Service Entrance Skid

Specifications

Cedar Road LFG Inc

1MW Landfill Methane Generation

Nanaimo, BC

Canada

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Lex Engineering Ltd.

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PART 1: GENERAL

1.1 SCOPE

1.1.1 This specification establishes the requirements for the design, manufacture, testing, and delivery to installation site, one (1) service entrance skid complete from the incoming line terminals to the outgoing line terminals as specified herein and as shown on the drawings to the Nanaimo 1MW Garbage Methane Generator project located at Suncurrent Industries Inc, Nanaimo, BC, Canada.

1.1.2 The service entrance skid shall consist of primary equipment, transformer, and secondary equipment as specified herein. The manufacturer of the service entrance skid shall furnish and coordinate all major components of the skid, including primary equipment section, transformer, and low-voltage section as well as circuit breakers, fusible switches, and metering components. Provide a single warranty covering all skid assemblies, transformers, and components.

1.1.3 Service entrance skid to be outdoors and shall consist of a single rigid freestanding enclosure unit containing the primary equipment, transformer, secondary equipment, and all their associated components, be of weatherproof construction, rodent proof, and contain 120V space heaters, receptacles, and lighting as required.

1.1.4 Connections between the primary device and transformer shall be flexible jumpers, and between the transformer and secondary device shall be flexible bus braid jumpers.

1.1.5 It is intended that the manufacturer have the widest possible scope within the limits of specification and shall state clearly where their proposal deviates from this specification. The manufacturer shall provide written details stating any clauses of this specification they cannot fully satisfy and provide reasons for the clarification. If these details are not provided, the manufacturer will be expected to meet or exceed all specified clauses at their cost.

1.2 REFERENCE STANDARDS

1.2.1 The service entrance skid shall be designed, assembled, tested, and installed to conform to and in accordance with latest relevant standards of IEEE, ANSI, NEMA, EEMAC, CSA, CEC, BC Hydro, and all local and municipal codes or bylaws, applicable to its three major sections.

1.2.2 The high-voltage load interrupter switchgear and all components shall be designed, manufactured, and tested in accordance with latest revisions and amendments of the following applicable standards:

(1) ANSI C37.20.3
(2) ANSI C37.20.4
(3) NEMA SG5
(4) NEMA SG6
(5) CSA C22.2 No. 31 – M1989
(6) EEMAC G8-3.2, 1989.

1.2.3 The transformer shall be manufactured and tested to conform to the latest revisions and latest amendments of the following standards:

(1)	CAN/CSA-C2-M91	Single-Phase and Three-Phase Distribution Transformers, Types ONAN and LNAN
(2)	CSA C50	Electrical Insulating Oil for Transformers and Reactors
(3)	CSA C308	Insulation Co-ordination
(4)	EEMAC GL1-2	Transformers and Reactor Bushings
(5)	EEMAC Y1-2	Performance Specification for Finishing Systems for Outdoor Electrical Equipment
(6)	ANSI/IEEE C57.12.00	General Requirements for Liquid Immersed Distribution, Power and Regulating Transformers
(7)	ANSI/IEEE C57.12.90	Test Code for Distribution, Power, and Regulating Transformers
(8)	IEEE C62.11	Standard for Metal-Oxide Surge Arresters for AC Power Circuits
(9)	NEMA TR1	Transformers, Regulators, and Reactors.

1.2.4 The low-voltage switchboard with metering and all components shall be designed, manufactured, and tested in accordance with the latest revisions and amendments of the following applicable standards:

(1)	ANSI-C37.20	Switchgear assemblies
(2)	ANSI-C37.13	Low-voltage power circuit breakers
(3)	ANSI-C37.16	Low-voltage power circuit breakers
(4)	ANSI-C37.17	Trip devices
(5)	ANSI-C37.90	Relays
(6)	ANSI-C39.1	Meters
(7)	NEMA SG-5	Switchgear assemblies
(8)	NEMA SG-3	Low-voltage power circuit breakers
(9)	CSA C22.2 No. 31	Switchgear Assemblies
(10)	CSA C22.2 No. 5.1	Moulded Case Circuit Breakers
(11)	CEC 14-012	
(12)	EEMAC G8-3.2, 1989	
(13)	NEMA PB-2	
(14)	UL 891.	

1.2.5 The high-voltage fuses shall meet the requirements of ANSI standards C37.40 to C37.47 and NEMA SG2.

1.2.6 All equipment to be CSA certified and approved prior to shipment to site.

1.3 SUBMITTALS FOR REVIEW AND APPROVAL

1.3.1 The manufacturer shall provide a detailed schedule for the design, manufacture, and delivery of the complete skid and all equipment, ensuring that the sequence and timing are consistent with the construction schedule.

1.3.2 The following information shall be submitted to the Engineer for review and approval prior to construction:

(1) Master drawing index
(2) Front view elevation
(3) Floor plan
(4) Top view
(5) Single line
(6) Schematic diagram
(7) Nameplate schedule
(8) Component list
(9) Conduit entry/exit locations
(10) Assembly ratings that include:
    a) Short circuit rating
    b) Voltages
    c) Continuous current
    d) Basic impulse level for equipment over 600V
    e) KVA
(11) Major component ratings that include:
    a) Voltages
    b) Continuous current
    c) Interrupting ratings
(12) Cable lug and terminal sizes
(13) Connection details between close-coupled assemblies
(14) Composite floor plan of close-coupled assemblies
(15) Impedance for transformer.

