

## **Part 1    General**

### **1.1       Related Requirements:**

- .1       26 05 01 Common Work Results - For Electrical
- .2       26 05 20 Wire and Box Connectors 0-1000 V
- .3       26 05 21 Wires and Cables (0-1000 V)
- .4       26 05 28 Grounding - Secondary
- .5       26 05 29 Hangers and Supports for Electrical Systems
- .6       26 05 31 Junction, Pull Boxes and Cabinets
- .7       26 05 34 Conduits, Conduit Fastenings and Conduit Fittings
- .8       26 28 14 Fuses – Low Voltage
- .9       26 28 23 Disconnect Switches - Fused and Non-Fused

### **1.2       References**

- .1       Canadian Standards Association (CSA International)
  - .1       CSA C22.1-12, Canadian Electrical Code, Part 1 (22<sup>nd</sup> 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 Work Included**

- .1 The specifications complement the drawings in describing the supply and installation of the complete electrical systems. These systems shall include but not be limited to the following:
  - .1 347/600V-3 phase-4 wire Power Systems

#### **1.5 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.

#### **1.6 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 plexiglass and locate as indicated.
  - .1 In main electrical room (Building C5) and generator room (Building C5).
- .3 Shop drawings:
  - .1 The Contractor shall prepare shop drawings showing in detail the design and construction of all equipment, panels, cabinets, lighting fixtures, 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.

#### **1.7 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.

#### **1.8 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 with aspects of its care and operation.

## **1.9 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.

## **1.10 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..

## **1.11 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.

## **1.12 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, 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 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.

**1.13     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.

**1.14     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.

**1.15     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.
- .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 facility 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 new generators, switchboards, panels, transfer switches and disconnect switches, 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 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, conduit 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 Sprinkler Protection**

- .1 All equipment such as panelboards, transformers, switchboard, relay cabinets, control cabinets, UPS cabinets, etc., installed in areas equipped with sprinkler protection, shall be fitted with sprinkler hoods and shall comply with the intent of C.E.C. Sections 26-008 and Appendix B-26-008.

## **2.8 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 existing slab (minimum embedment 100 mm. Concrete to be 21 kg/cm<sup>2</sup> 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.

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

### **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 switchboard, 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 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

**ONSA Job Number: 14-301**

### 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.***

***(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 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.
- .3 Divert unused wiring materials from landfill to metal recycling facility as approved by Consultant.

## **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 - 1000 V.
- .2 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### **1.2 References**

- .1 C22.2 NO. 0.3-09 (R2014) - Test methods for electrical wires and cables.

### **1.3 Product Data**

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

### **1.4 Waste Management and Disposal**

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

### **Part 3 Execution**

#### **3.1 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 Engineer is obtained.
- .2 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 Engineer.

#### **3.2 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.

**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 (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
  - .1 ANSI/IEEE 837-02, Qualifying Permanent Connections Used in Substation Grounding.
- .2 Canadian Standards Association, (CSA International)

### **1.3 Waste Management and Disposal**

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .2 Fold up metal banding, flatten and place in designated area for recycling.

## **Part 2 Products**

### **2.1 Equipment**

- .1 Grounding equipment shall be to CSA C22.2 No.41.
- .2 Ground conductors to be to ASA-G7.1.
- .3 Insulated ground conductors are to be RW90, green, for sizes up to and including #2. Insulated ground conductors #1 and larger to be TWH, green. All ground conductors to be copper without exception.
- .4 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 Bonding jumpers, straps.
  - .5 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 C.E.C., and as indicated on the drawings and further specified. Standards set either by drawings or specifications which are above those covered by C.E.C. shall not be reduced under any circumstances.
- .2 Generally, minimum grounding shall be provided by the metallic conduit/outlet box system and by the bond wire in cables. Additional insulated ground wires, sized as per the drawings, shall be provided as follows:
  - .1 In all EMT conduit feeders that supply panelboards, CDP panels, FDP panels, MCC's, and transformers - all sized as per C.E.C. Table 16.
  - .2 A separate green bond conductor sized as per Table 16 of the C.E.C. shall be installed in each EMT conduit run for branch circuit wiring.
  - .3 Where ground conductors terminate at ground buses in switchboards 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.
- .3 Install connectors in accordance with manufacturer's instructions.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Install bonding wire for flexible conduit, connected at one end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

### **3.2 System and Circuit Grounding**

- .1 Install system and circuit grounding connections.

