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(formerly NEMA TR 1-2013 (R2019))

Transformers, Step Voltage Regulators, and Reactors

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Foreword

This foreword is not part of NEMA TP 80050-202x (formerly NEMA TR 1-2013) Transformers, Step Voltage Regulators, and Reactors.

The Standards appearing in this publication have been developed by the Transformer Section and have been approved for publication by the National Electrical Manufacturers Association. They are used by the electrical industry to promote production economies and to assist users in the proper selection of transformers.

The Transformer Section is working actively with the IEEE Committee, C57 on Transformers, Regulators, and Reactors, in the development, correlation, and maintenance of national Standards for transformers. This Committee operates under the procedures both the American National Standards Institute (ANSI) and the Institute of Electrical and Electronics Engineers (IEEE).

It is the policy of the NEMA Transformer Section to remove material from the NEMA Standards publication as it is adopted and published in the IEEE C57 series Standards. The NEMA Standards publication for Transformers, Regulators, and Reactors references these and other American National Standards applying to transformers and is intended to supplement without duplication both the American National and IEEE Standards.

The NEMA Standards publication for transformers, regulators, and reactors contains a provision for the following:

a. IEEE and American National Standards adopted by reference and applicable exceptions approved by NEMA if any.

b. NEMA Official Standards Proposals—These are official drafts of proposed Standards developed within NEMA or in cooperation with other interested organizations, for consideration by ANSI and IEEE. They have a maximum life of ten years, during which time they must be revised as American National Standards, IEEE Standards, or adopted as NEMA Standards, or rescinded.

c. Manufacturing Standards—These are NEMA Standards which are primarily of interest to the manufacturers of transformers and which are not yet included in an American National or IEEE Standards.

d. Standards Which Are Controversial—These are NEMA Standards, on which there is a difference of opinion within Committee C57. The NEMA version will be included in the NEMA Standards publication until such time as the differences between ANSI, IEEE, and NEMA are resolved.

NEMA Standards publications are subject to periodic review and take into consideration user input. They are being revised constantly to meet changing economic conditions and technical progress. Users should secure the latest editions. Proposed or recommended revisions should be submitted to:

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This Standards publication was developed by the Transformer Products Section of the National Electrical Manufacturers Association. Section Approval of the Standard does not necessarily imply that all section members voted for its approval or participated in its development. At the time it was approved, the Section was composed of the following members:

ABB Inc.—Cary, NC
Cooper Power Systems—Waukesha, WI
Eaton Corporation
Emerson—Rosemont, Ill
Federal Pacific—Bristol, VA
Hammond Power Solutions Inc.—Guelph, Ontario, Canada
Hubbell Acme—Lumberton, NC
MGM Transformer Company—Commerce, CA
Power Grid Components--DI— Bessemer, AL
Prolec GE—Apodaca, MEX
Schneider Electric—Franklin, TN
Siemens Industry Inc.—Peachtree Corners, GA
Vantran Electric Corporation—Waco, TX
Virginia Transformer Corporation—Roanoke, VA

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Scope

This Standards publication applies to single phase and polyphase power and distribution transformers (including step-voltage regulators and reactors). This Standard excludes dry type transformers covered by NEMA ST20. This publication provides a reference list of applicable ANSI and IEEE C57 Standards.

In addition, this publication includes certain NEMA Standard test methods, test codes, properties, etc. of liquid-immersed transformers, step-voltage regulators, and reactors that are not IEEE Standards.

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Part 0
General

The following IEEE and 10 CFR Standards are applicable references and should be inserted in this part:

IEEE Std. C57.12.00-2010	*IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers*
IEEE Std. C57.12.01	*IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers including those with Solid-Cast and/or Resin-Encapsulated windings*
IEEE Std. C57.12.10	*IEEE Standard Requirement for Liquid-Immersed Power Transformers*
IEEE Std. C57.12.70	*IEEE Standard for Standard Terminal Markings and Connections for Distribution and Power Transformers*
IEEE Std. C57.12.90	*IEEE Standard Test Code for Liquid-immersed Distribution, Power & Regulating Transformers*
IEEE Std. C57.12.90	*IEEE Standard Test Code for Dry-Type Distribution and Power Transformers*
IEEE Std. C57.19.00	*IEEE Standard General Requirements and Test Procedure for Power Apparatus Bushings*
IEEE Std. C57.19.01	*IEEE Standard Performance Characteristics & Dimensions for Outdoor Apparatus Bushings*
IEEE Std. C57.91	*IEEE Guide for Loading Mineral-oil-immersed Transformers and Step-Voltage Regulators*
10 CFR 429	*Part 429-Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment*
10 CFR 431	*Part 431- Energy Efficiency Program for Certain Commercial and Industrial Equipment*

The NEMA Standards TR 1-0.01 through TR 1-0.03 on the following pages (see Part 0, Pages 2-3) also generally apply to transformers.