1.3.3 Where applicable, the following additional information shall also be submitted to the Engineer for review and approval prior to construction:

(1) Busway connection
(2) Key interlock scheme drawing and sequence of operations.

1.3.4 The manufacturer shall provide complete seismic anchorage details for placement of service entrance skid. Manufacturer shall recommend anchors and show detail anchor locations so that the anchoring meets the BC Building Code Seismic Restrain. Bolt diameter, projection, embedment, strength and length details to be supplied by the manufacturer. Seismic recommendations are to be certified by a BC, P.Eng.

1.3.5 Four (4) printed copies and one (1) electronic copy of all items listed in Section 1.3 shall be submitted to Lex Engineering Ltd. within four (4) weeks after receipt of order.

A. Xerox copies of submittals are acceptable, provided at least one (1) copy is original.
B. Copies must be legible and suitable for microfilming. Submittals that are not clear and legible will be returned for re-issue by the manufacturer.
C. All electronic copies of drawings shall be compatible with AutoCAD 2000.
D. All other electronic copies of submittals shall be in Word or PDF format.

1.4 SUBMITTALS FOR INFORMATION

1.4.1 The following product information shall be made available and submitted when requested by the Engineer:

(1) Descriptive bulletins
(2) Product sheets.

1.4.2 Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be submitted to the Engineer two (2) weeks prior to shipping. One (1) copy of these instructions shall also be included with the equipment at the time of shipment.

1.4.3 Operation and maintenance manuals shall include the following information:

(1) Instruction books and/or leaflets
(2) Recommended renewal parts list
(3) Installation information and drawings.

1.4.4 Four (4) printed copies and one (1) electronic copy of all operation and maintenance manuals listed in 1.4.3 shall be submitted to Lex Engineering Ltd. no less than two (2) weeks prior to shipping of the equipment.

A. Xerox copies of submittals are acceptable, provided at least one (1) copy is original.
B. Copies must be legible and suitable for microfilming. Submittals that are not clear and legible will be returned for re-issue by the manufacturer.
C. All electronic copies of drawings shall be compatible with AutoCAD 2000.
D. All other electronic copies of submittals shall be in Word or PDF format.

1.5 SUBMITTALS FOR CLOSEOUT

1.5.1 The following information shall be submitted for record purposes:
(1) Final as-built drawings and information for items listed in Section 1.3
(2) Wiring diagrams
(3) Certified production test reports
(4) Installation information
(5) Seismic certification and equipment anchorage details (See 1.3.4).

1.5.2 Four (4) printed copies and one (1) electronic copy of all of the items listed above shall be submitted to Lex Engineering Ltd. prior to final payment.
A. Xerox copies of submittals are acceptable, provided at least one (1) copy is original.
B. Copies must be legible and suitable for microfilming. Submittals that are not clear and legible will be returned for re-issue by the manufacturer.
C. All electronic copies of drawings shall be compatible with AutoCAD 2000.
D. All other electronic copies of submittals shall be in Word or PDF format.

1.6 UNIT RESPONSIBILITY

1.6.1 Manufacturer Supply
(1) One (1) service entrance skid complete with all specified equipment from the incoming line terminals to the outgoing line terminals.
(2) Printed and electronic copies of manufacturer's drawings, maintenance, operation, and storage instructions (See 1.3, 1.4, 1.5).
(3) Testing of protective devices and control.
(4) Commissioning and set-up assistance.

1.6.2 Owner Supply
(1) Concrete foundations
(2) Anchor bolts as recommended by manufacturer in 1.3.4.
(3) All labour and crane for off-loading at installation site.
(4) All labour for installation of the skid.
(5) All labour for erection and commissioning, excluding manufacturer's supervision.
(6) Wiring to incoming and outgoing line terminals.

1.7 QUALIFICATIONS

1.7.1 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

1.7.2 For the transformer, primary and secondary equipment specified herein, the manufacturer shall submit to Quality Management and Quality Assurance certified programs, for example, CSA Z2.99.1, 2, 3, 4 or ISO 9000, 9001 or 9002.

1.7.3 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.7.4 The equipment shall be suitable for and certified to meet all applicable seismic requirements of the British Columbia Building Code. The manufacturer shall provide guidelines for the installation consistent with these requirements (See 1.3.4)**.**

1.7.5 All equipment, products, installations and procedures shall comply with the Canadian Electrical Code (CEC).

1.8 PROJECT DRAWINGS

1.8.1 The following project drawings are to be used in reference with this specification.

Dwg No.	Revision	Description
A1-0571-101	Rev. P4	Single Line Diagram

1.9 OPERATING CONDITIONS

1.9.1 The service entrance skid consisting of high-voltage load interrupter switch, transformer, revenue meter, low-voltage switchboard, and all ancillary equipment shall be located freestanding outside and unshielded from the elements on a concrete pad in Nanaimo, BC.

1.9.2 Site Data for Nanaimo, BC:

(1) Outdoor temperature
  a) Summer
    i. Extreme high ..... 36.7 ºC
    ii. Average daily high ..... 24.2 ºC
  b) Winter
    i. Extreme low ..... -20.0 ºC
    ii. Average daily low ..... -1.2 ºC
  c) Mean annual temperature ..... 9.5 ºC
(2) Mean annual rain fall ..... 1045.0 mm
(3) Mean annual snow fall ..... 92.9 cm
(4) Elevation ..... 30 m
(5) Earthquake zonal velocity ratio 0.20
  a) Acceleration-related seismic zone Za 4.00
  b) Velocity-related seismic zone Zv 4.00
(6) Wind ..... Per N.B.C., Section 4.1.8, 30 year return

1.9.3 The service entrance skid shall be capable of operating normally in an environment with an ambient temperature range of -17.8ºC to 40ºC (0ºF to 104ºF) with a relative humidity of up to 95% (non-condensing). The current rating of all enclosed equipment, cables, and busway shall be de-rated by 10% for each 5ºC (9ºF) above 40ºC (104ºF), not exceeding 60ºC (140ºF).

