

American National Standard for Transformers— 230 kV and Below 833 / 958 through 8333 / 10 417 kVA, Single- Phase, and 750 / 862 through 60 000 / 80 000 / 100 000 kVA, Three-Phase Without Load Tap Changing; and 3750 / 4687 through 60 000 / 80 000 / 100 000 kVA with Load Tap Changing— Safety Requirement

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American National Standards Institute, Inc.

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Foreword (This Foreword is not part of American National Standard C57.12.10)

ANSI C57.12.10-1988, American National Standard for Transformers—230 kV and Below 833/958 through 8333/10417 kVA Single-Phase, and 750/862 through 60 000/80 000/100 000 kVA, Three-Phase without Load Tap Changing; and 3750/4687 through 60 000/80 000/100 000 kVA with Load Tap Changing—Safety Requirements was last issued in 1988. The focus of this revision was to consolidate requirements for single-phase, three-phase, and load tap changing substation transformers into a single document. This update combines C57.12.10-1977 and C57.12.30-1977.

In the fall of 1996, a working group was formed to determine if there was a need to revise this standard or if it was appropriate to reaffirm as written. The need to revise was apparent in order to update specific technologies, correct errors, and revise the document format.

To comply with current standard format styles, segmentation of the standard into Parts A and B was eliminated. This format was originally used to separate “Basic Standard” and “Other” ratings and Construction Features. All references and related standards were also brought up to date. A number of typographical errors were corrected along with specific section references.

Some of the most comprehensive changes were associated with the load tap changing control technology. Clause 6.5.2, Devices and Accessories was significantly expanded and renamed Requirements for Automatic Control. Clause 6.6.5 was also expanded to better define dielectric test requirements. The simplified reference schematic (Figure 7) for paralleling transformers was revised to comply with C37.2 and IEEE Standard 315. The cooling class designation references were changed from two to four characters.

This standard is a voluntary consensus standard. Its use may become mandatory only when required by a duly constituted legal authority, or when specified in a contractual relationship. To meet specialized needs and to allow innovation, specific changes are permissible when mutually determined by the user and the producer, provided that such changes do not violate existing laws, and are considered technically adequate for the function intended.

When this standard is used on a mandatory basis, the words *shall* and *must* indicate mandatory requirements; the words *should* or *may* refer to matters that are recommended or permissive, but not mandatory.

Suggestions for improvement gained in the use of this standard will be welcome. They should be sent to the American Standards Institute, 1430 Broadway, New York, NY 10018.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Transformers, Regulators, and Reactors, C57. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the C57 Committee had the following members:

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230 kV and Below

833/958 through 8333/10 417 kVA, Single-Phase,
and 750/862 through 60 000/80 000/100 000 kVA, Three-Phase
without Load Tap Changing;
and 3750/4687 through 60 000/80 000/100 000 kVA
with Load Tap Changing—Safety Requirements

1 Introduction and scope

1.1 Introduction

This voluntary consensus standard is intended for use as a basis for performance, interchangeability, and safety of equipment covered, and to assist in the proper selection of such equipment.

1.2 Scope

This standard covers certain electrical, dimensional, and mechanical characteristics and takes into consideration certain safety features of 60-Hz, two-winding, liquid-immersed transformers rated as follows, and used for step-down or step-up purposes:

- a) 833/958 through 8333/10 417 kVA, single-phase; 750/862 through 10 000/12 500 kVA, three-phase; high voltage, 2400 through 138 000 volts; low-voltage, 480 through 36 230 volts—without load tap changing;

NOTE—A subgroup of the above group is also identified as three-phase transformers 750-2500 kVA, with distribution BIL characteristics.

- b) 12 000/16 000/20 000 through 60 000/80 000/100 000 kVA, three-phase; high voltage, 23 000 through 230 000 volts; low voltage, 4800 through 36 230 volts—without load tap changing;
- c) 3750/4687 through 10 000/12 500 kVA, three-phase; high voltage, 6900 through 138 000; low voltage, 2400 through 36 230 volts—with load tap changing;
- d) 12 000/16 000/20 000 through 60 000/80 000/100 000 kVA, three-phase; high voltage, 23 000 through 230 000 volts; low voltage, 4800 through 36 230 volts—with load tap changing.

It is not intended that this standard apply to dry-type, regulating, pad-mounted, secondary-network, furnace, rectifier, or mine transformers.

1.3 Mandatory requirements

When this standard is used on a mandatory basis, the words “shall” and “must” indicate mandatory requirements, and the words “should” and “may” refer to matters that are recommended and permitted, respectively, but not mandatory.

