

SECTION 26 12 19  
PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of pad-mounted transformers.
- B. Pad-mounted transformers shall be complete, outdoor type, continuous duty, integral assembly, grounded, tamper-resistant, and weatherproof, with liquid-immersed transformers.

1.2 RELATED WORK

- A. Section 09 06 00, SCHEDULE FOR FINISHES: Finishes for electrical equipment.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground currents.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

Transformers shall be thoroughly tested at the factory to ensure that there are no electrical or mechanical defects. Tests shall be conducted as per UL and ANSI Standards. Factory tests shall be certified. The following tests shall be performed:

- 1. Perform insulation-resistance tests, winding-to-winding and each winding-to-ground.
- 2. Perform turns-ratio tests at all tap positions.

1.5 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, nameplate data, impedance, outline drawing with dimensions and front, top, and side views, weight, mounting details, decibel rating, termination information, temperature rise, no-load and full-load losses, regulation, overcurrent protection, connection diagrams, and accessories.

3. Complete nameplate data, including manufacturer's name and catalog number.

C. Manuals:

1. When submitting the shop drawings, submit companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
  - a. Identify terminals on wiring diagrams to facilitate installation, maintenance, and operation.
  - b. Indicate on wiring diagrams the internal wiring for each piece of equipment and interconnections between the pieces of equipment.
  - c. Approvals will be based on complete submissions of manuals, together with shop drawings.
2. Two weeks prior to the final inspection, submit four copies of the final up-dated maintenance and operation manuals to the COTR.
  - a. Update the manual to include any information necessitated by shop drawing approval.
  - b. Show all terminal identification.
  - c. Include information for testing, repair, trouble-shooting, assembly, disassembly, and recommended maintenance intervals.
  - d. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
  - e. Furnish manuals in loose-leaf binder or manufacturer's standard binder.

D. Certifications:

Two weeks prior to the final inspection, submit four copies of the following certifications to the COTR:

1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American Concrete Institute (ACI):

318-05.....Building Code Requirements for Structural  
Concrete

C. American National Standards Institute (ANSI):

- C37.47-00.....High Voltage Current-Limiting Type Distribution  
Class Fuses and Fuse Disconnecting Switches
- C57.12.00-00.....General Requirements for Liquid-Immersed  
Distribution, Power and Regulating Transformers
- C57.12.25-90.....Transformers-Pad-Mounted, Compartmental-Type,  
Self Cooled, Single-Phase Distribution  
Transformers with Separable Insulated High  
Voltage Connectors; High Voltage, 34500 Grd  
Y/19920 Volts and Below; Low-Voltage 240/120  
Volts; 167 kVA and Smaller Requirements
- C57.12.28-05.....Pad-Mounted Equipment Enclosure Integrity
- C57.12.29-99.....Pad-Mounted Equipment - Enclosure Integrity for  
Coastal Environments
- C57.12.34-04.....Pad-Mounted, Compartmental-Type, Self Cooled,  
Three-Phase Distribution Transformers, 2500kVA  
and Smaller - High Voltage 34500 Grd Y/19920  
Volts and Below; Low-Voltage 480 Volts and Below

D. American Society for Testing and Materials (ASTM):

- D3487-08.....Standard Specification for Mineral Insulating  
Oil Used in Electrical Apparatus

E. Institute of Electrical and Electronic Engineers (IEEE):

- C2-07.....National Electrical Safety Code
- C62.11-99.....Metal-Oxide Surge Arresters for Alternating  
Current Power Circuits
- 48-09.....Test Procedures and Requirements for Alternating  
Current Cable Terminations Used on Shielded  
Cables Having Laminated Insulation Rated 2.5kV  
Through 765kV or Extruded Insulation Rated 2.5kV  
Through 500kV
- 386-06.....Standard for Separable Insulated Connector  
Systems for Power Distribution Systems Above  
600V
- 592-96.....Standard for Exposed Semiconducting Shields on  
High Voltage Cable Joints and Separable  
Insulated Connectors

F. National Electrical Manufacturers Association (NEMA):

- C57.12.26-87.....Pad-Mounted, Compartmental-Type, Self-Cooled,  
Three-Phase Distribution Transformers for Use  
with Separable Insulated High-Voltage

- Connectors, High-Voltage, 34500 Grd Y/19920  
Volts and Below; 2500 kVA and Smaller
- LA1-92.....Surge Arresters
- TP1-02.....Guide for Determining Energy Efficiency for  
Distribution Transformers
- TR1-00.....Transformers, Regulators, and Reactors
- G. National Fire Protection Association (NFPA):
  - 70-08.....National Electrical Code (NEC)
- H. Underwriters Laboratories Inc. (UL):
  - 467-07.....Grounding and Bonding Equipment

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT, GENERAL

- A. Equipment shall be in accordance with ANSI, ASTM, IEEE, NEMA, NFPA, UL, as shown on the drawings, and as specified herein. The transformer shall be assembled as an integral unit by a single manufacturer.
- B. Ratings shall not be less than shown on the drawings.
- C. Provide transformers designed to withstand the mechanical stresses caused by rough handling during shipment in addition to the electrical and mechanical stresses that may occur during operation.
- D. Completely fabricate transformers at the factory so that only the external cable connections are required at the job site.
- E. Thoroughly clean, phosphatize, and finish all the metal surfaces at the factory with a rust-resistant primer and dark green enamel finish coat, except where a different color is specified in Section 09 06 00, SCHEDULE FOR FINISHES. All surfaces of the unit that will be in contact with the concrete pad shall be treated with corrosion-resistant compounds and epoxy resin or a rubberized sealing compound.

