

## **PART 1 GENERAL**

### **1.1 Summary**

- .1 This section of specification is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with general conditions, supplementary conditions of the contract, and section 260100-Electrical General Requirements.
- .3 Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install the Outdoor Pad-Mounted Transformer specified herein and on the drawings.
- .4 Contractor to provide an engineered concrete foundation design for the outdoor pad mounted transformer. Prepare a shop drawing submission of the foundation design, stamped by a Professional Engineer in Ontario.
- .5 Perform "locates" of existing site conditions prior to any excavation work.

### **1.2 Conflicting Requirements**

- .1 Any ambiguities in, or contradictions between, sections of this Specification, or between this Specification and the local codes, must be resolved by the equipment manufacturer to the satisfaction of the Engineer.

### **1.3 Codes and Standards**

- .1 Materials and workmanship shall comply with codes and standards of the Province in which the work is located and local codes, regulation and standards.
- .2 In addition, confirm to the latest editions and amendments of the applicable Codes and Standards of the following agencies:
  - .1 CSA Standard C22.1, Canadian Electrical Code, Part I plus Provincial supplements.
  - .2 Applicable sections of CSA C88 and ANSI/IEEE C37 and C57 Standards.
  - .3 Applicable sections of CSA C227.4.
  - .4 CSA C802.3-2015 Standard (latest edition) maximum losses for power transformers

### **1.4 Source Quality Control (Testing)**

- .1 Conduct equipment inspection. Provide field inspection, testing and start-up as per this section and Section 260100 – Electrical General Requirements.
- .2 Manufacturer will provide a standard factory testing of the transformer. Customer witness testing is not required.
- .3 Submit certified written test results to Engineer prior to shipment.

### **1.5 Guarantee**

- .1 Performance of the equipment shall be guaranteed throughout to perform the duty stated herein.
- .2 In addition, guarantee the equipment against faulty materials, construction and workmanship for a period of twelve (12) months from date of start-up or energization (i.e., commissioning).

### **1.6 Shop Drawings and Product Data**

- .1 Shop drawings must be reviewed by engineer prior to manufacturing. Refer to Section 16010.
- .2 The review of the shop drawings by the Engineer is for the sole purpose of ascertaining conformance with the general design concept. The Engineer will not approve the detail design inherent in the shop drawings. The Manufacturer submitting the shop drawings shall be responsible for the detail design inherent in the shop drawings. The Engineer's review shall not relieve the Manufacturer of responsibility for errors or omissions in the shop drawings or for meeting all requirements of the Contract. The Manufacturer is responsible for dimensions to be confirmed and correlated at the proposed substation location.
- .3 Indicate on the shop drawing submission:
  - .1 Complete nameplate data.
  - .2 Wiring diagrams.
  - .3 Overall layout of transformer.
  - .4 Anchoring method and dimensioned foundation template.
  - .5 Termination entry and exit locations.
- .4 Include manufacturer's stamp, certifying approval of submission and compliance with contract documents.

### **1.7 Metrication/Imperial**

- .1 All design data, drawings, calculations, etc., shall be prepared using metric units in accordance with SI practice with imperial units shown in parentheses.

### **1.8 Packaging and Shipping**

- .1 Pack, crate or otherwise protect each item so that it is not damaged in transit and arrives in serviceable condition at the site. In particular, ensure accumulation of water in equipment is prevented.
- .2 Include with the shipment one copy of erection drawings, instructions and maintenance manuals in English.
- .3 Clearly mark all crates, boxes and cartons to indicate the purchase order number and the name of the equipment.

- .4 Shipping invoice shall show the crate, box or carton number.

### **1.9 Operation and Maintenance Data**

- .1 Provide 3-ring binder(s) and indexed copies of operating and maintenance manuals with the following:
  - .1 Complete parts list and installation instructions.
  - .2 Operating and maintenance instructions.
  - .3 Drawing information.
  - .4 Factory and Field Test results (see Part 3 at the end of these specifications).