NOTE—The Foreword of this standard describes the circumstances under which the document may be used on a mandatory basis.

2 Referenced and related standards

2.1 Referenced American National Standards

This standard is intended for use in conjunction with the following American National Standards. When the referenced standards are superseded by a revision approved by the American National Standards Institute, Inc, the latest revision shall apply:

ANSI/ASME B1.1-1989, *American National Standard for Unified Inch Screw Threads (UN and UNR Thread Form)*

ANSI C57.12.70-1978, *Terminal Markings and Connections for Distribution and Power Transformers*

ANSI C84.1-1989, *American National Standard Voltage Ratings for Electric Power Systems and Equipment (60 Hz)*

ANSI/ASME B1.20.1-1983, *Pipe Threads, General Purpose (Inch)*

ANSI/IEEE C57.19.00-1991, *General Requirements and Test Procedure for Outdoor Apparatus Bushings*

ANSI/IEEE C57.19.01-1991, *Performance Characteristics and Dimensions for Outdoor Apparatus Bushings*

ANSI/IEEE 100-1992, *The New IEEE Standard Dictionary of Electrical and Electronics Terms*

ANSI/IEEE C37.90.1-1989, *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems*

ANSI/IEEE C57.12.00-1993, *General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers*

ANSI/IEEE C57.12.80-1978, *Terminology for Power and Distribution Transformers*

ANSI/IEEE C57.13-1993, *Requirements for Instrument Transformers*

ANSI/IEEE C57.91-1995, *Guide for Loading Mineral-Oil-Immersed Transformers*

ANSI/IEEE C57.116-1989, *Guides for Transformers Directly Connected to Generators*

IEEE C57.131-1995, *Requirements for Load Tap Changers*

2.2 Related standard

The following standard is listed for information only and is not essential for the completion of the requirements of this standard:

ANSI/IEEE C57.12.90-1993, *Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers*

3 Terminology

Standard transformer terminology in ANSI/IEEE C57.12.80-1978 shall apply. Other electrical terms are defined in ANSI/IEEE 100-1992.

4 Rating data

4.1 Usual service conditions

Service conditions shall be in accordance with ANSI/IEEE C57.12.00-1993.

4.2 Kilovolt-ampere ratings

4.2.1 Kilovolt-ampere ratings are continuous and based on not exceeding 65°C average winding temperature rise by resistance and 80°C hottest spot temperature rise, as covered and determined in ANSI/IEEE C57.12.00-1993.

4.2.2 Kilovolt-ampere ratings shall be as listed in Tables 1 and 2.

4.3 Kilovolt-ampere and voltage ratings

Kilovolt-ampere and voltage ratings for self-cooled transformers shall be as listed in Tables 3 through 6.

4.4 Insulation levels

Basic impulse insulation levels (BILs) for transformers shall be as listed in Tables 7 through 9.

4.5 Taps

4.5.1 High voltage winding taps for deenergized operation

The following four high-voltage rated kVA taps shall be provided: two (2) 2.5 percent above rated voltage, and two (2) 2.5 percent below rated voltage. Voltages and currents should be listed in accordance with 5.4.

4.5.2 Taps for load-tap-changing transformers

When a load-tap-changing transformer is specified, load-tap-changing equipment shall be furnished to provide approximately ± 10 percent automatic adjustment of the low-voltage winding voltage in approximately 5/8 percent steps, with sixteen steps above and sixteen steps below rated low voltage. The transformer shall be capable of delivering rated kilovolt-amperes at the rated low-voltage position and on all positions above rated low voltage. The transformer shall be capable of delivering low-voltage current corresponding to rated low voltage at all positions below rated low voltage.

4.6 Impedance voltage

4.6.1 Percent impedance voltage

The percent impedance voltage at the self-cooled rating as measured on the rated voltage connection shall be as listed in Table 10.

4.6.2 Tolerance on impedance voltage

The tolerance shall be as specified in ANSI/IEEE C57.12.00-1993.

4.6.3 Percent departure of impedance voltage on taps for deenergized operation

The percent departure of tested impedance voltage on any tap from the tested impedance voltage at rated voltage shall not be greater than the total tap voltage range expressed as a percentage of the rated voltage.

NOTE—This does not apply to load-tap-changing taps.

4.7 Top-liquid temperature-range limits

The transformer shall be suitable for operation over a range of top-liquid temperatures from -20°C to $+105^{\circ}\text{C}$, provided the liquid level has been properly adjusted to the indicated 25°C level.

NOTE—Operation at these temperatures may cause the mechanical pressure-vacuum bleeder device (5.7.2) to function to relieve excessive positive or negative pressures.

