

**Power Transformer, Three-Phase  
 26,400 GrdY/15,242 – 13,800Y/7970**

**1. General**

- 1.1 This specification covers three-phase, natural ester fluid-filled power transformers for use on a 26,400 GrdY/15,242, 60 Hz distribution system. The transformers are intended for installation above ground on pads.
- 1.2 Transformers supplied under this specification shall meet the requirements of IEEE C57.12.10 -2010, except as modified herein.
- 1.3 The transformer shall have a buried tertiary winding with a capacity of 35% of the transformer rating with a voltage of the manufacturer's choice.

**2. Rating**

- 2.1 The transformer shall have the following kVA ratings:

	Seattle City Light Stock No.	345588	345592	345594
Self-cooled at 55°C	5000	7500	10,000	
Self-cooled at 65°C	5600	8400	11,200	
With provisions for additional future cooling fans at 55 °C	6250	9375	12,500	
With provisions for additional future cooling fans at 65 °C	7000	10,500	14,000	
Maximum length and width (ft)	–	–	11.5 x 13.5	

- 2.2 The voltage rating shall be 26,400 GrdY/15,242-13,800Y/7,970 V.
- 2.3 The impedance shall be per IEEE C57.12.10, Section 4.6 for 150 kV BIL (6.5%)

**3. Insulation**

- 3.1 The basic impulse insulation level (BIL) design shall be 150 kV for the high-voltage windings and 110 kV BIL for the low-voltage windings. Note: IEEE C57.12.10 designates 150 kV BIL for the 26 kV H.V. windings; however, the bushings will limit testing to 125 kV BIL.
- 3.2 The transformer shall be designed for a 55/65° C rise with provisions for future fans. This shall be stated both on the bid and on the nameplate.

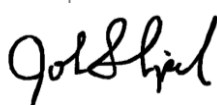
**4. Primary Bushings**

- 4.1 Four 600 ampere primary bushings shall be **welded** on the end wall of the transformer in approximately the upper one-third of the tank. The bushings shall be rated 600 amperes, 125 kV BIL and shall be suitable for operation on a 25,564 Gr.Y/14,760-volt system. **Gasketed bushings are not acceptable.** The bushings shall be labeled H<sub>0</sub>, H<sub>1</sub>, H<sub>2</sub>, or H<sub>3</sub> appropriately adjacent to each bushing. The bushings shall be mounted on a horizontal line a minimum of 9" to 12" apart. The end nut on the bushings inside the tank shall be 24" maximum (arm's length) from the handhole on the cover.
- 4.2 The bushings shall be Elastimold Apparatus Bushing K650S1 or K650T1. Other manufacturers' bushings may be acceptable provided (a) they are the welded-in type and, (b) certified test data are submitted showing that they are interchangeable with Elastimold K655 BLR elbow interfaces and electrical ratings. Bushings shall have a 5/8" threaded hole. Bushings with studs installed are not acceptable.

Standards Coordinator  
 Brett Hanson



Standards Supervisor  
 John Shipek



Unit Director  
 Darnell Cola



- 4.3 Each bushing shall have a cap to prevent the entrance of moisture or contamination during shipping and storage. The bushings shall be protected against damage during shipping and temporary storage with a wood or metal cover that is securely fastened to the transformer.
- 4.4 One parking stand (four total) shall be welded on the wall near each bushing, complete with stainless steel or copper-faced steel ground pads with a 1/2"-13 NC tapped hole, 7/16" (11 mm) deep. The threads shall be coated with oxide-inhibiting compound. The parking stand shall accommodate an Elastimold K650 SOP standoff plug.

## 5. Secondary Bushings

- 5.1 Four 600 ampere secondary bushings shall be **welded** on the end wall of the transformer in approximately the upper one-third of the tank. The bushings shall be rated 600 amperes, 125 kV BIL\* and shall be suitable for operation on a 13,800 Grd.Y/7970-volt system. **Gasketed bushings are not acceptable.** The bushings shall be labeled X<sub>0</sub>, X<sub>1</sub>, X<sub>2</sub>, or X<sub>3</sub> appropriately adjacent to each bushing. The bushings shall be mounted on a horizontal line a minimum of 9" apart. The end nut on the bushings inside the tank shall be 24" maximum (arm's length) from the handhole on the cover.
- 5.2 The bushings shall be Elastimold Apparatus Bushing K650S1\* or K650T1\*. Other manufacturers' bushings may be acceptable provided (a) they are the welded-in type, and (b) certified test data are submitted showing that they are interchangeable with Elastimold K655 BLR elbow interfaces and electrical ratings. Bushings shall have a 5/8" threaded hole. Bushings with studs installed are not acceptable.