## **PART 2 PRODUCTS**

### **2.1 Transformer General Requirements**

- .1 Transformers to be designed for continuous operation and normal life expectancy. Dimensions of transformer to be sized to fit within substation allowance (see site plan), and suitable for outdoor installation. Transformer must be Tamper-Resistant to CSA standards.
- .2 All doors to include "penta-head" bolts and provisions for padlocking. Also, provide penta-head bolts for all compartments and PRD cover.
- .3 Lightning arrestors (3) located in H.V. bushing enclosure (station class).
- .4 Nameplate Description:
  - .1 H.V.: 44 kV Delta, 3-Phase, 3 Wire, 60Hz.
  - .2 L.V.: 600/347V, Wye, 3-Phase, 4-Wire, 60Hz.
  - .3 Capacity: 2000 kVA, LNAV (Midel en-1204).
  - .4 Windings: Aluminum.
  - .5 Maximum Temperature Rise by Resistance: 65°C.
  - .6 Sound level: to CSA C88 standards.
  - .7 Impedance range at 75°C: 6.0-6.5%.
  - .8 H.V. BIL Full wave ratings: 250kV H.V. throughout.
  - .9 L.V. BIL Full wave rating: 30kV L.V. throughout.
  - .10 High efficiency design as per CSA C802.3-2015 standards.

## 2.2 Transformer Interference

- .1 Transformer shall operate without causing interference to radio and TV reception, or telephone communication circuits higher than the limits outlined in CSA Standard C22.4 103.

## 2.3 Grounding

- .1 Provide two lug terminals, located on base at diagonally opposite points.
- .2 Lugs to include 13mm Hex bolts for mechanical connection to ground conductor.
- .3 Grounding conductor size: Up to #4/0AWG copper.

## 2.4 H.V. Tap Changer

- .1 Provide high voltage "off-load" tap changer switch, with locking feature in any position.
- .2 Manually operated externally from transformer.
- .3 Include tap changer indication.
- .4 Tin-plated copper and spring-loaded contacts.
- .5 Tap rating: 2-2.5% FCAN and 2-2.5% FCBN.

## 2.5 Transformer Insulating Oil

- .1 Description: natural ester (seed based) fluid, non-propagating (i.e. self-extinguishing), biodegradable and environmentally friendly.
- .2 Flashpoint: greater than 300°C. Fire Point: greater than 350°C.
- .3 Non-PCB. Include on Transformer's nameplate.
- .4 High saturation limit (1100ppm at 20°C).
- .5 Absorbs large amounts of moisture with no reduction of breakdown voltage (up to 300ppm).
- .6 Low pour point at -31°C.
- .7 Acceptable product: Midel eN 1204.

## 2.6 Windings

- .1 Winding material and connections: Aluminum.
- .2 Class A insulation throughout.
- .3 Adequately braced to prevent displacement under short circuit surge conditions.
- .4 Add reinforcement to end turn insulation of both windings.

- .5 Mark ends of all leads to correspond with the connection diagram.

## **2.7 Core**

- .1 Non-aging high-grade silicon steel laminations in a three-legged stacked core arrangement.
- .2 High permeability and low hysteresis with suitable insulation to minimize eddy currents.
- .3 Insulate core from tank, except at one point (top). Ground core to tank.
- .4 Provide tank lifting means of adequate strength to lift core and coil assembly.

## **2.8 Sealed Tank**

- .1 High quality rolled steel plate, with electrically welded seams and bolted cover c/w tamper-proof flanges.
- .2 Tank not to include any manholes or handholes to comply with ESA requirements for tamper-proof design.
- .3 The tank shall withstand without permanent deformation, positive and negative pressures of 25% greater than stated on nameplate data.
- .4 Lifting lugs or hooks for complete unit.
- .5 Ensure interior of transformer tank is thoroughly cleaned prior to core assembly and filling with oil.
- .6 Include fin-style radiators on tank, to allow circulation and cooling of oil. Radiators to be welded to tank and once assembly, and free of any sharp corners or edges.