4.8 Routine tests

4.8.1 “Routine tests” shall be made in accordance with ANSI/IEEE C57.12.00-1993.

4.8.2 On load-tap-changing transformers, additional routine tests for load-tap-changing transformers listed in ANSI/IEEE C57.12.00-1993 shall be made.

Table 1 – Kilovolt-ampere ratings, self-cooled (ONAN)

Single-Phase (kV) Without Load Tap Changing	Three-Phase (kVA)	
	Without Load Tap Changing	With Load Tap Changing
833	750	—
1250	1 000	—
1667	1 500	—
2500	2 000	—
3333	2 500	—
5000	3 750	3 750
6667	5 000	5 000
8333	7 500	7 500
—	10 000	10 000

**Table 2 – Kilovolt-ampere ratings,
self-cooled (ONAN), forced-cooled first-stage, and forced-cooled
second-stage three-phase (with, or without, load tap changing), 12 000-100 000 kVA**

ONAN	First-Stage	Second-Stage
12 000	16 000	20 000
15 000	20 000	25 000
20 000	26 667	33 333
25 000	33 333	41 667
30 000	40 000	50 000
37 500	50 000	62 500
50 000	66 667	83 333
60 000	80 000	100 000

Table 3 – Range of voltage and kilovolt-ampere ratings for single-phase transformers, 833-8333 kVA

High-Voltage Ratings (V)		Low-Voltage Ratings (V)			
		6900/11 950Y,			14 400/24 940Y
		2400/4160Y,	7200/12 470Y	12 000,	—
		2520/4360Y,	7560/13 090Y,	12 600,	34 500,
		4800/8320Y,	7620/13 200Y,	13 200,	19 920/34 500Y
		—	—	13 800	—
480		5040/8720Y	7970/13 800Y	14 400	20 920/36 230Y
Self-Cooled (ONAN) Kilovolt-Ampere Ratings (kVA)					
2400/4160Y	833	—	—	—	—
4800/8320Y	833	—	—	—	—
6900/11 950Y,	833, 1250	833-2500	—	—	—
6930/12 000Y,	833, 1250	833-2500	—	—	—
7200/12 470Y,	833, 1250	833-2500	—	—	—
7620/13 200Y,	833, 1250	833-2500	—	—	—
7970/13 800Y,	833, 1250	833-2500	—	—	—
12 000, 13 200,	833, 1250	833-2500	—	—	—
13 800	833, 1250	833-2500	—	—	—
23 000	833, 1250	833-2500	833-2500	—	—
34 500	833, 1250	833-2500	833-3333	833-3333	
46 000	833, 1250	833-2500	833-8333	833-8333	2500-8333
69 000	—	833-2500	833-8333	833-8333	2500-8333
115 000	—	2500	2500-8333	2500-8333	2500-8333
138 000	—	2500	2500-8333	2500-8333	2500-8333

NOTES

- 1 All voltages are Δ unless otherwise indicated.
- 2 Kilovolt-ampere ratings separated by a dash indicate that all the intervening ratings listed in Table 1 are included. Kilovolt-ampere ratings separated by a comma indicate that only those listed are included.
- 3 Bold type-voltages listed in ANSI C84.1-1989.
- 4 Italics type-voltages not listed in ANSI C84.1-1989.

**Table 4 – Range of voltage and kilovolt-ampere ratings
for three-phase transformers, without load tap changing 750-10 000 kVA**

High Voltage Ratings (V)	Low-Voltage Ratings (V)					
	6900, 7200, 7560, 12 470Y/7200, 13 090Y/7560, 13 200Y/7620, 13 800Y/7970,					24 940GrdY/14 000
	480Y/277, 480	2400, 2520 4160Y/2400, 4360Y/2520	4800, 5040, 8320Y/4800, 8720Y/5040	13 800, 12 000, 12 600, 13 200, 14 400	34 500, 34 500GrdY/19 920, 36 230GrdY/20 920	
Self-Cooled (ONAN) Kilovolt-Ampere Ratings (kVA)						
2400	750-1500	—	—	—	—	—
4160,4800	750-1500	—	—	—	—	—
6900,7200	750-2500	1000-3750	—	—	—	—
12 000	750-2500	1000-7500	—	—	—	—
12 470	750-2500	1000-7500	—	—	—	—
13 200	750-2500	1000-7500	—	—	—	—
13 800	750-2500	1000-7500	—	—	—	—
23 000	750-2500	1000-7500	1000-10 000	1000-10 000	—	—
34 500	750-2500	1000-7500	1000-10 000	1000-10 000	1000-10 000	—
46 000	—	1500-7500	1500-10 000	1500-10 000	1500-10 000	5000-10 000
69 000	—	1500-7500	1500-10 000	1500-10 000	1500-10 000	5000-10 000
115 000	—	5000-7500	5000-10 000	5000-10 000	5000-10 000	5000-10 000
138 000	—	5000-7500	5000-10 000	5000-10 000	5000-10 000	5000-10 000