\* The requirement for 25 kV class bushings is for interchangeability with the majority of Seattle City Light's distribution system equipment.

- 5.3 Each bushing shall have a cap to prevent the entrance of moisture or contamination during shipping and storage. The bushings shall be protected against damage during shipping and temporary storage with a wood or metal cover that is securely fastened to the transformer.
- 5.4 One parking stand (four total) shall be welded on the wall near each bushing, complete with stainless steel or copper-faced steel ground pads with a 1/2"-13 UNC tapped hole 7/16" deep. The threads shall be coated with oxide-inhibiting compound. The parking stand shall accommodate an Elastimold standoff plug.

## 6. Tank Ground

- 6.1 Tank grounding provisions shall consist of four (two per end) copper-faced steel pads 2" x 3-1/2" with two 1/2"-13 UNC tapped holes 7/16" deep, 1-3/4" apart on the wall of the transformer near the base per IEEE C57.12.10, Section 5.5. The ground pads shall be mounted in the vertical position 34-1/2" center to center. All tapped holes for ground connections shall be coated with oxide-inhibiting compound.

## 7. Tank, Cover, and Handhole

- 7.1 The tank shall be constructed per IEEE C57.12.10, Section 5.8.
- 7.2 The tank shall be designed for an operating pressure of  $\pm 8$  psig minimum. The transformer shall be tested by the manufacturer as follows:
  - (a) 7 psig negative for 30 seconds. Permanent deformation of the metal shall constitute failure.
  - (b) 7 psig positive for 6 hours per IEEE C57.12.24, Section 8.5.1. Permanent deformation of metal or leaks shall constitute failure. It is strongly suggested talc or chalk powder be applied to all welds, seams, valves and plugs for leak detection. Removal of the powder prior to shipment is not required. It is also suggested the plug in the drain valve be removed during leak testing.
- 7.3 The maximum operating pressure (positive and negative) shall be indicated on the nameplate per IEEE C57.12.10, Section 5.8.1.

- 7.4 The main cover with two handholes, shall be welded per IEEE C57.12.10, Section 5.8.3; one handhole at the primary end and one at the secondary end. The handhole and cover shall be through-bolted and include a one-piece gasket with no dovetails. The handholes shall have a net opening of 200 to 400 square inches. The handhole cover with a one piece (no dovetail) reusable gasket shall be through-bolted to a raised flange which is welded to the transformer cover. Bolts shall be silicon bronze or stainless steel. If the gaskets are cork and synthetic rubber (BUNA-N) or similar material, they shall be installed without adhesives. The cover shall have means for breaking the seal (seal-breaking bolt or similar). Handholes will be opened for receiving inspection. Gaskets damaged will be replaced by the manufacturer at the manufacturer's expense. It is strongly suggested that the surfaces that mate with the gasket be painted with an epoxy paint allowing adequate cure time before installation of the gasket.
- 7.5 The fluid fill shall consist of a 2" NPT nipple welded in the center of one of the handhole covers complete with a brass pipe cap. A liquid thread compound shall be used on the pipe joint. Teflon tape is not acceptable.
- 7.6 A pressure relief device shall be per IEEE C57.12.10 Section 5.8.1 except it shall be installed in the middle of one of the handhole covers.
- 7.7 The covers and all appurtenances shall be designed to shed water.
- 7.8 Tank finish shall comply with IEEE C57.12.32 and be Light Gray Number 70, Munsell Notation 5BG 7.0/0.4.

## 8. Accessories

The transformers shall be equipped with the following accessories:

- 8.1 Taps. The transformer shall have a full-capacity, de-energized tap changer in the high-voltage windings for 27,100 volts, 26,400 volts, 25,700 volts, 25,000 volts, and 24,340 volts per IEEE C57.12.10, Section 5.1.1.
- 8.2 Liquid-Level Indicator. A magnetic liquid-level indicator shall be per IEEE C57.12.10, Section 5.1.2. The float mechanism shall have a stop that prevents the float from going over the high mark due to fluid sloshing during transit. It is strongly suggested the float mechanism be within arm's length of the handhole as this is a frequent receiving problem.
- 8.3 Liquid Temperature Indicator. A dial-type thermometer shall be per IEEE C57.12.10, Section 5.1.3. Unless other provisions are made, the indicator shall have contacts necessary for future fans.
- 8.4 Pressure-Vacuum Gage. A pressure-vacuum gage shall be per IEEE C57.12.10, Section 5.1.5.
- 8.5 Drain and Filter Valves. Drain and filter valves shall be per IEEE C57.12.10, Section 5.1.5 except the valve shall be installed on a pipe nipple welded to the tank. A liquid thread compound shall be used on the pipe joint. Teflon tape is not acceptable. Drain valve shall maintain a minimum of 3 inches of clearance from the base of the unit to prevent breakage during transport.
- 8.6 Lifting, Moving, and Jacking Facilities. Lifting, moving, and jacking facilities shall be per IEEE C57.12.10, Section 5.3, except **additional jacking bosses shall be provided**, one in each corner, 9" ± 1/2" above the ground, for jacking with hydraulic transformer jacks.
- 8.7 For seismic anchoring, each unit shall include base rails that are designed to be welded to beams embedded in the concrete pad. The details of the base rail shall be included on the outline drawing or on a separate drawing. The center of gravity shall be shown on the outline drawing.
- 8.8 Fans and Controls. **Provisions** for future fans and automatic controls, controlled from the top fluid temperature shall be per IEEE C57.12.10, Section 5.9. "Provisions" shall include all necessary equipment, cabinets, wiring and mountings except fans and controller. The fan power will be 120/240V, 1Ø and provided from an external source.

## 9. Short-Circuit Capability

The manufacturer shall submit certified test data proving its design has performed satisfactorily when tested in accordance with IEEE C57.12.90, except "Proof of Satisfactory Performance" shall include compliance with:

- (a) The visual inspection requirements of Section 12.5.1.
- (b) The dielectric tests of Section 12.5.2.
- (c) The wave shape of terminal voltage and current requirements of Section 12.5.3.
- (d) The leaking impedance allowable variations of Section 12.5.4.
- (e) The low-voltage impulse test of Section 12.5.5.
- (f) The excitation current requirements of Section 12.5.6.

In addition, the manufacturer shall supply proof that the design tested is essentially the same design being supplied.

## 10. Losses

Per IEEE C57.12.00 Section 5.9, transformer no-load and load losses shall be corrected to 20°C and 85° C respectively and evaluated for the KNAN design at the rates below:

- (a) No-load losses at \$5.90 per W
- (b) Load losses (windings) at \$2.60 per W

(Total Losses = No-Load Losses + Load Losses)

Losses shall be provided at the 55° C KNAN rating and the 65° C KNAN rating. Losses shall comply with IEEE C57.12.90.

## 11. Nameplate

A stainless steel diagrammatic nameplate shall be affixed to a standoff bracket using stainless steel fasteners. The nameplate standoff bracket shall be welded to the tank end or side wall, approximately 5 feet (1.5 m) above the base. The nameplate shall:

- (a) State all information per IEEE C57.12.00, Nameplate C.
- (b) Include the date (year) of manufacture.
- (c) State the operating pressure as required in IEEE C57.12.10, Section 5.8.1.
- (d) State "Contains less than one ppm PCB at time of manufacture."

## 12. Fluid

Natural ester insulating fluid complying with IEEE C57.147 shall be provided in the transformer up to the liquid level marking. Fluid shall be Cargill Envirotemp FR3 or ABB BIOTEMP. Each transformer shall have a minimum 5-inch diameter label indicating fluid brand.

## 13. Electrical Tests

The minimum following electrical tests shall be made by the manufacturer in accordance with IEEE C57.12.90 and NEMA TR1.

- (a) Resistance.
- (b) Ratio.
- (c) Polarity and phase relation.

- (d) Exciting current at 90 percent, 100 percent, and 110 percent of rated voltage.
- (e) %R, %X, X/R
- (f) No load loss at rated voltage.
- (g) Load loss at the 55° C KNAN rating and at the 65° C KNAN rating.
- (h) Regulation at 100 percent PF and 80 percent PF.
- (i) Temperature rise at 65° C rating.
- (j) Applied potential.
- (k) Induced potential.
- (l) Impulse test.
- (m) R.I.V. test per NEMA TR1-0.03 except test voltage shall be 17.4 kV, L-G for one minute. The R.I.V. level, not to exceed 100 microvolts, shall be recorded and reported.
- (n) Average audible sound levels at the KNAN 55°C and 65° C ratings.