### **3.3 Equipment Grounding**

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, elevators and escalators, distribution panels, outdoor lighting.

### **3.4 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 method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

- .4      Disconnect ground fault indicator during tests.

**END OF SECTION**

## **Part 1 General**

### **1.1 Related Sections**

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

### **1.2 Waste Management and Disposal**

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .2 Fold up metal banding, flatten and place in designated area for recycling.

## **Part 2 Products**

### **2.1 Support Channels**

- .1 U shape, size 41 x 41 mm x 2.5 mm 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 10 mm 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.

## **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 poured concrete with expandable inserts.

- .3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .4 Fasten exposed conduit or cables to building construction or support system using straps.
  - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .5 Suspended support systems.
  - .1 Support individual cable or conduit runs with 10 mm diameter threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 10 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
  - .3 Channel is to be sandwiched between nuts and washers located on both upper and underside portions of channels.
  - .4 All excess rod is to be cut-off within 12 mm of channel bottom
- .6 For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.
- .7 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .8 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .9 Do not use wire lashing or perforated strap to support or secure raceways.
- .10 Do not use supports or equipment installed for other trades.
- .11 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 305 mm 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 - Electrical.

### **1.2 Shop Drawings and Product Data**

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

### **1.3 Waste Management and Disposal**

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .2 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 300 mm x 300 mm and Type "C" for boxes 300 mm x 300 mm or larger.
- .2 Pull boxes shall be of sheet metal construction with all welded steel corners and screw on flat covers for surface mounting.

## **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 All suspended junction, pull and outlet boxes shall be supported with minimum size 10 mm 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 119 mm square. Two rods required for boxes larger than 119 mm square, up to and including 203 mm square. A minimum of four rods required for all boxes larger than 203 mm square.
- .3 Mount cabinets with top not higher than 2000 mm above finished floor.



- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m 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 and phase.

**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. 18.1 04 (R2009), Metallic Outlet Boxes.
  - .2 CAN/CSA C22.2 No. 18.2-06 (R2011), Nonmetallic Outlet Boxes.
  - .3 CAN/CSA C22.2 No. 18.3-12, Conduit, tubing, and cable fittings.
  - .4 CAN/CSA C22.2 No. 18.4-04 (R2009), Hardware for the Support of Conduit, Tubing, and Cable.
  - .5 CAN/CSA C22.2 No. 18.5-02 (R2012), Positioning Devices.
  - .6 CSA C22.2 No. 45.1-07 (R2012), Rigid Metal Conduit, Steel.
  - .7 CSA C22.2 No. 56 04 (R2009), Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit.
  - .8 CSA C22.2 No. 83 M1985 (R2008), Electrical Metallic Tubing.
  - .9 CSA C22.2 No. 211.2 06 (R2011), Rigid PVC (Unplasticized) Conduit.
  - .10 CAN/CSA C22.2 No. 227.3 05 (R2010), Flexible Nonmetallic Tubing.

### **1.3 Waste Management and Disposal**

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .2 Fold up metal banding, flatten and place in designated area for recycling.

## **Part 2 Products**

### **2.1 Conduits**

- .1 Thinwall Type "EMT" conduit shall conform to .8 CSA C22.2 No. 83 M1985 (R2008), Electrical Metallic Tubing, galvanized, sized as indicated.
- .2 Flexible galvanized steel liquid tight conduit shall conform to .7 CSA C22.2 No. 56 04 (R2009), Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit, sized as indicated.
- .3 Rigid PVC conduit shall conform to CSA C22.2 No. 211.2 06 (R2011), sized as indicated

## **2.2     Conduit Fastenings**

- .1     One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2     Beam clamps to secure conduits to exposed steel work.
- .3     Channel type supports for two or more conduits at 1500mm on centers.
- .4     Threaded rods, 10 mm 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 25 mm and larger conduits.
- .3     Couplings for thinwall Type "EMT" shall be set screw type, galvanized steel. Locknuts shall be case hardened steel.
- .4     Connectors for thinwall Type "EMT" shall be set screw type, galvanized steel. Locknuts shall be case hardened steel.
  - .1     Connectors 32 mm and larger shall be complete with threaded plastic bushings.
  - .2     Connectors less than 32 mm shall be complete with insulated throats.
- .5     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.
- .6     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.
- .7     Watertight steel connectors and steel couplings for EMT installed in vertical runs of conduit systems. Set-screws are not acceptable.