NOTES

- 1 All voltages are Δ, unless otherwise indicated.
- 2 Kilovolt-ampere ratings separated by a dash indicate that all the intervening ratings listed in Table 1 are included.
- 3 Bold type – voltages listed in ANSI C84.1-1989.
- 4 Italics type – voltages not listed in ANSI C84.1-1989.

**Table 5 – Range of voltage and kilovolt-ampere ratings
for three-phase transformers with load tap changing, 3750-10 000 kVA**

High Voltage Ratings (V)	Low-Voltage Ratings (V)					
	6900, 7200, 7560, 12 470Y/7200, 13 090Y/7560, 13 800, 12 000, 12 600, 13 200, 14 400					24 940 GrdY/14 400
	2400, 2520 4160Y/2400, 4360Y/2520	4800, 5040, 8320Y/4800, 8720Y/5040	13 200Y/7620, 13 800Y/7970	13 800, 12 000, 12 600, 13 200, 14 400	24 940 GrdY/14 400	34 500, 34 500 GrdY/19 920, 36 230 GrdY/20 920
Self-Cooled (ONAN) Kilovolt-Ampere Ratings (kVA)						
6900, 7200	3750	—	—	—	—	—
12 000	3750-7500	—	—	—	—	—
12 470	3750-7500	—	—	—	—	—
13 200	3750-7500	—	—	—	—	—
13 800	3750-7500	—	—	—	—	—
23 000	3750-7500	3750-10 000	3750-10 000	—	—	—
34 500	3750-7500	3750-10 000	3750-10 000	3750-10 000	—	—
46 000	3750-7500	3750-10 000	3750-10 000	3750-10 000	5000-10 000	5000-10 000
69 000	3750-7500	3750-10 000	3750-10 000	3750-10 000	5000-10 000	5000-10 000
115 000	5000-7500	5000-10 000	5000-10 000	5000-10 000	5000-10 000	5000-10 000
138 000	5000-7500	5000-10 000	5000-10 000	5000-10 000	5000-10 000	5000-10 000

NOTES

- 1 All voltages are Δ, unless otherwise indicated.
- 2 Kilovolt-ampere ratings separated by a dash indicate that all the intervening ratings listed in Table 1 are included.
- 3 Bold type – voltages listed in ANSI C84.1-1989.
- 4 Italics type – voltages not listed in ANSI C84.1-1989.

**Table 6 – Range of voltage and kilovolt-ampere ratings for three-phase transformers
with, or without, load tap changing, 12 000-60 000 kVA**

High Voltage Ratings (V)	Low-Voltage Ratings (V)				
	6900, 7200, 7560, 12 470Y/7200, 13 090Y/7560, 13 200Y/7620, 13 800Y/7970				24 940 GrdY/14 400
	4800, 5040, 8320Y/4800, 8720Y/5040	13 200Y/7620, 13 800Y/7970	12 000, 12 600, 13 200, 13 800, 14 400	24 940 GrdY/14 400	34 500, 34 500 GrdY/19 920, 36 230 GrdY/20 920
Self-Cooled (ONAN) Kilovolt-Ampere Ratings (kVA)					
23 000	12 000-15 000	12 000-30 000	—	—	—
34 500	12 000-15 000	12 000-30 000	12 000-30 000	—	—
46 000	12 000-15 000	12 000-30 000	12 000-30 000	—	—
69 000	12 000-15 000	12 000-30 000	12 000-30 000	—	—
115 000	12 000-15 000	12 000-60 000	12 000-60 000	12 000-60 000	12 000-60 000
138 000	12 000-15 000	12 000-60 000	12 000-60 000	12 000-60 000	12 000-60 000
161 000	12 000-15 000	12 000-60 000	12 000-60 000	12 000-60 000	12 000-60 000
230 000	12 000-15 000	12 000-60 000	12 000-60 000	12 000-60 000	12 000-60 000

NOTES

- 1 All voltages are Δ, unless otherwise indicated.
- 2 Kilovolt-ampere ratings separated by a dash indicate that all the intervening ratings listed in Table 2 are included.
- 3 Bold type – voltages listed in ANSI C84.1-1989.
- 4 Italics type – voltages not listed in ANSI C84.1-1989.