

.1 The ATS shall be furnished in a Type 3R enclosure 1524 mm (W) x 1524 mm (D) x 2311 mm (H).

.2 All standard and optional door-mounted switches and LED pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.

.3 When an automatic transfer switch is put into bypass mode, there shall be a remote visual and audible indication as follows: "ATS – in bypass mode".

2.9 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Control panel:

.1 For selector switch and manual switch: size 5 nameplates.

.2 For meters, indicating lights, minor controls: size 3 nameplates.

2.10 SOURCE QUALITY CONTROL

.1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Departmental Representative.

.2 Factory tests as outlined shall be witnessed by the Departmental Representative.

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

.3 Tests:

.1 Operate equipment both mechanically and electrically to ensure proper performance.

.2 Check selector switch, in modes of operation Test, Auto, Manual, Engine Start and record results.

.3 Check voltage sensing and time delay relay settings.

.4 Check:

.1 Automatic starting and transfer of load on failure of normal power.

.2 Retransfer of load when normal power supply resumed.

.3 Automatic shutdown.

.4 In-phase monitor operation.

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

2.11 MANUFACTURERS

.1 Asco 7000 Series.

PART 3 - Execution

3.1 INSTALLATION

.1 Locate, install and connect transfer equipment.

.2 Check relays, solid state monitors, and adjust as required.

3.2 START UP AND SYSTEM CHECKOUT

.1 The supplier of the ATS shall supervise and check out the installation and be present at the start up of the complete back-up power system. Provide a separate testing report for static verification and start-up verification.

.2 This Supplier shall also provide instruction to Maintenance Personnel, on the operation and maintenance of the ATS. The manufacturer shall then issue a letter to the Departmental Representative stating whether or not the installation of the ATS is in accordance with the Manufacturers recommendations. All such costs associated with commission and start-up shall be included in tender.

3.3 TRAINING

.1 In addition to the commissioning documents the Contractor shall provide a training session for up to 6 personnel for 1 normal workday 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.

3.4 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Perform test by a qualified, factory-trained, manufacturer’s representative.

.3 Energize transfer equipment from normal power supply.

.4 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.

.5 Set selector switch in "Manual" position and check to ensure proper performance.

.6 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.

.7 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 20 min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.

.8 Repeat, at 1h intervals, 4 times, complete test with selector switch in each position, for each test.

.9 Co-ordinate ATS testing with generator manufacturer.

.10 Include all required costs for all commissioning phases, testing and fuel costs associated with required testing.

.11 A phase 1 and phase 2 electrical phasing procedures are associated with this project. Carry all associated cost for retesting, recommissioning and fuel as required.

.12 When all commissioning phases are completed, the manufacturer shall issue a letter to the Departmental Representative stating whether or not the installation of the ATS is in accordance with the Manufacturer’s recommendations.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

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

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 26 05 01 – Common Work Results – Electrical.

Part 2 Products

2.1 LIGHTING FIXTURES

.1 Type 1:
- .1 General purpose industrial fixtures providing 10% uplight and 90% downlight.
- .2 CSA or cUL approved.
- .3 Housing and reflector are multi-stage phosphate treated for maximum corrosion resistance.

2.2 LAMPS

.1 Fluorescent lamps shall be reduced mercury, T8, 2950 initial lumens, 2830 mean lumens, 24,000 hour rated life, 3500K, and CRI minimum of 86. Lamps shall be designed to pass the Federal TCLP test, and in effect at the time of takeover.

2.3 BALLASTS

.1 All ballasts shall be supplied with a rated voltage matching the supply voltage indicated on the drawings and output current and voltage ratings of the lamp or lamps they are designed to operate.

.2 Non dimmed T8 fluorescent ballasts shall meet or exceed the following specifications:
- .1 Shall be electronic programmed start.
- .2 Shall have an average input wattage of 62 watts when operating two non-enclosed F32T8 rapid start lamps; and 34 watts when operating one non-enclosed F32T8 rapid start lamp in ambient of 25°C.
- .3 Ballast factor of 92% minimum.
- .4 Power factor of 98% minimum.
- .5 Class “A” sound rating.
- .6 Thermally protected.
- .7 Rated for 60 Hz and voltage as indicated by circuit on the drawings.
- .8 Rated for operation from 10 Degrees Celsius to 40 Degrees Celsius.
- .9 Case temperature shall not exceed 25 Degrees Celsius over ambient temperature.
- .10 Operating frequency of 20 kHz minimum. Ballast shall produce no visible lamp flicker.
- .11 The total harmonic distortion shall not exceed 10%.

