4 kV, Overhead-Type, Single-Phase, Natural Ester Fluid, Distribution Transformers

1. Scope

This standard details the manufacturer requirements for single-phase, pole-mounted transformers from 50 kVA to 167 kVA.

This standard applies to the following Seattle City Light (SCL) 4160GrdY/2400 single-phase transformer stock numbers:

kVA	120/240
50	351132
75	351134
100	351136
167	351142

2. Application

These transformers are used only for emergency replacements of existing units connected to the aging and shrinking 4kV distribution system.

3. Industry Standards

Transformers shall meet the applicable requirements of the following industry standards:

DOE 10 CFR, Part 431; “Energy Efficiency Program for Certain Commercial and Industrial Equipment”; Department of Energy

IEEE C57.12.00-2010; “Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers”

IEEE C57.12.20-2011; "Standard for Overhead-Type Distribution Transformers, 500 kVA and Smaller"

IEEE C57.12.90-2010; "Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers"

IEEE C57.147-2008; "Guide for Acceptance and Maintenance of Natural Ester Fluids in Transformers"

RCW 19.29.010, Rule 5 - 2011; Revised Code of Washington, Rules for Test Tag

NEMA TR 1-1993 (R2000); "Transformers, Regulators, and Reactors"

4. Conflict

Where conflict exists, the following order of precedence shall apply:

- Seattle City Light purchase order (PO)
- City of Seattle General Terms and Conditions
- This standard
- Other industry standards.

5. Ratings

5.1 Kilovolt-Ampere Ratings

Kilovolt-ampere ratings shall be 50, 75, 100, and 167 kVA.

Kilovolt-ampere ratings are continuous and are based on not exceeding a 65 °C average winding temperature rise.

The temperature rise of the insulating oil shall not exceed 65 °C when measured near the top of the tank.

5.2 Voltage Ratings

Voltage ratings shall be as specified on the purchase order or as follows:

4160GrdY/2400

6. Construction

6.1 General

Transformers shall be according to the requirements of IEEE C57.12.20 with the following clarifications and Figure 6.1, below.

Polarity shall be subtractive.

Figure 6.1. Transformer showing primary bushings

6.2 High-Voltage Bushing

High-voltage bushings shall have a BIL of 60 kV and be mounted per Figure 6.1.

High-voltage terminal shall be a handwheel type.

6.3 Low-Voltage Bushings

Low-voltage bushings shall have a minimum BIL of 30 kV.

6.4 Low-Voltage Terminals

Terminals shall be constructed per IEEE C57.12.20, Section 7.1.2 with the following clarification:

- Transformers sized 100 kVA or larger shall have Spade H terminals per IEEE C57.12.20, Table 9 and Figure 5b.

6.5 Accessories

Accessory equipment shall be provided per IEEE C57.12.20, Section 7.2.

6.6 Liquid Level Marking

Liquid level marking shall be provided per IEEE C57.12.20, Section 7.2.3.

6.7 Lifting Lugs

Lifting lugs shall be provided per IEEE C57.12.20, Section 7.2.4.

6.8 Pressure Relief Valve

A pressure relief valve shall be provided per SCL 4480.10 and IEEE C57.12.20, Section 7.2.5.1 with the following clarifications as described in the following subsections.

Figure 6.8. Pressure Relief Valve

6.8.1.Indicator

The pressure relief valve shall include an orange or red indicator that becomes visible only after the valve has vented.

6.8.2.Cap and pull ring

The valve shall be covered by a cap with a pull ring that separates from the assembly during venting, revealing the orange or red indicator and hanging down from the valve via a chain or strap.

6.8.3.Sealant

Valve threads shall be sealed with a liquid pipe thread compound such as Rectorseal, liquid Teflon, or similar, not Teflon tape.

6.8.4.Approved models

The pressure relief valve shall meet the requirements of SCL 4480.10.

6.8.5.Location

The valve shall be installed in segment 1 or the half of segment 2 or 4 nearest to segment 1 as defined in IEEE C57.12.20, Figure 1. See Figure 6.1 of this standard.

6.9 Enclosure Integrity

The completely assembled transformer enclosure shall comply with IEEE C57.12.20, Section 7.2.6.

6.10 Polarity, Terminal Markings, and Angular Displacement

Polarity, terminal markings, and angular displacement shall be according to the requirements of IEEE C57.12.20, Section 7.3.

