	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 10 03 Pad Mounted Distribution Transformers
		Date: 6/15/16
		Author: Office of Facilities
CC: Project Folder		

Change History

Date	Description of Change	Pages / Sections Modified	Change Approver Initials
6/15/16	Updated division section from 16361-E-E to 26 10 03, removed references to other section numbers	-	mg144

A. Summary

This section contains design criteria for pad mounted distribution transformers and protective devices.

B. References


The following industry standards, codes, and guidelines describe how the overall system should be designed:

1. C57.12.00 -IEEE Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.
2. C57.12.10 - Safety Requirements 230 kV and Below 833/958 Through 8333/10417 kVA, Single- Phase, and 750/862 through 6000/8000/10000 kVA, Three-Phase without Load Tap changing; and 3750/4687 through 6000/8000/10000 kVA with Load Tap changing.
3. C57.12.26 -Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers For Use with Separable Insulated High-Voltage Connectors, High Voltage, 34500GrdY119920 Volts and Below; 2500 kVA and Smaller.
4. C57.12.28 - Pad-Mounted Equipment -Enclosure Integrity.
5. C57.12.90 -IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE Guide for Short-Circuit Testing of Distribution and Power Transformers.
6. C57.92 -Guide for Loading Mineral-Oil-Immersed Power Transformers Up to and including 100 MVA with 65°C or 55°C Average Winding Rise.

C. System Design and Performance Requirements

Equipment service conditions shall meet temperature range of - 20° to 100°F and humidity range of 5 to 100 percent, non-condensing.

1. Transformers shall be three phase, copper wound, liquid immersed, dead front secondary distribution type, tamperproof and weatherproof, and suitable for mounting on a concrete pad. There shall be no exposed screws, bolts or other

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externally removable fastening devices. There shall be no openings through which foreign objects, such as sticks, rods, or wires might be inserted to contact live parts.


2. Transformers shall have efficient design per new D.O.E-1 Standard.
3. Transformers shall be rated 13,800V Delta primary, 480/277V Wye secondary with basic impulse insulation level (BIL) 95 kV.
4. Impedance: The percent impedance, as measured on the rated voltage connection, shall be as indicated in the table below. The tolerance on the impedance shall be +I- 7.5% of nominal value for impedance values greater than 2.5%. The tolerance on the impedance shall be +I- 10.0% for impedance values less than or equal to 2.5%.

Percent Impedance Voltage

kVA Rating	Impedance
75	1.00 – 5.00
112.5 - 300	1.20 – 6.00
500	1.50 – 7.00
750 -3750	5.75

5. The average winding temperature rise above 40°C ambient temperature, when tested at the transformer rating, shall not exceed 55 degree C with fan cool unit 65 degree C.
6. Dielectric Coolant
 - a. The dielectric coolant can be bio-based biodegradable electrical insulating and cooling liquid. The base fluid shall be 100% derived from edible seed oils. The performance enhancing additives shall be food grade. The fluid shall be certified to comply with the US EPA Environmental Technology Verification (ETV) requirements, and tested for compatibility with transformer components. The fluid shall be Factory Mutual Approved and UL Classified, Envirotemp **FR3** fluid.
 - b. The dielectric coolant can be silicone oil.
7. Average sound level per NEMA TRI shall not exceed the following values. The measurement procedure shall be as specified in ANSI C57.12.90. also latest D.O.E. standards.


KVA	Decibels
75	51
112.5 -300	55

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500	56
750 -1000	58
1500	60
2000	61
2500	62