### 2.2 COMPARTMENTS

- A. Construction:
  - 1. Enclosures shall be in accordance with ANSI C57.12.28 //or ANSI C57.12.29 if installed in coastal environments//.
  - 2. The medium- and low-voltage compartments shall be separated with a steel barrier that extends the full height and depth of the compartments.
  - 3. The compartments shall be constructed of sheet steel (gauge to meet ANSI requirements) with bracing, reinforcing gussets, and jig-welding to ensure rectangular rigidity.
  - 4. Use cadmium or zinc plated bolts, nuts, and washers.
  - 5. Sufficient space shall be provided for equipment, cabling, and terminations within the compartments.

6. Affix transformer nameplate permanently within the low-voltage compartment. Voltage and kVA rating, connection configuration, impedance, date of manufacture, and serial number shall be shown on the nameplate.

B. Doors:

1. Provide a separate door for each compartment with provisions for a single padlock to secure all doors. Provide each compartment door with open-position doorstops and corrosion-resistant tamperproof hinges welded in place. The medium-voltage compartment door shall be mechanically prevented from opening unless the low-voltage compartment door is open.
2. The secondary compartment door shall have a one-piece steel handle and incorporate three-point locking mechanisms.
3. Provide a 2 in [50 mm] size padlock for each assembly, as approved by the COTR. Padlocks shall be keyed to the COTR's established key set. Firmly attach the padlock to the door assembly by a chain.

2.3 TRANSFORMER FUSE ASSEMBLY

The primary fuse assembly shall be load-break combination fuse and dry-well fuse holder rated for system voltage, rated for 10 load makes and 10 load breaks, with rated 200 amp load current at 75% power factor, 10,000 symmetrical A close-in on fault duty, and 95 kV BIL. The entire fuse assembly shall be removable through the use of hot stick.

1. The fuses shall be concealed, hot stick removable, 50,000 A symmetrical interrupting, non-expulsion, current-limiting primary distribution type, of the size and voltage class as shown on the drawings. The fuses shall operate within the fuse holder as a unit disconnecting means. Fuses shall be in accordance with ANSI C37.47.
2. Transformers shall not have internal "weak link" fuses that require transformer tank cover removal for replacement.
3. For units above 500 kVA using fusing above the 50 A 15 kV and 100 A 5 kV application, a clip-mounted arrangement of the current limiting fuses (i.e., live-front configuration) is required.

2.4 PRIMARY CONNECTIONS

- A. Primary connections shall be 200 A dead-front load break wells and inserts for cable sizes shown on the drawings.
- B. Surge Arresters: Distribution class, one for each primary phase, complying with IEEE C62.11 and NEMA LA 1, supported from tank wall.

2.5 MEDIUM-VOLTAGE TERMINATIONS

- A. Terminate the medium voltage cables in the primary compartment with loadbreak premolded rubber elbow connectors, suitable for submersible applications. Elbow connectors shall have a minimum of 0.125 in [3 mm]

semi-conductive shield material covering the housing. The separable connector system shall include the loadbreak elbow, the bushing insert, and the bushing well. Separable connectors shall comply with the requirements of IEEE 386, and shall be interchangeable between suppliers. Loadbreak elbow and bushing insert shall be from the same manufacturer. Allow sufficient slack in medium-voltage cable, ground, and drain wires to permit elbow connectors to be moved to their respective parking stands. Elbow connectors shall be rated as follows:

1. Voltage: 15kV phase-to-phase.
2. Continuous current: 200 A RMS.

- B. Ground metallic cable shields with a device designed for that purpose, consisting of a solderless connector enclosed in watertight rubber housing covering the entire assembly.
- C. Provide insulated cable supports to relieve any strain imposed by cable weight or movement.

## 2.6 LOW-VOLTAGE EQUIPMENT

- A. The low-voltage leads shall be brought out of the tank by epoxy pressure tight bushings, and shall be standard arrangement per ANSI.
- B. Tin-plate the low-voltage neutral terminal and isolate from the transformer tank. Provide a removable ground strap sized in accordance with the NEC and connect between the neutral and ground pad.