## **2.9 H.V. Bushings**

- .1 Arrange H.V. bushings "left to right" (H3-H2-H1), on side of transformer, as viewed from H.V. side, 46kV Class, 250kV BIL, minimum 300Amps.
- .2 Provide suitable tin-plated copper bar bushings with bus bars to connect to underground high voltage cables, suitable for NEMA 4-hole connector.
- .3 The cable/bushing side wall enclosure: NEMA Type 4 watertight, tamper-resistant enclosure with hinged door and penta-head bolts, suitably sized for bushings, air terminals and lightning arrestors.
- .4 Include provisions to install kirk key interlock on enclosure door, to prevent opening of enclosure door unless upstream primary switch is opened.
- .5 Provide three Lightning Arrestors (LA) within enclosure, one per phase: include 39MCOV rated, Intermediate Class metal-oxide LA's c/w mounting brackets.

## 2.10 L.V. Bushings

- .1 Arrange L.V. bushings "left to right" (X0-X1-X2-X3), as viewed from L.V. side, 2.5kV voltage rating, 45kV BIL, minimum 3000Amps.
- .2 Provide suitable tin-plated copper bar bushings to connect to underground low voltage cables, with up to eight (8) NEMA 2-hole compression lug connectors (8/phase).
- .3 The L.V. bushing enclosure: NEMA Type 4 watertight, tamper-resistant enclosure with hinged door and penta-head bolts, suitably sized to accommodate cables as shown on contract drawings (size and arrangement of cables).

## 2.11 Miscellaneous Accessories

- .1 Control Cabinet Enclosure to house all instruments and control wiring, extended to base of transformer with open bottom for conduit entry. NEMA-Type 4 enclosure rating, with hinged pad-lockable hasp door and two penta-head bolts, mounted on side of transformer, sized to suit.
- .2 Insulating-oil drainage valve (25mm NPT), with non-corroding threaded plug with sampling device. Locate valve as close as practical to tank floor (for complete drainage) within control panel section.
- .3 Insulating-oil top filter-press valve (25mm NPT), with non-corroding threaded plug. Locate within control panel section.
- .4 Non-PCB. Include label on Transformer.
- .5 Pressure/vacuum Gauge (63XP).
  - .1 Scaled in kPa units with indicating pointer.
  - .2 Include Form C contacts (N.O./N.C.) for alarming and tripping.
- .6 Liquid Temperature Indicator (49OT):
  - .1 Scaled in degrees Celsius with indicating pointer and drag pointer (max. temperature).
  - .2 Drag pointer to be manually reset with transformer energized.
  - .3 Include Form C contacts (N.O./N.C.) for remote alarming and tripping of temperature.
- .7 Pressure relief device (63):
  - .1 Automatic pressure relief device, self-re-sealing with shroud.
  - .2 Opening pressure of pressure relief device must be less than the withstand pressure of

tank.

.3 Include Form C contacts (N.O./N.C.) for remote alarming of temperature.

.8 Winding Temperature Gauge (49WT):

.1 Scaled in degrees Celsius with indicating pointer and drag pointer (maximum temperature).

.2 Drag pointer to be manually reset with transformer energized.

.3 Include Form C contacts (N.O./N.C.) for remote alarming and breaker tripping.

.9 Transformer Oil Level Gauge:

.1 Scaled in percentage with indicating pointer. Include on scale normal operating range of oil level.

.2 Include Form C contacts (N.O./N.C.) for remote alarming.

.10 Wire all alarm signal (contacts) from instruments to terminal blocks, in a common enclosure/control box, mounted on the transformer. Provide the following features:

.1 NEMA-12 enclosure rating, with hinged door, sized to suit.

.2 Duplex receptacle (120VAC, 1-phase supply by others), mounted with in Control Cabinet Enclosure.

.3 Include fused space heater in control box, as required (120VAC, 1-phase supply by others).

.4 Wire all alarm signals from instrument devices to terminal blocks in control box.

## **2.12 Finish**

.1 Remove all rust on metal surfaces prior to finishing. Apply one coat of rust-resistant primer and two coats of outdoor paint to transformer tank, sill and cable compartment.