8. Transformer Construction

- a. High Voltage Bushings and Terminals: 15 kV, 200A bushing wells with bushing well inserts installed. The bushings shall be externally removable. Include parking stands, one for each high voltage bushing well. Radial Configuration feed shall be per Figure 5 of ANSI C57.12.26 and heights per Figure 7 of ANSI CS7.12.26.
- b. High Voltage Overvoltage Protection shall be deadfront, elbow-type, metal oxide varistor (MOV) units, and station class surge arresters (18 kV or 5 kV).
- c. Provide high-voltage over current protection with the transformer equal to an externally removable load break expulsion Bay-O-Net fuse assembly with a flapper valve to minimize oil spillage. The bayonet fuses shall be in series with ELSP under-oil partial-range current-limiting back-up fuses with an interrupting rating of 50,000 amperes. The expulsion fuses shall have a maximum rating of 300% primary full load current to comply with NEC Article 450-3(a), and shall be replaceable through the tank handhole. Provide one complete set of spare fuses inside the high voltage compartment.
- d. Secondary Voltage Bushings and Terminals: The transformer shall be provided with tin-plated spade-type bushings. The spacing of the connection holes shall be 1.75" on center, per ANSI C57.12.26 figure 9. The quantity of connection holes shall be 16 holes; 2 holes per phase conductor termination. Bushing supports shall be provided for units requiring 10 or more connection holes. Bushing supports shall be attached to the cabinet sidewalls or roof; tank-mounted support mountings are not acceptable.
 - 1) Secondary Bushing Configuration: The transformer shall be provided with bushings in a staggered arrangement in accordance with Figure 8a of ANSI C57.12.26. The bushing heights shall be in accordance with Figure 7 of ANSI C57.12.26.
- e. Tap Changer Full-Capacity Voltage Taps shall have four 2.5-percent taps; two above and two below rated high voltage; externally, hook stick operated for

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de-energized operation. Include: visible position indicator and provisions for pad locking in each tap position.

- f. Tank Design shall include the following features:
 - 1) Tank, cooling equipment and compartments shall be subject to operating pressures and full vacuum without permanent deformation.
 - 2) Sufficient expansion volume to allow operation under specified load conditions. One or more bolted-on handholes in the tank cover for access to bushing connections.
 - 3) Lifting lugs for each tank corner.
 - 4) Jacking pods or bosses.
 - 5) Tank base to allow skidding or rolling in any direction.
 - 6) Stainless steel cabinet hinges and mounting studs.
 - 7) Pressure relief valve with flow at 15 psig of 35 SCFM, minimum.
- g. Primary & Secondary Compartments:
 - 1) Depth-Comply with Figure 7 of C57.12.26, unless additional depth is required to meet BIL requirements.
 - 2) Locking -Recessed, padlockable, captive, pentahead bolt per ANSI C57.12.28, bolt is accessible only after removal of padlock.
 - 3) Low voltage compartment shall be on right.
- h. Grounding:
 - 1) Ground non-energized metallic components.
 - 2) Minimum of two stainless steel ground pads, welded to the base or to the tank wall near the base on diagonal corners. Transformer shall be grounded at two locations to grounding grid.
- i. Finish: Tank, cooling components and compartments shall meet requirements of ANSI C57.12.28 including:
 - 1) Salt spray test.
 - 2) Crosshatch adhesion test.
 - 3) Humidity test.
 - 4) Impact test.

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- 5) Oil resistance test.
- 6) Ultraviolet accelerated weathering test.
- 7) Abrasion resistance -Taber abraser.
- 8) Color -Munsell7GY3.2911.5 green.


j. Nameplate:

- 1) Stainless steel, laser engraved including: name of manufacturer, date of manufacture, place of manufacture and tested.
- 2) Include connection and rating information per ANSI C57.12.00 nameplate Type C, plus approximate weight of parts to be lifted for un-tanking, type and quantity of coolant liquid.
- 3) Marking shall include a NEMA Standard Figure 3 Outside Warning Label on the exterior side of the high voltage compartment door and a NEMA Standard Figure 4 Inside Danger Label on the inside low voltage compartment door.
- 4) High voltage warning signs, danger signs, Factory Mutual approval, and Underwriters Laboratory approval.

D. Submittals

Submit the following design and construction documents.

1. Manufacturer's product data and shop drawings:
 - a. Transformers and accessories physical arrangement and sizes.
 - b. Wiring diagrams.
 - c. Size and location of conduit entrances for connections.
 - d. Ground pad locations.
 - e. Mounting, anchoring and connection details and instructions.
 - f. Weight of core and coil, transformer tank and fittings, weight and gallons of fluid, and total shipping weight.
 - g. Equipment ratings and performance data, including overcurrent protection time-current curves.
 - h. Instruction, operating and maintenance manual.