1.9.4 Anti-condensation space heaters and lights shall be provided in the HV and LV cubicles.

1.9.5 The skid shall be suitable for operation in "medium pollution" air conditions.

1.10 PRICING

1.10.1 All costs shall be itemized and include all spare parts, manuals, drawings, certifications, equipment and site assistance as required and delivery DDP to site.

1.10.2 Bids will be evaluated and the vendor that offers the best value will be selected. The vendor with the lowest price will not necessarily be awarded the contract.

1.11 TECHNICAL QUESTIONS & SUBMISSION ADDRESS

1.11.1 All technical questions, drawings, documents, and manuals should be directed and submitted to:

Bill Hassard, P.Eng
E-mail: bhassard@lexeng.com

Shane D. Schneider, EIT
E-mail: sdschneider@lexeng.com

LEX Engineering Ltd.
Suite 200 – 2560 Simpson Road
Richmond, BC V6X 2P9

Tel: 604-273-1758
Fax: 604-273-1759

PART 2: PRODUCTS - PRIMARY SIDE EQUIPMENT

2.1 RATINGS

2.1.1 The high-voltage load interrupter switchgear ratings shall be as follows:

(1) Nominal System Voltage.....14,400/24,940Y V, three phase, four wire
(2) System Grounding..... Starpoint on transformer
(3) Maximum Design Voltage .....27.5 kV
(4) Basic Impulse Level (BIL).....150 kV
(5) Bus Continuous Current .....600 A
(6) Momentary Current .....12.5 kA
(7) Two-Second Current .....12.5 kA

2.1.2 The switch shall have the following minimum ratings:

(1) Maximum Design Voltage .....27.5 kV
(2) Basic Impulse Level (BIL).....150 kV
(3) Continuous and Load Interrupting Current.....600 A
(4) Momentary Current (Switch closed, 10 cycle) .....20 kA Asym.
(5) Fault Close Current.....20 kA Asym.
(6) Two Second Current.....12.5 kA Sym.

2.1.3 The high-voltage fuse shall have the following ratings:

(1) Fuse Rating 50E
(2) Nominal System Voltage.....25 kV
(3) Maximum Design Voltage .....27.5 kV
(4) Interrupting Rating .....12.5 kA RMS Sym.

2.2 CONSTRUCTION

2.2.1 The metal enclosed load interrupter switchgear shall consist of dead front, completely metal enclosed vertical sections containing the load interrupter switches and fuses (where shown) of the number, rating and type noted on the drawings or specified herein.

2.2.2 The following features shall be supplied on every vertical section containing a three-pole, two-position open-closed switch:

(1) A high impact viewing window that permits full view of the position of all three switch blades through the closed door.
(2) The door shall be interlocked with the switch so that:
   a) The switch must be opened before the door can be opened.
   b) The door must be closed before the switch can be closed.
(3) A grounded metal barrier in front of every switch to prevent inadvertent contact with any live part, yet allow for a full-view inspection on the switch blade position.
(4) Provision for padlocking the switch in the open or closed position.
(5) Permanent “Open-Closed” switch position indicators.

2.2.3 Vertical section construction shall be of the universal frame type using die formed and bolted parts. All enclosing covers and doors shall be fabricated from not less than 11-gauge steel. To facilitate installation and maintenance of cables and bus in each vertical section, a removable top and rear covers shall be provided.

2.2.4 Each outdoor vertical section shall have a sloped weatherproof roof. All openings shall be screened to prevent the entrance of small animals, and barriered to inhibit the entrance of rain, snow, sand, etc.

2.2.5 Each vertical section containing a switch shall have a single, full length, flanged front door and shall be equipped with two rotary latch type padlockable handles. Provision shall be made for operating the switch and storing the removable handle without opening the full-length door.

2.2.6 All covers, panels, and doors shall use tamper-resistant/security fasteners, hinges, and padlockable latches. Provide solid lockable covers for view ports.

2.2.7 Each load interrupter switch shall have the following features:

(1) Three-pole gang operated.
(2) Manual quick-make quick-break over toggle type mechanism that does not required the use of a chain or a cable for operation, and utilizing a heavy duty coil spring to provide the opening and closing energy.
(3) The speed of opening and closing the switch shall be independent of the operator, and it shall be impossible to tease the switch into any intermediate position under normal operation.
(4) Separate main and break contacts to provide maximum endurance for fault close and load interrupting duty.
(5) Insulating barriers between each phase and between the outer phases and the enclosure.
(6) A maintenance provision for slow closing the switch to check switch blade engagement and slow opening the switch to check operation of the arc interrupting contacts.

2.2.8 All cables to be bottom entry.

2.2.9 A minimum of one 250W, 120V space heater with thermostat shall be provided in each vertical section. A fused control power transformer mounted in the low-voltage switchboard section shall furnish power for space heaters. The design shall be non-walk-in type. Provide interior lighting for low voltage compartments.