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0.01 Preferred Voltage Ratings

Preferred system voltages and corresponding transformer voltage ratings are given in the American National Standard for Electric Power Systems and Equipment-Voltage Ratings (60 Hz); C84.1. It is recommended that these ratings be used as a guide in the purchase and operation of transformers.

0.02 Preferred Forced-Air and Forced-Liquid Ratings

Preferred forced-air and forced-liquid ratings are given in section 4 Table 1 of IEEE Std. C57.12.00-2010. It is recommended that these ratings be used as a guide in the purchase and operation of transformers.

0.03 Audible Sound Levels

Transformers shall be so designed that the average sound level will not exceed the values given in Tables 0-1 through 0-2 when measured at the factory in accordance with the conditions outlined in IEEE Std. C57.12.90.

The guaranteed sound levels should continue to be per Tables 1 through 2 until such time as enough data on measured noise power levels becomes available.

Sound pressure levels are established and published in this document. Sound power may be calculated from sound pressure using the method described in C57.12.90.

Rectifier, railway, furnace, grounding, mobile, and mobile unit substation transformers are not covered by the tables. The tables do not apply during operation “of” on load tap changers in power transformers and step-voltage regulators.

For audible sound levels of dry-type transformers 15000-Volt nominal system voltage and below the tables listed in the IEEE C57.12.01 Standard are applicable references.

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Table 1
Audible Sound Levels for Oil-Immersed Power Transformers

Average Sound Level tt. Decibels	Equivalent Two-Winding Rating*																	
	350 kV BIL and Below			450, 550, 650 kV BIL			750 and 825 kV BIL			900 and 1050 kV BIL			1175 kV BIL			1300 kV BIL. and Above		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
57	700																	
58	1000																	
59				700														
60	1500			1000														
61	2000																	
62	2500			1500														
63	3000			2000														
64	4000			2500														
65	5000			3000														
66	6000			4000			3000											
67	7500	6250▲▲		5000	3750▲▲		4000	3125▲▲										
68	10000	7500		6000	5000		5000	3750										
69	12500	9375		7500	6250		6000	5000										
70	15000	12500		10000	7500		7500	6250										
71	20000	16667		12500	9375		10000	7500										
72	25000	20000	20800	15000	12500		12500	9375										
73	30000	26667	25000	20000	16667		15000	12500		12500								
74	40000	33333	33333	25000	20000	20800	20000	16667		15000			12500					
75	50000	40000	41687	30000	26667	25000	25000	20000	20800	20000	16667		15000			12500		
76	60000	53333	50000	40000	33333	33333	30000	26667	25000	25000	20000	20800	20000	16667		15000		
77	80000	66687	66667	50000	40000	41667	40000	33333	33333	30000	26667	25000	25000	20000	20800	20000	16667	
78	100000	80000	83333	60000	53333	50000	50000	40000	41667	40000	33333	33333	30000	26667	25000	25000	20000	20800
79		106667	100000	80000	66667	66667	60000	53333	50000	50000	40000	41667	40000	33333	33333	30000	26667	25000
80		133333	133333	100000	80000	83333	80000	66667	66667	60000	53333	50000	50000	40000	41667	40000	33333	33333
81			166667		106667	100000	100000	80000	83333	80000	66667	66667	60000	53333	50000	50000	40000	41667
82			200000		133333	133333		106867	100000	100000	80000	83333	80000	66667	66667	60000	53333	50000
83			250000			166667		133333	133333		10686	100000	100000	80000	83333	80000	66667	68667
84			300000			200000			166667		13333	133333		106667	100000	100000	80000	83333
85			400000			250000			200000			166667		133333	133333		106667	100000
86						300000			250000			200000			166667		133333	133333
87						400000			300000			250000			200000			168667
88									400000			300000			250000			200000
89												400000			300000			250000
90															400000			300000
91																		400000

Column 1 • Class*ONAN. ONWN and OFWF Rating*

Column 2 • Class* ONAF and ODAF First stage Auxiliary Cooling"t

Column 3 • Straight OFAF Ratings, ONAF * and ODAF * Second stage Auxiliary Cooling"t'

Classes of cooling, see section 5.1 IEEE Std. C57.12-2010

"First- and second stage auxiliary cooling, see section 4 Table 1 of IEEE Std. C57-12-2010

f For column 2 and 3 ratings, the sound levels are with the auxiliary cooling equipment in operation.

tf For intermediate kVA ratings, use the average sound level of the next larger kVA rating.