## 2.7 TRANSFORMERS

- A. Transformers shall be three-phase, liquid-immersed, isolated winding, and self-cooled by natural convection.
- B. The kVA ratings shown on the drawings are for continuous duty without the use of cooling fans.
- C. Temperature rises shall not exceed the NEMA TR1 standards of 149° F [65° C] by resistance, and 180° F [80° C] hotspot at rated kVA.
- D. Transformer insulating material shall be less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 600° F [300° C] when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
- E. Transformer impedance shall be not less than 4.5% for sizes 150 kVA and larger. Impedance shall be as shown on the drawings.
- F. Sound levels shall conform to NEMA TR1 standards.
- G. Primary and Secondary Windings for Three-Phase Transformers:
  1. Primary windings shall be delta-connected.
  2. Secondary windings shall be wye-connected, except where otherwise indicated on the drawings. Provide isolated neutral bushings for secondary wye-connected transformers.

3. Secondary leads shall be brought out through pressure-tight epoxy bushings.
- H. Primary windings shall have four 2.55 full-capacity voltage taps; two taps above and two taps below rated voltage.
- I. Core and Coil Assemblies:
  1. Cores shall be grain-oriented, non-aging, and silicon steel to minimize losses.
  2. Core and coil assemblies shall be rigidly braced to withstand the stresses caused by rough handling during shipment, and stresses caused by any possible short-circuit currents.
  3. Coils shall be continuous-winding type without splices except for taps. Material shall be copper.
  4. Coil and core losses shall be optimum for efficient operation.
  5. Primary, secondary, and tap connections shall be brazed or pressure type.
  6. Provide end fillers or tiedowns for coil windings.
- J. The transformer tank, cover, and radiator gauge thickness shall not be less than that outlined in ANSI.
- K. Accessories:
  1. Provide standard NEMA features, accessories, and the following:
    - a. No-load tap changer (Provide warning sign).
    - b. Lifting, pulling, and jacking facilities.
    - c. Globe-type valve for oil filtering and draining, including sampling device.
    - d. Pressure relief valve.
    - e. Liquid level gauge and filling plug.
    - f. A grounding pad in the medium- and low-voltage compartments.
    - g. A diagrammatic nameplate and operating instructions enclosed by a transparent cover located in the low-voltage compartment.
    - h. Dial-type liquid thermometer with a maximum reading pointer and an external reset.
    - i. Hot stick. Securely fasten hot stick within low-voltage compartment.
  2. The accessories shall be made accessible within the compartments without disassembling trims and covers.
- L. Transformers shall meet the minimum energy efficiency values per NEMA TP1:

KVA	(%)
75	98.1

112.5	98.3
150	99.0
225	99.0
300	99.0
500	99.1
750	99.2
1000	99.2
1500	99.3
2000	99.4
2500	99.4

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

A. Install transformers as shown on the drawings, in accordance with the NEC, and as recommended by the manufacturer.

B. Foundation:

1. Provide foundation of reinforced concrete, Type C, 21mPa (3000 psi minimum, 28 day compressive strength), complying with the ACI 318.
2. Locate the top of foundation pads 6 in [150 mm] above the adjacent finished grade, unless otherwise shown on the drawings. Refer to drawings for size, location, and structural steel reinforcing required.
3. Grade the adjacent terrain so that surface water will flow away from the foundation.
4. Anchor transformers with cadmium- or zinc-plated bolts, nuts, and washers. Bolts shall not be less than 0.5 in [12 mm] diameter.

C. Grounding:

1. Ground each transformer in accordance with the requirements of the NEC. Install ground rods per the requirements of Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS, to maintain a maximum resistance of 5 ohms to ground.
2. Connect the ground rod to the ground pads in the medium- and low-voltage compartments, and to the secondary and primary neutral with not less than a No. 2/0 AWG bare copper conductor.
3. Independently connect cable shield grounding devices ground wires to ground with sufficient slack to permit elbow connector operation. Connect elbow connectors with a No. 14 AWG bare copper drain wire from its grounding eye to the related cable shield grounding device ground wire. Do not connect drain wires in any manner that could



permit circulating currents, or cable fault currents, to pass through them.

### 3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform tests in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections.

B. Transformers:

1. Compare equipment nameplate data with specifications and approved shop drawings.
2. Inspect physical and mechanical condition. Check for damaged or cracked bushings and liquid leaks.
3. Verify that control and alarm settings on temperature indicators are as specified.
4. Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections, or perform thermographic survey after energization under load.
5. Verify correct liquid level in transformer tank.
6. Perform specific inspections and mechanical tests as recommended by manufacturer.
7. Verify correct equipment grounding per the requirements of Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
8. Verify the presence of transformer surge arresters, if provided.
9. Verify that the tap-changer is set at specified ratio.

### 3.3 FOLLOW-UP VERIFICATION

Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the transformers are in good operating condition and properly performing the intended function.

### 3.4 SPARE PARTS

Deliver the following spare parts for the project to the COTR two weeks prior to final inspection:

1. Six stand-off insulators.
2. Six insulated protective caps.
3. One spare set of medium-voltage fuses for each size fuse used in the project.

### 3.5 INSTRUCTIONS

The contractor shall instruct maintenance personnel, for not less than one 2-hour period, on the maintenance and operation of the equipment on the date requested by the COTR.

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