Primary terminals, secondary terminals and ground lugs shall be marked with minimum 1-in tall letters.

6.11 Nameplate

Nameplate shall be according to the requirements of IEEE C57.12.20, Section 7.3.4 with the following clarifications:

- Class shall be KNAN.
- Approximate total weight in pounds shall be indicated for all transformer sizes.
- Gallons of insulating fluid shall be indicated.
- The statement “CONTAINS LESS THAN 1PPM PCB AT TIME OF MANUFACTURE.” shall appear on the nameplate.

Figure 6.11. Nameplate, PCB statement

6.12 kVA Rating

The kVA rating shall be provided on the tank per IEEE C57.12.20, Section 7.3.5 in numerals approximately 2.5 inches high. Numerals may be applied by stenciling or by any other permanent means.

6.13 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 Cooper Envirotemp FR3. Each transformer shall have a 5-in diameter minimum label indicating fluid brand. Label shall be located in Segment 1 near the boundary with Segment 2 or 4 per IEEE C57.12.20 Figure 1.

6.14 Tank

6.14.1. Covers and Handholes

Cover shall comply with IEEE C57.12.20, Section 7.5.1.

6.14.2. Support Lugs

Support lugs shall comply with IEEE C57.12.20, Section 7.5.2. Support lugs shall be secured to the tank with fillet welds on all edges.

6.14.3. Tank Finish

Tank finish shall comply with IEEE C57.12.20, Section 7.5.3 with the following clarifications. When measured with a magnetic thickness gauge, the paint thickness shall be the following.

- Cover- 8 mils thick, minimum
- Tank- 3 mils thick, minimum

6.14.4. Tank Grounding

Tank grounding provision, tank grounding connector, low-voltage grounding connection, low-voltage grounding provision, and static cover bond shall comply with IEEE C57.12.20, Section 7.5.4.

The low-voltage grounding provision shall be a solderless connector that will accommodate conductor size Number 8 AWG solid to Number 2 AWG stranded and will match the tank grounding provision.

All grounding provisions shall be treated with an oxide-inhibiting compound.

The tank ground shall be located at the intersection of segments 3 and 4 as defined in IEEE C57.12.20, Figure 1.

6.15 Weight

Each unit, including all accessories and fluid, shall not exceed 2,500 lb.

7. Tests

7.1 General

Except as specified in Dielectric Tests, all applicable tests shall be performed as specified in IEEE C57.12.00 and in IEEE C57.12.90.

7.2 Dielectric Tests

Dielectric tests shall be performed as specified in IEEE C57.12.20, Section 6.2 and IEEE C57.12.90, Section 10. Dielectric test levels shall be in accordance with the levels specified in IEEE C57.12.00.

7.3 Tank Design Tests

Tests shall be performed as specified in IEEE C57.12.20, Section 9.

7.4 Short Circuit Tests

Short circuit tests shall be performed as specified in IEEE C57.12.90, Section 12.

7.5 Audible Sound Levels

Audible sound levels for each unit shall be according to the requirements of NEMA TR-1, Section 0.05. Tests shall be performed per IEEE C57.12.90, Section 13.

7.6 Radio Influence Voltage Test

Radio influence voltage shall be according to the requirements of NEMA TR-1, Section 0.03.

7.7 Documentation

Tests reports demonstrating conformance to all tests completed shall be submitted in a single Adobe Acrobat PDF file.

All documentation shall be in English and use customary inch-pound units.

7.8 Test Tag

A weatherproof test tag conforming to the requirements of the Revised Code of Washington RCW 19.29.010, Rule 5 shall be firmly attached to each unit. Tag shall read

“THIS TRANSFORMER HAS BEEN SUBJECTED TO AN INSULATION TEST IN ACCORDANCE WITH THE STANDARDIZED RULES OF IEEE/ANSI. THIS TRANSFORMER HAS BEEN TESTED AT RATED LINE VOLTAGE.” Tag shall indicate the date on which the test was made, and the name of the person who performed the test.

Figure 7.8. Test Tag

8. Design Changes

Manufacturer shall inform Seattle City Light in writing of all design changes that would affect the transformer's understood or published capabilities.

9. Shipping and Handling

Each transformer shall be supplied on its own pallet.

9.1 Pallet Material

Pallet and all pallet accessories shall be constructed of unpainted wood and suitable for yard storage through all weather conditions.