.2 Apply bituminous waterproofing compound to underside of transformer base.

.3 Colour: light grey, as per ASA 70. Provide a 100mL container of finish for touch-up and scratches.

## **2.13 Acceptable Transformer Manufacturers:**

.1 CES Transformers, Pioneer Transformers Ltd, PTI Transformers and Stein Industries.

## **2.14 Concrete Foundation Design for Transformer**

- .1 Provide an engineered concrete foundation pad design, to fully supported the outdoor pad mounted transformer assembly and underground cable connections. Include all necessary re-bar and concrete requirements in the design.
- .2 Coordinate and identify all underground conduit and grounding sleeve connections and openings, accordingly.
- .3 Prepare shop drawings for submission of the foundation design, stamped by a Professional Engineer in Ontario.

## **PART 3 EXECUTION**

### **3.1 Source Quality Control (Factory Testing)**

- .1 Provide manufacturer's type test certificates, and in accordance with the latest CSA, ANSI, IEEE and NEMA standards.
- .2 Manufacturer to provide the following standard factory tests:
  - .1 Insulation resistance measurements of all windings, at rated voltage and tap extremes.
  - .2 Turns ratio test of each winding, at each tap setting.
  - .3 Polarity and phase relation test.
  - .4 No-load loss test at rated voltage.
  - .5 Impedance and load loss at rated current, at rated voltage and tap extremes.
  - .6 Applied and induced potential tests.
  - .7 Insulation power factor and capacitance tests.
  - .8 Leak detection test for transformer tank and cooling system.
  - .9 Core insulation tests.
  - .10 Standard representative type tests; temperature rise (heat run), lightning-impulse strength, overexcitation, partial discharge, radio-influence voltage, Doble insulation tests, and sound level sound.
- .3 Provide a Dissolved Gas Analysis (DGA) report of the transformer oil prior to shipping of transformer.
- .4 Submit certified written test results to Engineer prior to shipment.
- .5 Include copies of the test results and reports within the Operation and Maintenance Data.

### **3.2 Packing**

- .1 Protect equipment against corrosion, dampness, heavy rain, etc. Also provide adequate protection against damage or loss of components from the time the equipment leaves the manufacturer's factory until received at the destination. Ensure packing is acceptable to the transportation companies.
- .2 Include heavy duty plastic sheet or bags to cover components vulnerable to construction dust. Tag this packing suitably to instruct the Contractor to leave this protection in place (where practical) until construction and clean-up is complete.
- .3 Provide in each manual a complete inventory of all spare parts, tools and accessories, a copy to accompany the shipment and a copy forwarded to the Engineer and/or Site Engineer.

### **3.3 Shipment**

- .1 Do not ship equipment from manufacturer's plant except by prior agreement with the purchaser.
- .2 Arrange the shipment on the transport to facilitate off-loading by the Contractor's crane or skids at the job site. Coordinate with contractor prior to shipping.

### **3.4 Installation**

- .1 Provide concrete foundation pad, at location identified on site plan.
- .1 Set and secure transformer in place on concrete foundation pad, rigid, plumb and square to building and grade. Care must be taken due to the "unbalanced" nature of the equipment.
- .2 Make field power and control connections as indicated.
- .3 Make grounding connections between equipment ground busses and building grounding system.
- .4 Check all factory-made connections for mechanical security, electrical continuity and current phasing of bus. Ensure phase sequence matches existing plant configuration.

### **3.5 Inspection, Testing and Commissioning**

- .1 Perform inspection, testing, commissioning and training in accordance with Section 260100, Electrical General Requirements.
- .2 Include field testing of transformer as follows:
  - .1 Turns ratio.
  - .2 Winding resistance.
  - .3 Power factor and dissipation.
  - .4 Insulation resistance.

- .5 Dissolved Gas Analysis (DGA) and standard oil sample.
- .3 Operate equipment with primary voltage only to prove satisfactory performance for minimum 24-hour "soak-in" period prior to applying any secondary load to the equipment.
- .4 Submit start-up report identifying all of the above testing requirements.

**END OF SECTION 26 12 00**