## **2.4     Fish Cord**

- .1     Polypropylene.

## **Part 3   Execution**

### **3.1     Installation**

- .1     Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2     Conceal conduits except in mechanical and electrical service rooms.

- .3 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.
- .4 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 16 of the C.E.C..
- .5 All 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 152 mm. Conduits shall run through ceiling spaces and down in walls.
- .6 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 one meter of each outlet box, junction box, cabinet, couplings or fittings and the spacing between supports as follows:
  - .1 Less than 1524 mm for 13 mm and 19 mm EMT;
  - .2 Less than 2286 mm for 25 mm and 32 mm EMT;
  - .3 Less than 3048 mm for 38 mm EMT or larger.
- .7 Liquid tight flexible conduit, not smaller than 10 mm I.D., shall be used for connections to all transformers, motors and equipments, in both wet and dry areas.
- .8 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.
- .9 All conduit subject to corrosive elements shall be treated with corrosion resistant compounds.
- .10 Conduit shall not pass through structural members without the permission of the Engineer.
- .11 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.
- .12 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .13 Mechanically bend steel conduit over 19 mm diameter.
- .14 Install fish cord in empty conduits.
- .15 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .16 Dry conduits out before installing wire.

### **3.2 Surface Conduits**

- .1 Run parallel or perpendicular to building lines.
- .2 Run conduits in flanged portion of structural steel.
- .3 Group conduits wherever possible on suspended or surface channels.
- .4 Do not pass conduits through structural members except as indicated.
- .5 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

### **3.3 Couplings and Connectors**

- .1 Thinwall Type "EMT" couplings shall be securely tightened.
- .2 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.

### **3.4 Conduit Fittings**

- .1 Install conduit fittings where required. Secure conduit in fittings and secure conduit to structure within 300 mm 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 Requirements**

- .1        Section 26 28 26 Power Circuit Breakers.

### **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.

### **1.3        System Description**

- .1        Switchboard to consist of:
  - .1        Synchronizing panel.
  - .2        Two generator panels.
  - .3        Totalizing meters panel.
  - .4        Two feeder sections to supply transfer switches and portable load bank.

### **1.4        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 Switchboard assembly.
- .3        Provide operation and maintenance data for generator switchboard 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.

### **1.5        Health And Safety**

- .1        Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

## **Part 2    Products**

### **2.1        Power Circuit Breakers**

- .1        Draw out type, sized as indicated.

### **2.2        Meters**

- .1        Existing, ASCO equipment to be transferred from existing switchboard to new switchboard.

**2.3      Instrument Transformers**

- .1      Existing, ASCO equipment to be transferred from existing switchboard to new switchboard.

**2.4      Synchronizing Panel**

- .1      Existing, ASCO equipment to be transferred from existing switchboard to new switchboard.

**2.5      Generator Panels**

- .1      Existing, ASCO equipment to be transferred from existing switchboard to new switchboard.

**2.6      Totalizing Meter Panel**

- .1      Existing, ASCO equipment to be transferred from existing switchboard to new switchboard.

**2.7      Permanent Generator Breakers**

- .1      Electrically operated, motorized power circuit breaker.
- .2      100% rated, 1600A frame, trip unit sized as indicated.
- .3      24VDC to trip
- .4      120VAC to close
- .5      One normally open, one normally closed auxiliary contact per breaker.
- .6      Fully adjustable long time, short time, instantaneous and ground fault settings.
- .7      Kirk key interlock with portable generator breaker.

**2.8      Portable Generator Breaker**

- .1      Manually operated power circuit breaker.
- .2      100% rated, 1600A frame, trip unit sized as indicated.
- .3      One normally open, one normally closed auxiliary contact.
- .4      Fully adjustable long time, short time, instantaneous and ground fault settings.
- .5      Kirk key interlock with permanent generator breakers.

**2.9      Feeder Sections**

- .1      Feeder Section No.1:
  - .1      Fully populated with four power circuit breakers, 100% rated, 1600A frame, trip unit sized as indicated.
  - .2      One normally open, one normally closed auxiliary contact per breaker.
  - .3      Fully adjustable long time, short time, instantaneous and ground fault settings.
  - .4      24 VDC shunt trip device where indicated.
- .2      Feeder section No. 2:

- .1 Identical to feeder section No.1 except:
  - .1 Provisions only for future power circuit breakers (4)

## **2.10 Voltage Regulator**

- .1 Existing, ASCO equipment to be transferred from existing switchboard to new switchboard.

