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## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2007

Revised throughout - changes not indicated by CHG tags

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### SECTION 26 12 00.00 40

#### MEDIUM-VOLTAGE TRANSFORMERS 07/07

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NOTE: This specification covers the requirements for single- and three-phase dry-type and oil-insulated transformers. Drawings should indicate size, type, and installation details.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

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## PART 1 GENERAL

### 1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the

reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 877 (2002e1) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

ASTM D 924 (2004) Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.00 (2000) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE C57.12.20 (1997; R 1998) Transformers -- Overhead Type Distribution Transformers, 500 KVA and Smaller: High Voltage 34 500 Volts and Below: Low Voltage, 7970/13 800 Y Volts and Below

IEEE C57.12.25 (1990) Standard for Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors; High Voltage (34 500-Grd Y/19 920 Volts and Below; Low Voltage, 240/120 Volts; 167 kVA and Smaller - Requirements)

IEEE C57.12.26 (1992; Addenda 1993) Transformers - Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High Voltage, (34 500 Grd Y/19 920 and Below; 2500 kVA and Smaller)

IEEE C57.12.80 (2002) Standard Terminology for Power and Distribution Transformers

IEEE C57.12.90 (2006) Standard Test Code for Liquid-Immersed Distribution, Power, and

## Regulating Transformers

IEEE Std 62 (1995) Guide for Diagnostic Field Testing of Electric Power Apparatus-Part 1: Oil Filled Power Transformers, Regulators, and Reactors

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ST 1 (1988; R 1997) Standard for Specialty Transformers (Except General Purpose Type)

NEMA ST 20 (1992; R 1997) Standard for Dry-Type Transformers for General Applications

## U.S. DEPARTMENT OF ENERGY (DOE)

DOE CI-2 (2000) How to Buy an Energy-Efficient Distribution Transformer

## UNDERWRITERS LABORATORIES (UL)

UL 506 (2000; Rev thru May 2006) Specialty Transformers

### 1.2 GENERAL REQUIREMENTS

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NOTE: If Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.  
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Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Certification of previous tests on similar units under actual conditions may be submitted for impulse tests, temperature rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

Equipment and performance data shall be submitted for distribution transformers including resistance measurements, impedance, efficiencies and voltage and load losses at rated currents.

Equipment foundation data for distribution transformers shall include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

### 1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept

to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

The following shall be submitted for distribution transformers:

Connection Diagrams  
Fabrication Drawings  
Installation Drawings

#### SD-03 Product Data

Equipment and Performance data and Equipment Foundation Data shall be submitted for distribution transformers.

Manufacturer's catalog data shall be submitted for the following items:

Distribution Transformers  
Dry-Type Distribution Transformers  
Overhead Distribution Transformers  
Pad-Mounted Liquid-Filled Distribution Transformers  
Pad-Mounted Dry-Type Distribution Transformers

#### SD-06 Test Reports

Test reports shall be submitted for the following tests on distribution transformers in accordance with the paragraph entitled, "Field Testing," of this section.

Insulating Liquid Tests  
Power Factor Tests  
Insulation Resistance Tests  
Insulation Power Factor (Doble) Tests

#### SD-07 Certificates

Certification of previous tests on similar units (type-testing) under actual conditions may be submitted for impulse tests, efficiencies, temperature-rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

#### SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Dry-Type Distribution Transformers  
Overhead Distribution Transformers  
Pad-Mounted Liquid-Filled Distribution Transformers  
Pad-Mounted Dry-Type Distribution Transformers

### 1.4 FACTORY TESTING

Tests on transformers shall comprise the manufacturer's standard tests including resistance measurements of all windings; ratio tests; polarity and phase-relation tests; no-load loss at rated voltage; impedance; voltage and load loss at rated current; [insulation power factor \(Doble\) tests](#), insulation oil tests, and dielectric tests. For oil-filled units manufacturer shall certify that the oil contains no PCB's and shall affix a label to that effect on the transformer tank and on each oil drum containing the insulating oil.

### 1.5 DRAWINGS

[Connection diagrams](#) shall be submitted for distribution transformers indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system or portion of system with another, and internal tubing, wiring, and other devices.

[Fabrication drawings](#) shall be submitted for distribution transformers consisting of fabrication and assembly details to be performed in the factory.

[Installation drawings](#) shall be submitted for distribution transformers in accordance with the paragraph entitled, "Installation," of this section.

## PART 2 PRODUCTS

### 2.1 EQUIPMENT STANDARDS

#### 2.1.1 Dry-Type Distribution Transformers

General-purpose dry-type transformers for connection to low-voltage distribution circuits of 600 volts or less and the supply of current for lighting and power loads shall be two-winding, 60-hertz, self-contained, self-cooled, Class AA in accordance with [NEMA ST 1] [NEMA ST 20] and UL 506.