▲The equivalent two-winding 55ºC or 65ºC rating is defined as one-half the sum of the kVA rating of all windings

▲▲ Sixtv-seven decibels for all kVA ratings equal to this or smaller.

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Table 2
Audible Sound Levels for Liquid-Immersed
Network Transformers and Step-Voltage Regulators

Equivalent Two-Winding kVA	Average Sound Level Decibels
0-50	48
51-100	51
101-300	55
301-500	56
501-750	57
751-1000	58
1001-1500	60
1501-2000	61
2001-2500	62
2501-3000	63

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Part 1
Power Transformers

The IEEE Std. C57.12.10 is an applicable reference Standard for power transformers and should be inserted in this Part 1.

The IEEE Std. C57.91 is an applicable reference Standard and should be inserted in this Part 1.

The following other parts of this edition of NEMA TR 1 shall also apply for power transformers.

a. Part 0 General
b. Part 9 Terminology
c. Part 10 Test Code

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Part 2
Substation And Distribution Step-Voltage Regulators

The following IEEE Standards are applicable references for substation and distribution step-voltage regulators and should be inserted in this Part 2:

IEEE Std. C57.15	*IEEE Standard Requirements, Terminology, and Test Code for Step-Voltage Regulators*
IEEE Std. C37.90-1	*IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus*
IEEE Std. C37.90.2	*IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers*
IEEE Std. C37.90.3	*IEEE Standard Electrostatic Discharge Tests for Protective Relays*
IEEE Std. C57.12.31	*IEEE Standard for Pole-Mounted Equipment--Enclosure Integrity*
IEEE Std C57.91	*IEEE Guide for Loading Mineral-Oil-Immersed Transformers and Step-Voltage Regulators*
IEEE Std. C57.98	*IEEE Guide for Transformer Impulse Tests*
IEEE Std. C57.131	*IEEE Standard Requirements for Tap Changers*

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Part 3
Distribution Transformers

The following IEEE Standards are applicable references for distribution transformers and should be inserted in this Part 3:

IEEE Std. C57.12.20	*IEEE Standard for Overhead-Type Distribution Transformers, 500 kVA and Smaller: High Voltage, 34500 Volts, and Below; Low Voltage, 7970/13800Y Volts, and Below*
IEEE Std. C57.12.23	*IEEE Standard for Submersible Single-Phase Transformers: 167 kVA and Smaller, High-Voltage 25000 V and Below; Low-Voltage 600 V and Below*
IEEE Std. C57.12.24	*IEEE Standard for Submersible, Three-Phase Transformers, 3750 kVA and Smaller: High Voltage, 34500 GrdY/19920 Volts, and Below; Low Voltage, 600 Volts, and Below*
IEEE Std. C57.12.29™	*IEEE Standard for Pad-Mounted Equipment-Enclosure Integrity for Coastal Environments*
IEEE Std. C57.12.30™	*IEEE Standard for Pole-Mounted Equipment-Enclosure Integrity for Coastal Environments*
IEEE Std. C57.12.31™	*IEEE Standard for Pole-Mounted Equipment-Enclosure Integrity*
IEEE Std. C57.12.32™	*IEEE Standard for Submersible Equipment- Enclosure Integrity*
(	
IEEE Std. C57.12.34™	*IEEE Standard for 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 and Below.*
IEEE Std. C57.12.35™	*IEEE Standard for Bar Coding for Distribution Transformers and Step-Voltage Regulators*
IEEE Std. C57.12.36™	*IEEE Standard Requirements for Liquid-Immersed Distribution Substation Transformers*
IEEE Std. C57.12.38™	*IEEE Standard for Pad-Mounted-Type, Self-Cooled, Single-Phase Distribution Transformers; High Voltage, 34 500 GrdY/19 920 V and below, Low Voltage, 240/120 V; 167 kVA and smaller*
IEEE Std. C57.105™	*IEEE Guide for Application of Transformer Connections in Three-Phase Distribution Systems*

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The following other parts of this edition of NEMA TR 1 shall apply for distribution transformers:

a. Part 0 General
b. Part 9 Terminology
c. Part 10 Test Code

3.01 Design Test for Enclosure Security of Padmounted Compartmental Transformers

The following IEEE Standards provide a means for evaluating the security of enclosures for transformers.