## **2.11 Fabrication**

- .1 Switchboard assembly to CAN/CSA-C22.2 No.31, free standing, floor mounted, dead front metal enclosed type with:
  - .1 Totally enclosed swinging synchronizing panel hinged at left side of generator panel No.1.
  - .2 Hinged locked doors on front for generators, totalizing meter and feeder panels, and removable access covers on rear.
- .2 Install main bus from generator panel No.1 to last feeder panel.
- .3 Install meters and equipment in each panel.
- .4 Wire disconnects to permit isolation of circuit breakers from main bus in generator and feeder panels.
- .5 Install wiring to meters, instrument transformers, relays, terminal strips and circuit breaker controls.

## **2.12 Source Quality Control**

- .1 Perform following tests for each assembly:
  - .1 High potential insulation level test on switchboard assembly.
  - .2 Operating check of meters.
  - .3 Instruments and relays under service tests by impressing properly phased current and voltage.
  - .4 Operation of breaker control, sequence and interlocking circuits.

## **2.13 Finishes**

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .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.

## **2.14 Equipment Identification**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - for Electrical.



- .2 Nameplates for switchboard panels: size 6.
- .3 Nameplates for instruments and controls: size 4.

### **2.15 Manufacturer**

- .1 Generator switchboard shall be manufactured by ASCO. All controls equipment shall be removed from the existing ASCO generator switchboard, stored on site and reinstalled in the new generator switchboard.

## **Part 3 Execution**

### **3.1 Installation**

- .1 Installation of all control equipment swapped from the existing switchboard to the new switchboard shall be by the manufacturer's representative (ASCO).
- .2 For generator unit No. 1:
  - .1 Connect alternator leads to power circuit breaker in generator panel No. 1.
  - .2 Connect exciter leads to voltage regulator and field rheostat in generator panel No. 1.
  - .3 Connect governor motor to governor switch in generator panel No. 1.
  - .4 Connect engine start/stop terminals to start/stop switch on generator panel No. 1.
  - .5 Connect engine monitoring circuits to instrumentation.
- .3 For generator unit No. 2:
  - .1 As for generator unit No. 1 with connections to generator panel No. 2.
- .4 Connect load side of feeder circuit breakers to feeder circuits.
- .5 Grounding: to Section 26 05 28- Grounding - Secondary.

### **3.2 Field Quality Control**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Start generator unit No. 1 and adjust voltage to nominal value.
- .3 Close circuit breaker on generator panel No. 1 to energize switchboard bus.
- .4 Close feeder panel circuit breakers to load bus.
- .5 Check meters for correct readings.
- .6 Start generator unit No. 2 and synchronize with No. 1 unit.
- .7 Check generator panel No. 2 meters.

### **3.3 Commissioning**

- .1 Perform commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Commission generator switchboard with power generating units as complete system.

- .1 Allow five days minimum for testing and instruction to operating and maintenance staff.
- .3 Manufacturer's representative to remain on site until defects, that may occur during installation, are corrected.
  - .1 Include costs in this contract.
- .4 Complete two (2) copies of field testing data sheets. Data sheets shall be signed by supplier's field technician and by Departmental Representative.
- .5 Provide one (1) copy immediately to Departmental Representative. Make additional copies as required and include one (1) 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.

### **1.2 References**

- .1 Canadian Standards Association (CSA)
  - .1 C22.2 NO. 248.12-11 - Low-voltage fuses - Part 12: Class R fuses (Tri-national standard, with UL 248-12 and NMX-J-009/248/12-ANCE).

### **1.3 Shop Drawings and Product Data**

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

### **1.4 Waste Management and Disposal**

- .1 Place materials defined as hazardous or toxic waste in designated containers.
- .2 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

### **1.5 Delivery and Storage**

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard or disconnect switches.
- .3 Store fuses in original containers.

### **1.6 Maintenance Materials**

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Six spare fuses of each type and size installed.