2.3 BUS

2.3.1 All phase bus conductors shall be copper and be mounted on indoor NEMA class insulators.

2.3.2 Provide a full-length ground bus for the skid.

2.3.3 Ground bus conductor shall be copper and be directly fastened to a bare metal surface of every vertical section and be of a size sufficient to carry the rated two-second current of the switchgear assembly.

2.4 WIRING/TERMINITIONS

2.4.1 One terminal pad per phase shall be provided for attaching contractor supplied cable terminal lugs for a maximum of two conductors per phase of the sizes indicated on the drawings. Sufficient space shall be supplied for 25kV cable stress relief terminations.

2.4.2 All control wiring, fuse blocks, and terminal blocks within vertical section shall be furnished as indicated on the drawings. Each control wire shall be labelled with wire markers. All control wire shall be #14, type TBS. Terminal blocks shall be provided for customer connections to other apparatus.

2.5 FUSES

2.5.1 Fault protection shall be furnished by fuses rated as shown in the contract documents and drawings.

2.5.2 Fuses shall have a minimum interrupting rating of 12.5 kA symmetrical at 27.5 kV.

2.5.3 Fuses shall be expulsive type with three (3) spare fuse refills for each fused switch.

2.5.4 Fuses shall have a blown fuse indicator as part of the shunt and spring assembly. The blown fuse indicator shall operate in both disconnect and non-disconnect fuse mountings.

2.6 LINE PROTECTION RELAY

2.6.1 Provide a line protection relay where shown on the drawings and wired to the shunt trip of the circuit breaker in the low-voltage switchgear. Provide a separate relay compartment with front-hinged door within the high-voltage switchgear. Include all associated instrument transformers.

2.6.2 Supply a Schweitzer SEL-351 Directional Overcurrent Relay, model number 035131, c/w screw-terminal blocks and firmware version 3, as the line protection relay for the above item. Wire the relay as shown in the drawings.

2.7 INSTRUMENT TRANSFORMERS

2.7.1 Current transformer where shown on the drawings or elsewhere specified shall be wired to shorting type terminal blocks.

2.7.2 Voltage transformers including primary and secondary fuses with disconnecting means shall be supplied as shown in the drawings.

2.8 SURGE ARRESTERS

2.8.1 Manufacturer shall provide 18kV MCOV station class surge arresters, one per phase, connected after the load break switch in the incoming section and securely grounded to the metal structure as shown on the drawings.

2.9 KEY INTERLOCKS

2.9.1 Supply key interlock from the 25kV load break switch to the revenue metering compartment in the low-voltage switchboard (see 4.10), as shown on the drawings.

2.10 NAMEPLATES

2.10.1 Engraved nameplates, mounted on the face of the assembly, shall be furnished for each switch vertical section in accordance with the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum.

2.10.2 Furnish Master nameplate giving switchgear designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.

2.11 FINISH

2.11.1 Prior to assembly, all enclosing steel shall be thoroughly cleaned and phosphatized. A powder coating shall be applied electrostatically, then fused on by baking in an oven. The coating is to have a thickness of not less than 1.5 mils.

2.11.2 The finish shall have the following properties:

(1) Impact Resistance (ASTM D-2794)..... 60 direct / 60 indirect
(2) Pencil Hardness (ASTM D-3363)..... H
(3) Flexibility (ASTM D-522) .....Pass 1/8" mandrel
(4) Salt Spray (ASTM B117-85 [20])..... 600 hours
(5) Colour .....ANSI 61 Grey

PART 3: PRODUCTS - TRANSFORMER

3.1 TYPE

3.1.1 The transformer to be an outdoor, three-phase, two winding, oil immersed with natural circulation of oil and air for cooling (ONAN).

3.1.2 The transformer shall be standard mineral oil liquid filled and shall be in accordance with the latest edition of CEC and CSA.

3.1.3 Alternatives based on dry type transformers of similar rating to that specified will be considered. Dry type transformers must be fitted with a thermal overload that will operate the shunt trip on the main LV circuit breaker. Dry type transformers shall conform to CSA Standard C9, Dry-Type Transformers.

3.1.4 Transformer to be enclosed in an outdoor enclosure and form part of the service entrance skid.

3.2 RATINGS

3.2.1 Power capacity rating:
(1) At 65ºC temperature rise ..... 1200 kVA ONAN

3.2.2 Impedance:
(1) At centre tap.....7%

3.2.3 HV windings:
(1) Voltage rating, phase-to-phase, at no load ..... 24,960 V
(2) Configuration.....Wye
(3) Minimum Basic Impulse Insulation Level (BIL)..... 95 kV
(4) Taps.....±2½%, ±5%

3.2.4 LV windings:
(1) Voltage rating, phase-to-phase, at no load ..... 480 V
(2) Configuration..... Delta
(3) Minimum Basic Impulse Insulation Level (BIL)..... 10 kV

3.2.5 The transformer shall carry its continuous rating with average winding or temperature rise by resistance that shall not exceed 65ºC rise, based on an average ambient of 30ºC over 24 hours with a maximum of 40ºC.

3.2.6 All ratings shall be tested to the requirements of CEC, CSA, and EEMAC.

3.3 WINDINGS

3.3.1 The HV, 25 kV windings shall be wye connected and fully insulated.

3.3.2 The LV, 480 V windings shall be delta connected and fully insulated.

3.3.3 The neutral is to be brought out through an insulated bushing.

3.3.4 All winding conductors shall be **copper**.

3.3.5 The angular displacement between the HV and LV windings shall be 30º, (Yd1).

3.3.6 Transformer core shall be insulated from the enclosure and shall have a removable ground connection accessible from the exterior of the transformer for the purpose of testing the insulation level. Core ground to be accessible through hand hole.

