**SECTION 26 12 19**

**MEDIUM-VOLTAGE TRANSFORMERS, LIQUID-FILLED, PAD-MOUNTED (OUTDOOR)**

**BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/21**

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

**PART 1 - GENERAL**

**SCOPE**

The work under this section includes outdoor, liquid-filled, pad-mounted, medium voltage distribution transformers. Included are the following topics:

PART 1 - GENERAL

 Scope

 Related Work

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PART 2 – PRODUCTS

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RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 – Commissioning Process

**REFERENCE STANDARDS**

Pad-mounted transformers shall conform to the most recent edition of the following standards.

C57.12.00 – IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

C57.12.28 – IEEE Standard for Pad-Mounted Equipment-Enclosure Integrity

C57.12.34 - IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 5 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage & Below

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

FM 3990 – Approval Standard for Less or Nonflammable Liquid-Insulated Transformers

U.S. Department of Energy (DOE) CFR Title 10, Chapter II, Subchapter D, Part 431, Subpart K - Distribution Transformers.

**SUBMITTALS**

Shop Drawings

Provide overall dimensions of transformer enclosure showing front, side, and plan views, primary and secondary termination location, conduit entry location, and unit weight.

Electrical data shall include kVA, voltage, temperature rise, winding and tap configurations, impedance ratings and characteristics, loss data and efficiency at 25, 50, 75 and 100 percent rated load, nameplate data, and single-line and three-line diagrams.

Include manufacturer's installation instructions.

Factory Certified Tests

A certified test report shall be submitted for the transformer being supplied. The transformer serial number shall be noted in the report. The following factory certified tests shall be performed:

1. No-Load (85 degrees C) losses at rated voltage.
2. Total (85 degrees C) losses at rated current.
3. Percent Impedance (85 degrees C) at rated current.
4. Excitation Current (100 percent voltage) test.
5. Winding Resistance measurement tests for each winding at the rated voltage tap.
6. Ratio Tests using all tap settings.
7. Polarity and Phase relation tests.
8. Induced potential tests.
9. Full wave and Reduced wave impulse test.
10. Applied potential test shall be made on all high and low voltage windings to ground.

# OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS and specification Section 01 91 01 or 01 91 02.

**QUALITY ASSURANCE**

Manufacturer: Company specializing in distribution transformers with minimum ten years of experience manufacturing liquid-filled transformers.

**PART 2 - PRODUCTS**

**GENERAL REQUIREMENTS**

Description: Three phase, pad-mounted, liquid filled medium voltage distribution transformers suitable for locating in an outdoor environment.

All transformers 2500 kVA and below shall meet the U.S. Department of Energy (DOE) minimum efficiency levels for distribution transformers as mandated in CFR Title 10, Chapter II, Subchapter D, Part 431, Subpart K - Distribution Transformers.

All characteristics, definitions, and terminology, except as specifically covered in this specification, shall be in accordance with the latest revision of ANSI, IEEE and NEMA standards.

The liquid-filled distribution transformer shall be rated and configured in accordance with the one-line diagram, and shall conform to the following specification.

***Specify the correct operating voltage for the site and delete the others.***

The transformer is intended for use on a three-phase, solidly grounded wye distribution system operating at [4160Y/2400] [12470Y/7200] [13800Y/7970] volts.

**APPROVALS**

The transformer shall be UL Listed and Factory Mutual (FM) Approved and shall conform to the requirements of NEC 450-23.

**RATINGS**

Capacity: [\_\_\_\_\_] kVA [size as shown on drawings]

Primary Voltage: [\_\_\_\_\_] kV [as shown on drawings]

Primary Winding Connection: Delta

Secondary Voltage: [480Y/277] [208Y/120] volts [as shown on drawings]

Secondary Winding Connection: Grounded Wye with the low voltage neutral brought out to a fully insulated X**o** bushing.

***Use 60 kV BIL for 5 kV class transformers and 95 kV for 15 kV class transformers.***

Primary Voltage Basic Impulse Level (BIL): [60] [95] kV.

Primary Winding Taps:

Each transformer shall be furnished with full capacity high-voltage taps. Each tap changer shall be clearly labeled to reflect that the transformer must be de-energized before operating the tap changer. The tap changer switch shall be an externally operated, snap-action switch with padlocking provisions. The unit shall have the following tap configuration:

Two 2-1/2 percent taps above and two 2-1/2 percent taps below rated voltage (split taps).

Temperature Rise:

The average winding temperature rise above ambient temperature, when tested at the transformer rating, shall not exceed 65 degrees C.