## **Part 2 Products**

### **2.1 Fuses General**

- .1 Fuses: product of one manufacturer for entire project.
- .2 Fuses for protection of motors, transformers, and electric heating circuits and feeders:

- .1 Shall be HRC, Form I, Class J, Type D (Time Delay), plated contacts, rated 600V, current limiting type, standard time delay - hold 500% of current rating for 10 seconds.
- .2 Specified unit: Mersen Type 'AJT' c/w spot indication.
- .3 Other approved manufacturer: Little-Fuse, Bussman.

### **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.

**END OF SECTION**

## **Part 1 General**

### **1.1 Related Requirements**

- .1 Section 26 24 13 Generator Switchboard.

### **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: 1600 A.
  - .2 Trip rating: as indicated.
  - .3 Interrupting rating: 50,000 kA, RMS symmetrical minimum.
- .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 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.
- .6 Breakers with on-off indicator and spring charged/discharged indicator.
- .7 Interlocks to prevent circuit breaker draw out when in closed position and to prevent closing unless fully engaged or in test position.
- .8 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 Optional Features**

- .1 Shunt trip (where indicated).
- .2 Auxiliary switches: 1 N.O., 1 N.C.
- .3 Alarm switch.
- .4 Pilot light.
- .5 Control switch.
- .6 Key interlock where indicated.
- .7 Remote close (120VAC operation).
- .8 Lockout devices.

- .9 Padlocking provision.
- .10 Operation counter.
- .11 Provide external remote racking unit, one for facility each breaker.

### **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 air circuit breakers as indicated.

#### **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.

**END OF SECTION**

## **Part 1    General**

### **1.1       Related Sections**

- .1       Section 01 33 00 - Submittal Procedures.

### **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.

## **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.

### **2.2       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.
  - .3 On-off locking device.
  - .4 Handle mechanism to be supplied on all breakers 225amps and greater.
  - .5 Shunt trip mechanism

### **Part 3    Execution**

#### **3.1        Installation**

- .1 Circuit breakers shall be securely mounted in panelboards 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 in panelboards for all unused breaker spaces.
- .4 Set trip units as per the fault and coordination study described in 26 05 01 Common Work Results for Electrical.

**END OF SECTION**

## **Part 1 General**

### **1.1 Related Sections**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 35 29.06 - Health and Safety Requirements.
- .3 Section 26 05 01 - Common Work Results - Electrical.
- .4 Section 26 28 14 - Fuses - Low Voltage.

### **1.2 References**

- .1 Canadian Standards Association (CSA International).
  - .1 CAN/CSA C22.2 No.4-M89 Enclosed Switches.
  - .2 CSA C22.2 No.39-M89, Fuseholder Assemblies.

### **1.3 Submittals**

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

### **1.4 Shop Drawings**

- .1 Submit shop drawings and product data in accordance with 26 05 01 Common Work Results - For Electrical
- .2 Indicate on shop drawings:
  - .1 Fuse clip arrangement/class.
  - .2 Overall length, height and depth of each type of switch.
  - .3 Number of poles, including neutrals where required, amperage rating, and voltage rating of each type of disconnect required.

### **1.5 Health and Safety**

- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

### **1.6 Waste Management and Disposal**

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .2 Fold up metal banding, flatten and place in designated area for recycling.

## **Part 2 Products**

### **2.1 Disconnect Switches**

- .1 Fusible and non fusible disconnect switches in CSA rated enclosures, size as indicated, Type "1".
- .2 Provision for padlocking in "ON" and "OFF" position.
- .3 Mechanically interlocked door to prevent opening when handle in "ON" position.
- .4 Fuses: size as indicated, in accordance with Section 26 28 14 - Fuses - Low Voltage.
- .5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.
- .8 Fuseholder assemblies to CSA C22.2 No. 39.

### **2.2 Equipment Identification**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

## **Part 3 Execution**

### **3.1 Installation**

- .1 Install disconnect switches complete with fuses if applicable.
- .2 Supply all necessary mounting hardware and channel as required to mount switches.

**END OF SECTION**

## **Part 1    General**

### **1.1       Related Requirements**

- .1       Section 01 33 00 - Submittal Procedures.
- .2       Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3       Section 01 78 00 - Closeout Submittals.
- .4       Section 26 05 01 - Common Work Results – For Electrical.