3.3.7 Insulation between layers of the windings shall be of Insuldur paper or equal.

3.3.8 Transformer to have full capacity off-load primary taps at ±2½% and ±5% selectable by terminals.

3.4 SHORT CIRCUIT CHARACTERISTICS

3.4.1 The transformer shall have the ability to withstand a short circuit current for two (2) seconds. The magnitude of such short circuit current shall be that resulting from a bolted three-phase fault on the transformer LV when the transformer is supplied from a source with short circuit strength of 500 MVA.

3.5 BUSHINGS AND TERMINATIONS

3.5.1 The transformer shall include an HV terminal compartment to facilitate connections between the primary bus and the transformer using flexible jumpers.

3.5.2 The transformer shall include an LV busway flange to facilitate connections between the transformer and the secondary bus using flexible bus braid jumpers.

3.5.3 The high voltage phase bushings shall be the porcelain or epoxy type, copper NEMA pads.

3.5.4 The low voltage phase bushings shall be porcelain or epoxy type, copper NEMA pads suitable for flexible bus braid.

3.6 GROUNDING TERMINALS

3.6.1 Two copper-faced ground pads in accordance with CAN/CSA-C88-M90 shall be provided at diagonally opposite sides of the tank, each complete with a Burndy GC 2929 or equal ground connector.

3.7 COOLING EQUIPMENT

3.7.1 Radiators shall be individually welded and fixed.

3.7.2 Radiator tubes shall be easily accessible for visual inspection and paint repairs.

3.7.3 Radiators shall receive a quality control pressurized check for leaks.

3.8 MAIN TANK AND COVER

3.8.1 Construction of the main tank and attached components shall consist of carbon steel plate reinforced with external sidewall braces. All seams and joints shall be continuously welded.

3.8.2 The main tank and attached components shall be capable of withstanding a full vacuum without permanent deformation.

3.8.3 The main tank shall have the sampling and draining facilities so arranged, that if a small quantity of water gathers on the bottom of the tank, it may immediately be detected by taking an oil sample. The draining facilities shall be so arranged that such water may be rapidly and completely drained off without interfering extensively with the oil level in the transformer.

3.8.4 Main tank shall have a welded-on tank cover with hand hole and one inch filling plug and filter press connection to the main tank.

3.8.5 The completed transformer shall receive a quality control pressure check and be completely free of oil leaks.

3.9 MAIN TANK OIL

3.9.1 The transformer shall use standard mineral oil for coolant that shall conform to CSA Standards C2 and C50.

3.10 ENCLOSURE

3.10.1 The transformer shall form part of the service entrance skid and be enclosed in an outdoor enclosure that will align with the primary and secondary equipment enclosures.

3.10.2 The transformer enclosure shall have a sloped weatherproof roof. All openings shall be adequate for transformer ventilation and screened to prevent the entrance of small animals, and barriered to inhibit the entrance of rain, snow, sand, etc.

3.10.3 All covers, panels, and doors shall use tamper-resistant/security fasteners, hinges, and padlockable latches.

3.11 TRANSFORMER INSTRUMENTS

3.11.1 Provide standard instruments and fittings as required by CSA Standard C2.

3.11.2 Provide weatherproof (EEMA 4) junction boxes for all transformer instruments.

3.11.3 Wire all alarms and trips of the instruments to the inputs of the line protection relay in the high-voltage switchgear.

3.11.4 Control power for instruments and space heaters shall be supplied from the control power transformer in the low-voltage switchboard.

3.12 MOVING FACILITIES

3.12.1 The transformer shall be equipped with lifting lugs capable of handling its total filled mass.

3.12.2 The transformer base shall be suitable to skidding the transformer into the service entrance skid.

3.13 NOISE LEVEL

3.13.1 The transformer shall be designed to meet the sound level standards for liquid transformers as defined in NEMA TR1 and as per CAN/CSA-C2-M91.

3.14 LOSSES

3.14.1 The bidder shall design the transformer for minimal no load and full load losses based on a capital value of $2000 per kW. The Bidder shall state no-load and full-load losses in their proposal.

3.15 TOOLS

3.15.1 All special tools required to operate and maintain the transformer and accessories on site shall be supplied.

3.16 NAMEPLATES

3.16.1 Engraved nameplates, mounted on the face of the assembly, shall be affixed in an easily readable position, and shall follow the format of CAN/CSA-C2-M91.

3.17 FINISH

3.17.1 All parts shall be cleaned of scale, rust and excess weld.

3.17.2 The inside of the tank shall be shot blasted and given one coat of quality primer of dry thickness of 2 mil (inch) to avoid chemical action with transformer oil.

3.17.3 When free from oil and moisture, the exterior of the tank and accessories shall be given one coat of first quality primer of dry thickness 2 mil (inch), which shall be followed by two coats of first quality finish paint of No. 70 LIGHT GREY per EEMAC Y1-2.

3.17.4 Prior to assembly of the enclosure, all enclosing steel shall be thoroughly cleaned and phosphatized. A powder coating shall be applied electrostatically, then fused on by baking in an oven. The coating is to have a thickness of not less than 1.5 mils.