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- i. Location of the nearest service shop, owned and operated by the manufacturer, which is capable of repairing components of the transformer.
2. Upon completion of factory production tests, submit certified copies of test reports for each unit, identified by serial number.

E. Product Standards

Products shall conform to the following standards:

1. NEMA TP-1, 1993 (R2000)
2. NEMA TR-1, 1993 (R2000)
3. EPA Environmental Technology Verification (ETV)

F. Manufacturers

Subject to compliance with the design requirements, provide unit pad mounted distribution transformers by one of the following manufacturers:

1. Cooper Power Systems
2. General Electric
3. ABB


G. Equipment

1. Materials and products provided shall be suitable for and UL listed and labeled. Transformers shall be Factory Mutual (FM) approved code listed and labeled, designed in accordance with the requirements of ANSI C57.12.00 and labeled by Factory Mutual Research Corporation as meeting the requirements of FMRS Approval Standard Class 3990.

H. Accessories or Special Features

Pad mounted distribution transformer standard features:

1. Drain Valve: 1 inch (25 mm), with sampling device and filler plug.
2. Dial-type thermometer.
3. Liquid-level indicator.
4. Pressure-vacuum gage.
5. Pressure-Relief Device: Self-sealing with an indicator.

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I. Extra Materials


1. One spare set of three 15 kV or 5 kV power fuses shall be required.

J. Installation Guidelines

1. Install unit substations on 4 inches high concrete housekeeping pad with 2 inches wider and longer than substation widest and longest section.
2. Coordinate exact configuration and location of primary and secondary conduit entries to suit
3. Provide minimum of two (2) ground rods and #4/0 bare copper ground loop placed 30-inches below undisturbed earth and 12-inches from pad perimeter and bonded to the transformer per Code; minimum two locations.
4. Protection: Where subject to vehicular damage, provide one 4-inch vertical steel pipe bollard filled with concrete and located at each corner of the concrete pad. Minimum height above grade shall be 60-inches; minimum depth below grade shall be 40-inches. Deliver the transformer after protection is installed.
5. Tighten all electrical connectors and terminals according to manufacturer's published torque values or as specified in UL 486A and UL 486B.
6. Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from transformer and components.

K. Quality Control

1. **Factory Quality Control Testing**
 - a. Each unit shall be fully tested at the factory in accordance with ANSI Test Code C57.12.90.
 - b. In addition to the ANSI tests, each unit shall be tested for the following:
 - 1) No-load (85°C) losses at rated current.
 - 2) Total (85°C) losses at rated current.
 - 3) Percent impedance (85°C) at rated current.
 - 4) Excitation current (100% voltage).
 - 5) Winding resistance measurement.

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- 6) Ratio tests using all tap settings.
 - 7) Polarity and phase relation.
 - 8) Induced potential.
 - 9) Full wave and reduced wave impulse
 - 10) Oil test..
- c. Submit copies of test reports, including certification that units comply with applicable standards and specifications, and are acceptable to use.

2. Field Quality Control Testing

- a. After transformer installation, but prior to energizing, the contractor shall provide the services of a factory-authorized field service technician to inspect each installation, perform factory-recommended tests, and certify each as ready to energize. Minimum field testing shall include oil sample test, DC megger and turns ratio tests.
- b. A certified field service report for each unit shall be submitted for record.

L. Cleaning and Adjusting

1. After installing and cleaning, touch up scratches and mars on finish to match original finish. Wipe all buses and terminals to remove dust with water or alcohol damped cloth.
2. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.
3. Occupancy Adjustment: When requested within 12 months of date of Substantial Completion, provide an-site assistance in readjusting transformer tap settings to suit actual occupied conditions. Provide up to 2 visits to Project Site for this purpose without additional cost.
4. Voltage Recordings: Contractor performed. Provide up to 48 hours of recording on the low-voltage system of each medium-voltage transformer.
5. Point of Measurement: Make voltage recordings at load outlets selected by Owner.

End of Section