### **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       System 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       Shop Drawings**

- .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 Automatic transfer switch: make, model and type.
- .5 Manual bypass switch: make and model.
- .6 Battery: make, type and capacity.
- .7 Battery charger: make, type and model.
- .8 Alternator control panel: make and type of meters and controls.
- .9 Governor type and model.
- .10 Cooling air requirements in m<sup>3</sup>/s.
- .11 Flow diagrams for:
  - .1 Diesel fuel.
  - .2 Cooling air.
- .12 Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, enclosure and total weight.
- .13 Continuous full load output of set at 0.8PF lagging.
- .14 Description of set operation including:
  - .1 Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
  - .2 Manual starting.
  - .3 Automatic shut down and alarm on:
    - .1 Overcranking.
    - .2 Overspeed.
    - .3 High engine temp.
    - .4 Low lube oil pressure.
    - .5 Short circuit.
    - .6 Alternator overvoltage.
    - .7 Lube oil high temperature.
    - .8 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 Disposal, 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, 12 month warranty period is extended to 60 months 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 2 fuel filter replacement elements.
  - .2 2 lube oil filter replacement elements.
  - .3 2 air cleaner filter elements.
  - .4 2 sets of fuses for control panel.
  - .5 Special tools for unit servicing.

## **Part 2 Products**

### **2.1 Diesel Engine**

- .1 Diesel engine: to ISO 3046-1.
  - .1 Engine: standard product of current manufacture, from company regularly engaged in production of such equipment.
- .2 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 an electrically panel internally mounted within the generator's weatherproof housing.

- .1 Battery chargers shall be supplied with battery fault contacts. Wire contacts to generator control/anunciator panel.
  - .2 Two battery charges are required, one for each set of batteries.
  - .3 Provide battery warming blankets.
- .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 Drip tray.

## 2.2 **Alternator**

- .1 Alternator: to ANSI/NEMA MG1.
- .2 Rating: 3-Phase, 347/600V, 3 Phase, 4 Wire, 600 kW, 60Hz, at 0.8PF.
  - .1 A 100% rated, integral emergency generator circuit breaker is required. Breaker shall be complete with:
    - .1 Solid state trip unit with fully adjustable long, short and instantaneous settings,
    - .2 One normally open and one normally closed auxiliary contact,
    - .3 24 VDC shunt trip mechanism.
- .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 °C 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 PWM signal for connection to generator switchboard.
- .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.

## 2.3 Control Panel

- .1 Totally enclosed, mounting base isolated from diesel generator.
- .2 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".
- .3 Controls:
  - .1 Engine start button.
  - .2 The engine controls shall also include a 4-position selector switch with the following positions: OFF/RESET - AUTO - MANUAL - AUTO/COOL DOWN.
  - .3 Operating lights, panel mounted:
    - .1 "Normal power" pilot light.
    - .2 "Emergency power" pilot light.
    - .3 Green pilot lights for breaker on and red pilot lights for breaker off.
  - .4 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 Low battery voltage.
- .3 Ventilation failure.
- .4 Low coolant temperature.
- .5 Battery failure.
- .6 Generator run status.
- .5 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.
- .6 Lamp test button.
- .7 Provide CANBUS output modules (to be mounted by ASCO in generator switchboard) for interconnection between generator and generator controllers.

## **2.4 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.

## **2.5 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.

## **2.6 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 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.

## **2.7 Equipment Identification**

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

## **2.8 Fabrication**

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

## **2.9 Finishes**

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

## **2.10 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 4 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 Operation of manual bypass switch.
  - .3 Automatic shut down of engine on resumption of normal power.
  - .4 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 Coordinate and include all cost associated with start-up and commissioning of the automatic transfer switch. Locate generating unit and install as indicated.

#### **3.2 Field Quality Control**

- .1 This contractor shall provide a remote load bank, necessary interconnect cabling to test the emergency power system under 100% load as outlined below. Load bank shall be made available for a minimum of five business days to allow for generator testing and commissioning as well as tuning and commissioning of the generator switchboard. All work is to be coordinated with ASCO.
- .2 Perform tests in accordance with Section 26 05 01 - Common Work Results – For Electrical.
- .3 Notify Departmental Representative 10 working days in advance of test date.
- .4 Provide fuel for testing and leave full tanks on acceptance.
- .5 Demonstrate:
  - .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.
- .6 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.
- .7 At end of test run, check battery voltage to demonstrate battery charger has returned battery to fully charged state.

**END OF SECTION**