3.17.5 The enclosure finish shall have the following properties:

(1) Impact Resistance (ASTM D-2794)..... 60 direct / 60 indirect
(2) Pencil Hardness (ASTM D-3363)..... H
(3) Flexibility (ASTM D-522) .....Pass 1/8” mandrel
(4) Salt Spray (ASTM B117-85 [20])..... 600 hours
(5) Colour .....ANSI 61 Grey

PART 4: PRODUCTS - SECONDARY SIDE EQUIPMENT

4.1 RATINGS

4.1.1 Voltage rating shall be 480V as indicated on the drawings. The entire assembly shall be suitable for 480 volts, three-phase, three-wire AC Service.

4.1.2 The service panel bus shall be rated for 2000A. Bus bar temperature rise shall not exceed 65ºC over an ambient of 40ºC based on CSA C22.2 #31 requirements.

4.1.3 The bus system shall have a minimum ANSI 4-cycle short circuit withstand rating of 30,000 amperes asymmetrical.

4.1.4 The assembly shall be rated, type tested, and CSA listed to withstand mechanical forces exerted during short circuit conditions when connected directly to a power source having available fault current of 30,000 amperes RMS symmetrical at rated voltage.

4.1.5 All circuit breakers shall have a minimum symmetrical interrupting capacity of 30,000 amperes RMS. To assure a fully selective system, all circuit breakers shall have 30 cycle short time withstand ratings equal to their symmetrical interrupting ratings, regardless of whether equipped with instantaneous trip protection or not.

4.1.6 Breakers to be 100% current rated.

4.1.7 A low-voltage neutral to be provided through an artificial neutral with ground-fault relay rated for 5A (See 4.8).

4.1.8 All ratings shall be tested to the requirements of CEC, CSA, and EEMAC.

4.1.9 Provide interior lighting for each compartment. Also provide one GFI duplex outlet mounted inside the equipment.

4.2 CONSTRUCTION

4.2.1 The switchboard shall be completely factory assembled, wired, installed in service skid and tested before delivery. It shall be built and CSA approved to latest revision of CSA standard C22.2 #31.

4.2.2 The switchboard is to come c/w all a fused control power transformer and capacitors for breaker control operations or trip unit power.

4.2.3 The switchboard shall be dead front type, completely metal enclosed, floor mounted, and self-supporting. It shall consist of the required number of vertical sections bolted together to form a rigid structure. All vertical sections shall align front and rear.

4.2.4 The switchboard cubicles shall be of formed side sheet construction and joined with fasteners that will prevent loosening during shipping. All enclosing covers and doors shall be fabricated from not less than 11-gauge steel.

4.2.5 To facilitate installation and maintenance of cables and bus in each vertical section, removable top and rear covers shall be provided. All cables to be bottom entry.

4.2.6 The front of each vertical section shall consist of multiple flanged front doors. Each door shall be equipped with two rotary latch type padlockable handles. Provision shall be made for operating the switches and breakers without opening the doors.

4.2.7 All covers, panels, and doors shall use tamper-resistant/security fasteners, hinges, and padlockable latches.

4.2.8 The structure assembly shall be CSA listed to meet and exceed all short circuit withstand requirements as per CEC 14-012 and CSA C22.2 #31. The complete assembly shall be marked with its Short Circuit Withstand Rating on the main factory data nameplate.

4.2.9 The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor. Provisions shall be made for jacking of shipping groups, for removal of skids or insertion of equipment rollers. Base of assembly shall be suitable for rolling directly on pipes without skids.

4.2.10 Each outdoor vertical section shall have a sloped weatherproof roof. All openings shall be screened to prevent the entrance of small animals, and barriered to inhibit the entrance of rain, snow, sand, etc.

4.2.11 A minimum of one 250W, 120V space heater with thermostat shall be provided in each vertical section. A control power transformer mounted in the low-voltage switchboard shall furnish power for space heaters. The design shall be non-walk-in type.

4.2.12 Provide a metal barrier full height and depth between adjacent vertical structures.

4.2.13 Provide a glass polyester full height barrier between adjacent vertical structures in the bus compartment with appropriate slots for main bus.

4.2.14 Provide a glass polyester full height barrier between the vertical bus and the cable compartment.

4.2.15 Provide slots for secondary bus runbacks for cable connection.

4.2.16 Provide channel sill for seismic anchoring.

4.2.17 Provide nameplates for the cubicles, breakers, and external components (See 4.12.2).

4.3 BUS

4.3.1 All bus bars shall be copper with CSA listed single bolt connections at joints. All connections shall be torqued to manufacturer's specification.

4.3.2 The maximum temperature rise of the bus shall not exceed 65ºC over a 40ºC ambient.

4.3.3 The horizontal bus shall be mounted on glass polyester insulators with all three phases arranged in the same vertical plane.

4.3.4 The main bus shall be rated 2000A and shall be braced for 30,000A RMS.

4.3.5 Bus splices shall be provided between adjacent distribution sections.

4.3.6 A continuous copper ground bus shall be furnished and firmly secured to each vertical section structure and shall extend the entire length of the switchboard. The ground bus short time withstand rating shall meet that of the largest circuit breaker within the assembly (2000A minimum short time rating). A ground lug, sized to meet CEC requirements, shall be furnished in the incoming section.

4.3.7 All hardware used shall be high-tensile strength and zinc plated. All bus joints shall be provided with Belleville type washers.

4.3.8 Bus bracing to be capable of withstanding full bolted faults.

4.3.9 All bus work and materials shall be included.

4.3.10 All bus work and materials shall be rated as dictated by the Canadian Electrical Code (CEC).

4.3.11 Allow for site verification of all bus work and connections.

4.4 WIRING/TERMINATIONS

4.4.1 All wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. All control wiring shall terminate on numbered terminal blocks.