Impedance:

Transformers rated 750 kVA and above: 5.3% to 6.2% (5.75% nominal)

Transformers rated 300 kVA to 500 kVA: 3.1% to 6.2%

Transformers rated below 300 kVA: 2.7% to 5.75%

Frequency: 60 Hertz

**INSULATING FLUID**

The dielectric fluid shall be a listed less-flammable fluid meeting the requirements of NEC 450-23, including a minimum fire point of 300 degrees C. The fluid shall be biodegradable and non-toxic. The fluid shall be Factory Mutual Approved and UL Classified, Envirotemp FR3 fluid or equal.

**HIGH VOLTAGE BUSHINGS AND TERMINATIONS**

***The 200 amp elbows can accommodate a maximum cable size of 4/0. If the primary cable size is 4/0 or smaller, the 200A bushings are preferred. If the primary cable size is larger than 4/0, then 600A bushings must be specified. Choose either 200A or 600A bushings and delete the requirements for the other.***

***Use the following paragraph for 200A bushing applications.***

[The high voltage bushings shall consist of six (6) 15kV, 200A bushing wells with loadbreak bushing inserts installed and in accordance with ANSI/IEEE C57.12.34 specific dimensions for loop-feed configurations. The transformer shall be provided with three (3) 200A loadbreak elbows rated for full three-phase duty and three (3) deadfront elbow surge arresters. The installing contractor shall connect the primary incoming cables on three of the bushings and the elbow surge arresters on the other three bushings.]

***Use the following paragraph for 600A bushing applications.***

[The high voltage bushings shall consist of three (3) 15kV, 600A deadbreak one piece bushings, externally removable, and in accordance with ANSI/IEEE C57.12.34 specific dimensions for radial-feed configurations. The transformer shall be provided with three (3) 600A deadbreak connectors containing a 200A loadbreak tap and three (3) deadfront elbow surge arresters for installation on the connector tap.]

Cable accessory parking stands shall be provided and shall be located such that the separable insulated connectors can be operated by hot-line tools.

**LOW VOLTAGE BUSHINGS AND TERMINALS**

The transformer shall be provided with tin-plated spade-type low voltage bushings.

The low voltage neutral shall be fully insulated with a removable ground strap.

The configuration of the secondary shall be a staggered low voltage terminal arrangement conforming to the specific dimensions of ANSI/IEEE C57.12.34. The bushings shall be replaceable utilizing the access provided or through the removal of the cover.

**OVERCURRENT PROTECTION**

***The Bay-O-Net type fusing is only available for transformers with a rated primary current of less than 125 amps. Therefore, Bay-O-Net fusing is only available for 4160V transformers rated 750 kVA and below, and 12.47 kV or 13.8 kV transformers rated 2500 kVA and below. Delete the following paragraph on Bay-O-Net fusing if the transformer size is larger than that indicated above.***

[The transformer primary shall include an externally removable loadbreak Bay-O-Net assembly with a flapper valve to minimize oil spillage. Overcurrent protection shall be provided by a two fuse-scheme utilizing a Bay-O-Net expulsion fuse in series with an under-oil current limiting backup fuse. The fusing scheme shall provide a full range of overcurrent protection.]

***Delete the following paragraph if Bay-O-Net fusing above is specified.***

[The transformer overcurrent protection will be provided by fuses in a separate upstream switchgear unit.]

**OVER-VOLTAGE PROTECTION**

Primary over-voltage protection shall be provided by externally mounted, deadfront elbow MOV surge arrestors mounted on the 200A loop-feed bushings or connector loadbreak tap. Elbow surge arresters shall be distribution class and meet the following ratings:

***Choose the applicable voltage rating and delete the others.***

[4160Y/2400 volt solidly grounded distribution system ratings: 3 kV duty rated, 2.55 kV MCOV, maximum discharge voltage at 10 kA (8 X 20 microsecond current wave) - 11.4 kV crest maximum.]

[12470Y/7200 volt solidly grounded distribution system ratings: 9 kV duty rated, 7.65 kV MCOV, maximum discharge voltage at 10 kA (8 X 20 microsecond current wave) - 32.8 kV crest maximum.]

[13800Y/7970 volt solidly grounded distribution system ratings: 10 kV duty rated, 8.40 kV MCOV, maximum discharge voltage at 10 kA (8 X 20 microsecond current wave) - 34.1 kV crest maximum.]

**CORE AND COIL**

The core and coil shall be vacuum processed to ensure maximum penetration of insulating fluid into the coil insulation system. While under vacuum, the windings will be energized to heat the coils and drive out moisture, and the transformer will be filled with preheated filtered degassed insulating fluid. The core shall be manufactured from burr-free, grain-oriented silicon steel and shall be precisely stacked to eliminate gaps in the corner joints.

The transformer windings shall be copper or aluminum.