9.2 Support

Pallet supplied shall accommodate lifting by both forklifts and pallet jacks.

Pallet end openings shall be a minimum of 3.5 inches tall.

Open bottom pallets are preferred.

The bottom of each pallet shall be open or have minimum 8-in openings to allow pallet jack sheels to exit pallet bottom and lift. See Figure 9.2.

The most central pallet stringer shall be centered and a maximum of 7-in wide.

The minimum exterior stringer-to-stringer dimension shall be 23 inches wide.

The pallet deck shall be wide enough that all parts are a minimum of 1 inch away from the pallet edge to prevent transformer damage.

The bottom of each pallet shall be open or have 8-in openings. See Figure 9.2.

Figure 9.2. Pallets

9.3 Orientation

Transformer shall be centered on pallet and banded to pallet via its lifting lugs. Transformer shall be oriented on the pallet with secondary terminals perpendicular to the forklift entrance to prevent accessories (secondary terminals, support lugs, etc.) from coming into contact with pallet moving equipment. See Figure 9.3. If accessories are near edge of pallet, enclose them with protective devices to prevent damage.

Figure 9.3. Orientation

9.4 Arrival Condition

Transformers shall be delivered on enclosed trucks.

Transformers shall be received by Seattle City Light in clean condition.

10. Seattle City Light Processes

10.1 Bid Process

Bid process details are available at www.Seattle.gov.

Bid documentation shall be submitted with details demonstrating conformance to this standard. Submittal details shall be listed to correspond with this standard's section formatting.

Any exceptions taken to the standard shall be summarized in an attached letter, complete with section numbering relating to this standard. Requests for approved equal components must be submitted with first bid documents; all subsequent requests will be rejected.

10.2 Loss Factors

Load and no-load loss measurements shall be performed and corrected to 85°C and 20°C, respectively according to the requirements of IEEE C57.12.00, Section 5.9 and shall comply with IEEE C57.12.90.

10.3 Load Loss

Load losses shall be assessed at $2.60 per watt.

10.4 No-load Loss

No-load "core" losses shall be assessed at $5.90 per watt.

10.5 Loss Assessment

Total Price ($) = Bid Price + Loss Total

Loss Total = Load Loss + No-load Loss

Load Loss = Losses (Watts) x $2.60

No-load Loss = Losses (Watts) x $5.90

The penalty shall be the difference between the total loss values delivered less the total loss value in the bid proposal.

Tolerances will be allowed in accordance with IEEE C57.12.90, Section 9.3, except, tolerances shall apply to transformers of a given size and voltage; i.e., one line item.

Individual transformers that exceed these tolerances may be rejected and returned to the manufacturer.

10.6 Bid Completion

Upon completion of the bidding process, the successful bidder shall submit in a single Adobe Acrobat PDF file the following:

Transformer dimensions
Nameplate
Loss data
Instructional materials demonstrating the proper installation, operation, and maintenance of the equipment.
Certified test data for each transformer type bid and for every category listed in IEEE C57.12.00, Section 8.7. Format test data using numbering system shown in IEEE C57.12.00, Section 8.7.

10.7 Inspection and Electrical Testing

Upon delivery, 100% of the transformers will be inspected for physical defects and conformance to this standard.

A minimum of 10% of the transformers will be tested electrically for Radio Influence Voltage (per NEMA TR-1, Section 7 at 1MHz and 17.4kV, RIV not to exceed 100 microVolts), Losses and a small battery of other tests.

If any transformers fail, the manufacturer will be notified and an additional 10% will be tested.

If more transformers fail, the manufacturer will be contacted and given the option to return the lot, test 100% of the lot, or return the lot except the units that passed during initial testing.

10.8 Guarantee

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. Any defect discovered within this period shall be corrected on all transformers furnished on the order at the manufacturer's expense, either by repair or replacement.

11. Issuance

Stock Unit: EA

12. Approved Manufacturers

Manufacturer	Location
Power Partners	Athens, Georgia
Central Moloney	Pine Bluff, Arkansas
Cooper Power	Nacogdoches, Texas
Howard Industries	Laurel, Mississippi

13. References

SCL Material Standard 4480.10; “Valves, Transformer Pressure Relief”

14. Sources

Hanson, Brett; SCL Standards Engineer; subject matter expert, and originator of 4154.00

SCL Stock Catalog page 30-16; July 31, 2013