4.4.2 All control wire shall be #14, type TBS. Wire bundles shall be secured with nylon ties and anchored to the assembly with the use of pre-punched wire lances. Terminal connections to remote devices or sources shall be front accessible.

4.4.3 NEMA 2-hole compression type lugs shall be provided for all outgoing cable terminations and be suitable for copper cable of the size indicated on the drawings. A termination system shall be provided such that no additional cable bracing, tying or lashing is required to maintain the short circuit withstand ratings of the assembly through 30kA. Provide in the main incoming line section the connection to the main grounding bus. Additional lugs for connection of distribution grounding conductors to the ground bus shall be provided.

4.5 MAIN LOW-VOLTAGE DISCONNECT DEVICE

4.5.1 The main disconnect device for the low-voltage switchboard shall be a fix mounted, 2000A trip, 480V rated, 30kA RMS interrupting, 30kA RMS short time withstand, quick-make, quick-break moulded case breaker with a microprocessor-based RMS sensing trip unit with shunt trip as indicated in the drawing.

4.5.2 The shunt trip of the main breaker shall also be wired to the line protection relay of the high-voltage load interrupter switchgear as indicated in the drawing and as per section 2.6.

4.5.3 Ground-fault protection to be provided through artificial neutral and ground-fault relay as per section 4.8.

4.5.4 A capacitive trip device capable of reliably operating the shunt trip plus all relays during a voltage collapse shall be provided.

4.6 DISTRIBUTION SECTIONS

4.6.1 Each distribution section shall have a minimum 50X distribution space for full height sections. Breakers and fusible switches shall be capable of being mixed on the same distribution interior and rated for 100% of continuous ampere rating.

4.6.2 The switchboard shall be complete with a panel mounted distribution section, incorporating moulded case breakers with an interrupting capacity of 30kA RMS symmetrical @ 480V. Distribution breakers shall be of the number and size indicated in the drawings. Allow provisions for one (1) future breakers up to 800A frame size, replacing the 250A circuit breaker.

4.6.3 All distribution sections shall be provided ready for the addition of future cells, c/w all connection kits installed. Spaces not occupied by breakers shall have a cover plate to prevent access to live parts.

4.6.4 All internal devices shall be removable from the front and shall be panel mounted

4.6.5 All terminals shall be of anti-turn solder-less type, suitable for Cu or Al cable, of the sizes indicated in the drawings.

4.7 MOULDED CASE CIRCUIT BREAKERS

4.7.1 All protective devices in low-voltage switchboard shall be moulded case circuit breakers with inverse time and instantaneous tripping characteristics.

4.7.2 Circuit breakers shall be operated by a toggle-handle and shall have a quick-make, quick-break over-centre switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

4.7.3 Circuit breakers must have a means to padlock breaker in the open position. Lock out point must consist of a metallic hasp for locking out breaker in open position.

4.7.4 Circuit breakers shall be CSA certified for application at 100% of their continuous ampere rating in their intended enclosure and conform to CSA standard C22.2 #5.

4.7.5 Circuit breakers up to and including 400A frame shall be twin mounted.

4.7.6 Circuit breakers shall have a minimum symmetrical interrupting capacity of 30kA RMS.

4.7.7 Circuit breakers 400A frame and below shall have magnetic trip units and inverse time-current characteristics equivalent to Cutler-Hammer type Series C moulded case circuit breakers.

4.7.8 Circuit breakers above 400A frame shall have microprocessor-based RMS sensing trip units that meet the following requirements:

(1) Tripping system consisting of three current sensors, a microprocessor-based trip unit, and a flux-transfer shunt trip. 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.

(2) Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

(3) Shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.

(4) Allow for system coordination by providing the following microprocessor-based time-current curve shaping adjustments:
   i. Long time pick-up and delay
   ii. Short time pick-up and delay, with selectable curve shaping
   iii. Instantaneous pick-up

4.7.9 Wire one 52/a contact of each breaker to the input I/O block of the digital multifunctional meter system (See 4.11.1).

4.8 ARTIFICIAL NEUTRAL

4.8.1 Provide and install an artificial neutral consisting of a zig-zag transformer and neutral grounding resistor rated for 5A.

4.8.2 Artificial neutral to have a ground-fault detection relay with alarm adjustable from 10% to 100% of fault-level, wired to the shunt trip of the main disconnect breaker of the low-voltage switchboard.

4.8.3 All devices and components to be CSA approved.

4.9 CONTROL POWER TRANSFORMER

4.9.1 Manufacturer to supply and install a fused control power transformer suitable for all space heaters and auxiliary equipment throughout service entrance skid, including all devices for the primary, transformer, and secondary side equipment.

4.10 UTILITY REVENUE METERING

4.10.1 The switchboard is to be suitable for service entrance, therefore, an utility revenue metering compartment shall be provided to meet utility revenue requirements.

4.10.2 Where indicated on the drawings, the revenue metering compartment shall contain provisions for current transformers and voltage transformers as required by the utility, BC Hydro. The construction of the compartment shall conform to the utility company's metering standards. It shall also conform to the general electrical and construction design of the switchboard specified herein. Metering current and voltage transformers will be supplied by BC Hydro.

4.10.3 The compartment shall have provision for sealing to BC Hydro revenue metering requirements. This door will have concealed hinges to prevent tampering.

4.11 OWNER POWER METERING

4.11.1 The switchboard to be supplied complete with a solid-state digital multifunctional meter system c/w all associated instrument transformers, testing blocks, and all sensors as indicated in the drawings. The solid-state digital multifunction meter to be a microprocessor-based data collection and storage meter that shall monitor power conditions on the distribution system.