**TANK AND TERMINAL COMPARTMENT**

The exterior of the unit shall be painted Munsell 7GY3.29/1.5 green in color.

The transformer termination cabinet shall be 24 inches deep, minimum.

The high-voltage and low-voltage compartments, separated by a metal barrier, shall be located side-by-side on one side of the transformer tank. When viewed from the front, the low-voltage compartment shall be on the right. Each compartment shall have a door that is constructed so as to provide access to the high-voltage compartment only after the door to the low-voltage compartment has been opened.

In addition to pad-locking provisions, all access doors shall be secured by a recessed, captive, pentahead bolt that meets the dimensions set forth in IEEE C57.12.28.

The tank must be welded using precision cut, cold-rolled steel and equipped with extra-heavy duty, welded-in-place lifting lugs and jacking pads. The tank base must be designed to allow skidding or rolling in any direction.

The transformer shall be of sealed tank construction of sufficient strength to withstand a pressure of 7 psig without permanent distortion, and 15 psig without rupturing. The tank shall include a pressure relief valve with a flow at 15 psig of 35 SCFM minimum, or as required to meet the listing of the fluid.

The tank shall be cleaned with an alkaline cleaning agent to remove grease and oil. An iron phosphate coating shall then be chemically bonded to the metal to assure coating adhesion and retard corrosion. The tank shall be primed with an electrodeposited powder epoxy to provide a barrier against moisture, salt, and corrosives. The top-coat shall be a liquid polyurethane coating to seal and provide ultraviolet protection. The tank coating shall meet all requirements in IEEE C57.12.28.

The pad-mounted equipment shall meet the requirements for tamper resistance set forth in IEEE C57.12.28 including but not limited to the pry test, pull test, and wire probe test.

Provide a laser engraved nameplate within the secondary terminal compartment.

**ACCESSORIES**

The following accessories shall be provided:

* Lifting lugs (4)
* 24-inch deep cabinet, minimum
* Stainless steel cabinet hinges and mounting studs
* 1-inch upper fill plug
* 1-inch drain valve with sampling device
* Automatic pressure relief device
* Liquid Level Gauge
* Dial Type Thermometer
* Pressure/Vacuum Gauge
* Stainless steel NEMA 2-hole ground pad in secondary compartment
* Pre-drilled copper ground busbar in primary compartment. Busbar shall be ¼” thick by 4” wide and sized to accommodate (4) one-hole compression connectors (0.28” diameter holes) and (4) two-hole compression connectors (0.44” diameter holes with 1.00” spacing).
* Danger High Voltage Warning Signs

**LABELING**

Hazard-Alerting Signs:

The transformer shall be provided with Danger High Voltage Warning Signs and all required NEMA safety labels.

Nameplates, Ratings Labels, and Connection Diagrams:

The transformer shall be provided with a nameplate indicating the manufacturer’s name, catalog number, model number, and date of manufacture, serial number, and equipment ratings.

**LOCKS**

The installing contractor shall provide a padlock on the transformer cabinet door. Padlock shall match user agency’s present padlocks and be keyed per user agency requirements. Coordinate and confirm padlock information with the facility staff.

**PART 3 - EXECUTION**

**EXAMINATION**

Verify field measurements are as shown on Drawings.

Beginning of installation means installer accepts conditions.

**INSTALLATION**

Install in accordance with manufacturer's instructions.

***Provide a concrete pad detail on the drawings.***

Set transformer on an oversized reinforced concrete pad. The pad shall extend a minimum of 12 inches past the transformer enclosure and cooling fins on all sides. Coordinate the pad requirements with the transformer manufacturer.

Provide one ¾” x 10’ ground rod within the window of the transformer pad on the primary compartment side and leave 1’0” accessible above grade. Provide a second ground rod outside of the pad footprint and buried below grade. Space the ground rods a minimum of 6’ apart. Bond the transformer enclosure to the ground rods with a #1/0 copper wire.

Mount elbow surge arresters on the bushings or connector taps inside the transformer primary termination compartment.

Install a padlock on the transformer cabinet door.

**FIELD QUALITY CONTROL**

Prior to energizing the transformer, field testing will be performed by an independent testing consultant furnished by the DFD. The contractor shall coordinate the scheduling of the testing consultant with DFD.

Check for damage and torque connections to manufacturer recommendations prior to energizing transformer.

Verify and/or connect transformer "XO" to ground, load side of "WYE" systems.

Measure the secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

Adjust primary taps so that secondary voltage is within 2 percent of rated voltage.

# CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01 or 01 91 02 in accordance with the procedures defined for construction verification checklists.

**AGENCY TRAINING**

All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

END OF SECTION