IEEE Std. C57.12.28™	*IEEE Standard for Pad-Mounted Equipment - Enclosure Integrity*
IEEE Std. C57.12.34™	*IEEE Standard for 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 and Below.*
IEEE Std. C57.12.38™	*IEEE Standard for Pad-Mounted-Type, Self-Cooled, Single-Phase Distribution Transformers; High Voltage, 34 500 GrdY/19 920 V and Below, Low Voltage, 240/120 V; 167 kVA and Smaller*

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Part 4
Secondary Network Transformers

The American National Standard Requirements for C57.12.40 *Secondary Network Transformers, Subway and Vault Types (Liquid Immersed)*, (with the exception of paragraphs 5.5.4 and 11.5.2 on finishes) is an applicable reference for secondary network transformers and should be inserted in this Part 4.

The following other parts of this edition of NEMA TR 1 shall also apply for secondary network transformers.

a. Part 0 General
b. Part 9 Terminology
c. Part 10 Test Code

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Part 5
Dry-Type Transformers

The following IEEE/NEMA Standards are applicable references for dry-type transformers and should be inserted in this Part 5:

IEEE Std. C57.12.01	*IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin-Encapsulated Windings*
IEEE Std. C57.12.91	*IEEE Standard Test Code for Dry-Type Distribution and Power Transformers*
IEEE Std. C57.12.50	*Requirements for Ventilated Dry-Type Distribution Transformers, 1 to 500 kVA, Single-Phase; and 15 to 500 kVA, Three-Phase; With High-Voltage 601-34500 Volts, Low-Voltage 120-600 Volts*
IEEE Std. C57.12.51	*IEEE Standard for Ventilated Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase, With High-Voltage 601-34500 Volts, Low-Voltage 208Y/120V to 4160V-General Requirements*
IEEE Std. C57.12.52	*IEEE Standard for Sealed Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase, With High-Voltage 601-34500 Volts, Low-Voltage 208Y/120V to 4160V-General Requirements*
IEEE Std. C57.94	*IEEE Recommended Practices for Installation, Application, Operation and Maintenance of Dry-Type General Purpose Distribution and Power Transformers*
IEEE Std. C57.96	*Guide for Loading Dry-Type Distribution and Power Transformers*
NEMA ST 20	*Dry Type Transformers for General Applications*

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Part 6
Substation Transformers

The following other parts of this edition of NEMA TR 1 shall also apply for substation transformers.

a. Part 0 General
b. Part 9 Terminology
c. Part 10 Test Code

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Part 7
Arc Furnace Transformers

The following other parts of this edition of NEMA TR 1 shall also apply for arc furnace transformers.

a. Part 0 General
b. Part 9 Terminology
c. Part 10 Test Code

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Part 8
Shunt Reactors

The IEEE Std. C57.21 is an applicable reference and should be inserted in this Part 8.

To facilitate safe and effective operation and consistency of reporting for all shunt reactor transformers, it is recommended that the information listed this IEEE Standard be included in the test report for every shunt reactor transformer.

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Part 9
Terminology

The ANSI/IEEE Std. C57.12.80- is an applicable reference for terminology and should be inserted in this Part 9.

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Part 10
Test Code

The following IEEE Standards are applicable references for transformer test codes and should be inserted in this Part 10:

IEEE Std. C57.12.90™	*IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers*
IEEE Std. C57.12.91	*IEEE Standard Test Code for Dry-Type Distribution and Power Transformers*
IEEE Std. C57.13™	*IEEE Standard Requirements for Instrument Transformers*
IEEE Std. C57.98™	*IEEE Guide for Transformer Impulse Tests*

To facilitate safe and effective operation and consistency of reporting for all power and distribution transformers, it is recommended that the information listed in the IEEE Std. C57.12.00-2010, section 8.7 be included in the test report for every transformer.

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