#### **14. Data to Be Submitted with Bid**

- 14.1 All bidders shall submit their proposal with the data listed below. They shall submit a description of any changes, additions, or exceptions to the specification they propose, together with reasons for the change. Product evaluation and conformance to standard will be determined on the basis of the information submitted. The drawings and data furnished must be in sufficient detail and clarity to enable making a complete and positive check with the technical provisions of this standard.
- (a) Outline drawings with overall dimensions.
  - (b) Details of the high- and low-voltage bushings including the manufacturer's name and catalog number.
  - (c) Average load losses, and no-load losses at the KNAN rating corrected to 85° C and 20° C respectively.
  - (d) That the transformer is a 55/65° C rise design.
  - (e) A copy of an instruction book or an outline of all required maintenance
  - (f) Regulation at power factors of 100 percent and 80 percent.
  - (g) Impedance of windings at rated load expressed in percent of rated voltage.
  - (h) Details of tank materials and tank finish.
  - (i) Make, specification, number of gallons, and weight of insulating fluid.
  - (j) Detailed information regarding short-circuit capability. See Section 9 of this standard.
  - (k) State all electrical tests given to the transformers at the factory. Include all tests listed in Section 13 in bid price.
  - (l) Total weight of completely assembled transformer, including insulating fluid.
  - (m) Provide information on each type of transformer insulation material used.
  - (n) Average audible sound level at the KNAN 55° C and 65° C ratings.

## 15. Data to be Supplied by Manufacturer

15.1 As soon as possible after award of contract, but not later than 45 days thereafter, the manufacturer shall furnish for approval three copies of drawings showing all of the basic design details.

Approval of the manufacturer's drawings by the City shall not relieve the manufacturer of any part of its obligation to meet all of the requirements of these specifications nor of the responsibility for the correctness of such drawings, diagrams, and schematics.

15.2 Thirty days prior to delivery, the manufacturer shall furnish:

- (a) Six copies of transformer dimensions with all accessories, showing the center of gravity.
- (b) Six copies of details of the base rails, if not included with the outline drawing. These are required for design of seismic anchoring systems.
- (c) Six copies of transformer nameplate.
- (d) Six copies of an instruction book covering installation.
- (e) Six copies of complete parts list for the above equipment. The list shall include the part numbers for all components necessary for fan operations.

15.3 Six copies of the certified test reports noted in Section 13 shall be furnished attached to the invoice.

## 16. Guarantee and Penalties

16.1 Any transformer failing, due to defective design, material, and/or workmanship, within 12 months after being energized or 18 months after delivery, shall be repaired or replaced without cost to the City of Seattle, City Light Department. Any defect in design, material, and/or construction discovered within this period shall be corrected on all transformers furnished on this order at the manufacturer's expense, either by repair or replacement.

16.2 The manufacturer will be assessed a penalty for transformers delivered that exceed the total loss value stated and calculated on the bid proposal.

$$\text{Total loss value} = \text{no-load loss} \times \$5.90/\text{watt} + \text{load loss} \times \$2.60/\text{watt}.$$

The penalty shall be the difference between the total loss value delivered less the total loss value in the bid proposal. Tolerances will be allowed in accordance with ANSI C57.12.00, Section 9.3, Table 18, except "on a given order" shall mean transformers of a given size and voltage; i.e., one line item.

16.3 Upon delivery, all transformers will be tested and inspected. Transformers that fail to pass the tests will be returned to the manufacturer. The cost of **retesting** transformers that have been returned to the manufacturer for correction of defects will be charged to the manufacturer.

## 17. Approved Manufacturers and Factories

Carte International, Winnipeg, Manitoba, Canada  
ABB, South Boston, Virginia

## 18. References

IEEE C57.12.00 - 2015  
IEEE C57.12.10 - 2010  
IEEE C57.12.24 - 2009  
IEEE C57.12.32 - 2008  
IEEE C57.12.40 - 2011  
IEEE C57.12.90 - 2015  
NEMA TR1 – 1993 (R2000)

## 19. Sources

**SCL Construction Standard 0035.5**; "Power Transformer, Three-Phase, 26,400 GrdY/15,242 – 13,800Y/7970" (canceled)

**Power Transformer, Three-Phase  
 26,400 GrdY/15,242 – 13,800Y/7970**