.12 Crest factor of 1.6 maximum.

.13 Shall contain no PCB's (polychlorinated biphenyls).

.14 Shall withstand line transients and noise as defined in ANSI/IEEE Standard C62.41, Category A.

.15 Lamp ignition time shall be 0.5 seconds minimum and shall be operated in accordance with ANSI Spec C82.1.

.16 EMI and RFI emission compliance with FCC (CFR47), Part 18, sub-part C, Class A, and FCC (CFR47) Part 15, Sub-part B, Class B.

.3 Manufacturer shall provide written warranty against defects in material or workmanship including replacement, for five years from date of manufacture when ballast case temperature does not exceed 70°C.

Part 3 Execution

3.1 INSTALLATION

.1 The Contractor shall supply, store and install all the light fixtures under this Contract in such a manner that their attachment to the ceiling shall be secure in all respects. In order to avoid any danger that the weight of the fixtures might distort hung ceilings (where such occur), approved type independent supports shall be provided by the Contractor to the satisfaction of the Departmental Representative.

.2 Fixtures shall not be hung directly from plasterboard ceilings, but shall derive their support from channels independently mounted in the ceiling space.

.3 Any supporting angles, channels, unistrut, clips, etc., required to adequately secure and support the fixtures shall be provided and installed by the Contractor. Exposed supporting system shall be painted white and blended in with the background colours.

.4 All lamps shall be new and burning at the time of take over. All fixtures shall be clean and in like new condition, at the time of takeover.

.5 This Division shall ensure the compatibility of the electronic ballast manufacturer and the fluorescent lamp manufacturer.

END OF SECTION

Part 1 General

1.1 INTRODUCTION

.1 The basic purpose of electrical and mechanical commissioning is to provide documented confirmation that electrical and mechanical systems function in compliance with the criteria set forth in the contract documents to satisfy the operational needs of the owner.

1.2 EQUIPMENT AND MATERIALS

.1 The Contractor shall provide all equipment as required to perform all commissioning.

.2 The Contractor shall provide all equipment not provided by the Owner as required to perform all commissioning, including PFT.

1.3 SUBMITTALS

.1 The contractor shall submit the following documentation prior functional performance testing.

- .1 Record drawings.
- .2 Operation and Maintenance Manuals.
- .3 Letter of acceptance from the inspection authority.
- .4 Letter of guarantee.
- .5 Copies of the following test results:
  - .1 Insulation/meggar tests.
  - .2 Load balance tests on the main switchboard, distribution panels, transformers and panels.
  - .3 Voltage regulation/tap tests on transformers.
  - .4 Load tests on motors.
  - .5 A Commissioning and/or Certification Report from the manufacturer.
  - .6 Written verification from the end user that staff training has been performed according to the manufacturer's recommendations.

1.4 FUCTIONAL PERFORMANCE TESTING (FPT)

.1 The Departmental Representative will commence a functional performance testing program independent of other processes, upon receipt of written verification from the General Contractor that:

- .1 All systems are complete and operational.
- .2 All specified reports and documents have been submitted and approved.
- .3 All tests, commissioning and start-up processes are complete.
- .4 All demonstrations have been completed and documented.
- .5 Written verification identified during the construction process and during the commissioning process have been corrected.

.2 Provide one electrician and all manufacturers' technical representatives as required by the Owner. Make all arrangements and pay all associated costs.

.3 FPT's shall be performed on all electrical systems in the contract documents which may include, but not limited to, the following:

.1 Power outlet box.

.2 Power distribution system.

.3 Digital meter.

.4 Emergency lighting.

.5 Lighting and lighting control.

.6 Heating.

.7 HVAC system.

.8 Pad mounted transformers.

.9 Primary cable.

.4 Deficiencies discovered during the FPT process shall be rectified immediately by the Electrical Contractor and re-tested.

END OF SECTION