4.11.2 Meter to display true RMS value of:

(1)	Amps	3-phase current
(2)	Volts	Line-to-line or line-to-neutral 3-phase voltage
(3)	KW	kilowatts
(4)	KVA	kilovoltamperes
(5)	Pf	power factor
(6)	F	frequency
(7)	kWD	kilowatt demand
(8)	AD	amperes demand
(9)	kWH	kilowatt hours
(10)	V_{aux}	auxiliary input to 120 V AC/DC
(11)	Gnd. Amp	Ground Fault current

4.11.3 Meter to record and store the following information in meter memory. Recall and reset stored data via meter controls and meter indicator.

(1)	Volts	max/min at 1 second interval
(2)	Amps	max/min at 1 second interval
(3)	F	max/min at 1 second interval
(4)	kW	max/min at 1 second interval
(5)	Pf	max/min (or kVA max/min) at 1 second interval
(6)	kWd	at field programmable intervals of 1 minute to 30minutes
(7)	Ad	per kWd

4.11.4 Meter to be capable of remote communications through an RS 485 Ion Enterprise protocol communications port, an RS 485 Modbus RTU protocol communications port, and an Ethernet communications port.

4.11.5 The digital meter shall have current shorting blocks and primary and secondary VT fuses.

4.11.6 Meter to have field programmable for set-up of system variables.

4.11.7 Manufacturer of switchboard to install meter and instrument transformers as indicated in the drawings.

4.11.8 All devices to be CSA approved.

4.11.9 ***Pre-approved:*** Power Measurement Ltd. Ion #7330 Series.
ION 7330 Model P7330-A0B0B0E0A0A includes auto ranging Volt inputs (50-347 VAC) 60 Hz, 5 Amp inputs, RS-485 ports supporting ION or MODBUS RTU protocol, and Ethernet port.

4.12 ACCESSORIES

4.12.1 Provide and install shunt trips, capacitive trips, bell alarms, and auxiliary switches as shown in the drawings. Capacitors to be sized to be able to power the shunt trip.

4.12.2 Provide and install all required current transformers, zero-sequence current transformers, voltage transformers, other instrument transformer, fuses, and test blocks required for power meter, artificial neutral and ground-fault relay, all with ratios to suit application.

4.13 NAMEPLATES

4.13.1 Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum.

4.13.2 Furnish Master nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.

4.14 FINISH

4.14.1 Prior to assembly, all enclosing steel shall be thoroughly cleaned and phosphatized. A powder coating shall be applied electrostatically, then fused on by baking in an oven. The coating is to have a thickness of not less than 1.5 mils.

4.14.2 The finish shall have the following properties:

(1) Impact Resistance (ASTM D-2794)..... 60 direct / 60 indirect
(2) Pencil Hardness (ASTM D-3363)..... H
(3) Flexibility (ASTM D-522) .....Pass 1/8" mandrel
(4) Salt Spray (ASTM B117-85 [20])..... 600 hours
(5) Colour .....ANSI 61 Grey

PART 5: EXECUTION

5.1 FACTORY TESTING

5.1.1 Standard factory tests shall be performed on all equipment supplied under this specification. All tests shall be in accordance with the latest revision of ANSI, NEMA, CSA, and EEMAC standards.

5.1.2 The following factory tests shall be made on the main transformer supplied under this specification. All tests shall be in accordance with the latest revision of ANSI, NEMA, CSA, and EEMAC standards.

(1) Resistance measurements of all windings on the rated voltage connection the transformer and at the tap extremes of a given rating on this project.
(2) Ratio tests on the rated voltage connection and on all tap connections.
(3) Polarity and phase-relation tests on the rated voltage connections.
(4) No-load loss at rated voltage on the rated voltage connection.
(5) Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only of a given rating on this project.
(6) Applied potential test.
(7) Induced potential tests.
(8) Hot oil pressure test for oil leaks on transformer tank.

5.1.3 The witnessing of some or all of the factory testing in the presence of the owner's representative may be requested. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.

5.1.4 The manufacturer shall provide three (3) certified copies of factory test reports. The report shall include transformer loss data acceptable to BC Hydro for programming transformer loss parameters into the revenue meters.

5.2 INSTALLATION

5.2.1 The owner will provide an installation contractor who shall install the service entrance skid at the site according to the manufacturer’s recommendations and the contract drawings.

5.3 FIELD QUALITY CONTROL

5.3.1 Make available, when requested, the services of a qualified factory-trained manufacturer’s representative to assist the contractor in installation and start-up of the equipment specified under this section for a period of one (1) working day. The manufacturer’s representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

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

5.3.3 The manufacture shall provide three (3) copies of the field start-up report and three (3) copies of their representative's certification before final payment is made.

5.3.4 All of the above work shall be carried out at the daily or hourly rate indicated by the vendor in their bid proposal.

5.4 TRAINING

5.4.1 The manufacturer shall provide a training session for up to six (6) owner's representatives for one (1) normal workday at the jobsite.

5.4.2 The training session shall be conducted by a manufacturer's qualified representative and shall include instructions on the service entrance skid and its components, including the primary equipment, transformer, and secondary equipment. All circuit breakers, protective devices, relays, power monitoring meters, and other major components shall also be included in the training session.

5.4.3 All training sessions shall be carried out at the daily or hourly rate indicated by the vendor in their bid proposal.

End of Specification