Insulation system limiting temperature shall be in accordance with the following table, with a temperature rise of:

<u>Dry-Type Class</u>	<u>Maximum Rise by Resistance</u>	<u>Reference Temperature</u>
A	55 degrees C	75 degrees C
B	80 degrees C	110 degrees C
F	115 degrees C	135 degrees C
H	150 degrees C	180 degrees C

#### 2.1.2 Overhead Distribution Transformers

Overhead distribution transformers with primary connections to overhead high-voltage lines to 15 kilovolts (kV) and secondary connections to overhead low-voltage distribution feeder circuits shall be the two-winding, single-phase, 60-hertz, oil-immersed, 65-degree C rise, self-cooled, Class OA, outdoor type, conforming to IEEE C57.12.00, IEEE C57.12.20, and IEEE C57.12.80.

#### 2.1.3 Pad-Mounted Liquid-Filled Distribution Transformers

Pad-mounted liquid-filled distribution transformers with primary connections to underground high-voltage lines and secondary connections to underground low-voltage distribution feeder circuits shall be two-winding, single- or three-phase, as indicated, 60-hertz, oil-immersed, 65-degree C rise, self-cooled, Class OA, outdoor type, conforming to IEEE C57.12.25, IEEE C57.12.26, IEEE C57.12.80, and IEEE C57.12.90. Primary windings of three-phase pad-mounted transformers shall be [delta] [wye] connected.

#### 2.1.4 Pad-Mounted Dry-Type Distribution Transformers

Pad-mounted dry-type distribution transformers with primary connections to underground high-voltage lines and secondary connections to underground low-voltage distribution feeder circuits shall be two-winding, [single-] [three-]phase, 60-hertz, Class AA dry type, 115-degrees C temperature rise above 40 degrees ambient, nonventilated, 220-degrees C insulation class, outdoor type, conforming to IEEE C57.12.25. Primary windings of three-phase pad-mounted transformers shall be [delta] [wye] connected.

#### 2.1.5 Efficiencies

Distribution transformers shall have efficiencies in accordance with the recommended levels specified in DOE CI-2.

## 2.2 FACTORY FINISH

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NOTE: For all outdoor applications and all indoor applications in a harsh environment refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS. High performance coatings are specified for all outdoor applications because ultraviolet radiation will break down most standard coatings, causing a phenomena known as chalking, which is the first stage of the corrosion process. For additional information contact The Coatings Industry Alliance, specific suppliers such as Keeler and Long and PPG, and NACE International (NACE).  
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Transformers shall be provided with the [manufacturer's standard paint finish] [\_\_\_\_\_] when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Dry type transformers shall be installed on resilient vibration-isolating mountings and connected with flexible metallic conduit to prevent transmission and amplification of sound.

Pad-mounted distribution transformers shall be installed on precast or poured-in-place concrete pads and shall be grounded to a ground grid.

Provisions shall be made for forced cooling and related requirements. Voltage and kilovolt-ampere (kVA) ratings shall be as noted.

Each overhead and pad-mounted distribution transformer shall have its kVA rating conspicuously displayed in 75 millimeter 3-inch high yellow letters on its tank or enclosure in addition to the complete manufacturer's standard identification plate.

### 3.2 FIELD TESTING

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NOTE: For transformers rated under 100KVA and less than 4160 Volts on both primary and secondaries power factor testing is an optional acceptance test.  
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Transformers shall be tested in accordance with IEEE Std 62.

#### 3.2.1 Insulating Liquid Tests

##### 3.2.1.1 Dielectric Tests

Liquid filled transformers shall have the insulating liquid dielectrically tested after installation and before being energized. Insulating liquid shall be tested in accordance with ASTM D 877, and breakdown voltage shall be not less than [33,000] [\_\_\_\_\_] volts.



#### 3.2.1.2 Power Factor Tests

Liquid filled transformers shall have the oil power factored at 20 degrees C, per ASTM D 924 prior to being energized. Results shall not be greater than 0.5 percent at 20 degrees C.

#### 3.2.2 Insulation-Resistance Tests

Transformer windings shall be given an insulation-resistance test using the following test set versus voltage level criteria:

Dry type 480- to 600-volt transformers - 1,000-volt test set

Dry type 240-volt and below transformers - 500-volt test set

Liquid type 2.4-kilovolt transformers - 2500-volt test set (primary)

Liquid type 15-to 5-kilovolt transformers - 5000-volt test set (primary)

Readings shall be recorded every 15 seconds for the first minute and every minute thereafter for 10 minutes. Resistance between phase conductors and ground shall be no less than the following:

Liquid type 5 to 15 KV - 125 megohms

Liquid type 600 volt to 5 KV - 75 megohms

Liquid type below 600 volts - 25 megohms

Dry type 5 to 15 KV - 1000 megohms

Dry type 600 volt to 5 KV - 500 megohms

Dry type below 600 volts - 200 megohms

#### 3.2.3 Insulation Power Factor (Doable) Tests

Transformer windings shall be given an insulation power factor test and winding excitation test in accordance with ANSI IEEE C57.12.90. Insulation power factor shall not exceed 0.5 percent for new liquid filled units. New dry type units can have power factors up to 5.0 percent and still be acceptable.

#### 3.2.4 Acceptance

Final acceptance shall depend upon the successful performance of the equipment under test. Transformers shall not be energized until recorded test data have been approved by the Contracting Officer. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

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