

# Standards relevant to transformers - Part II

AIEE, founded in 1884, treated transformer related topics with great care, forming a separate committee for transformers in 1918

## KEYWORDS

AIEE, IEEE, history, standards, transformers



# The first standard (or ‘rules’, as they were called then), was presented and adopted by the Institute in 1899; it was a common standard for generators, motors and transformers

## IEEE- Institute of electrical and electronics engineers

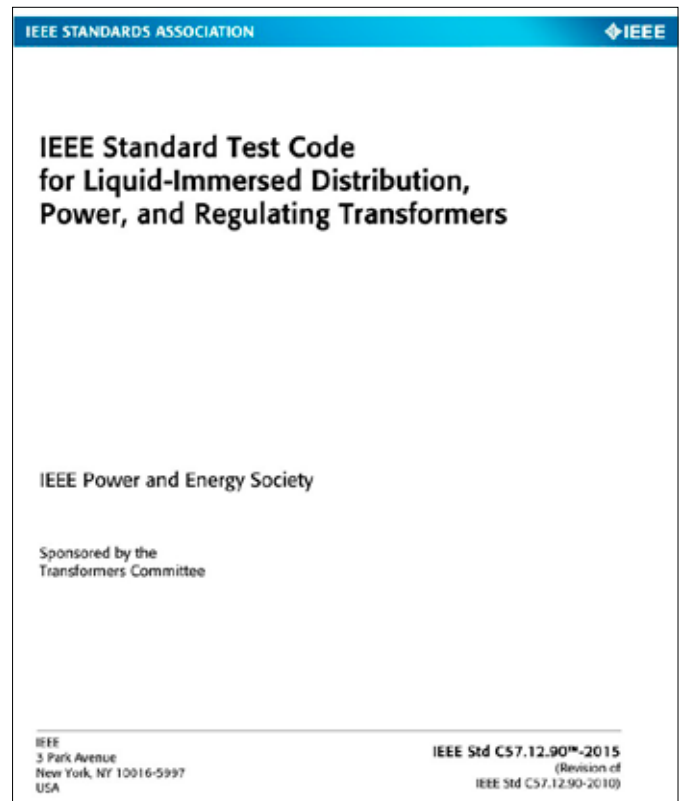
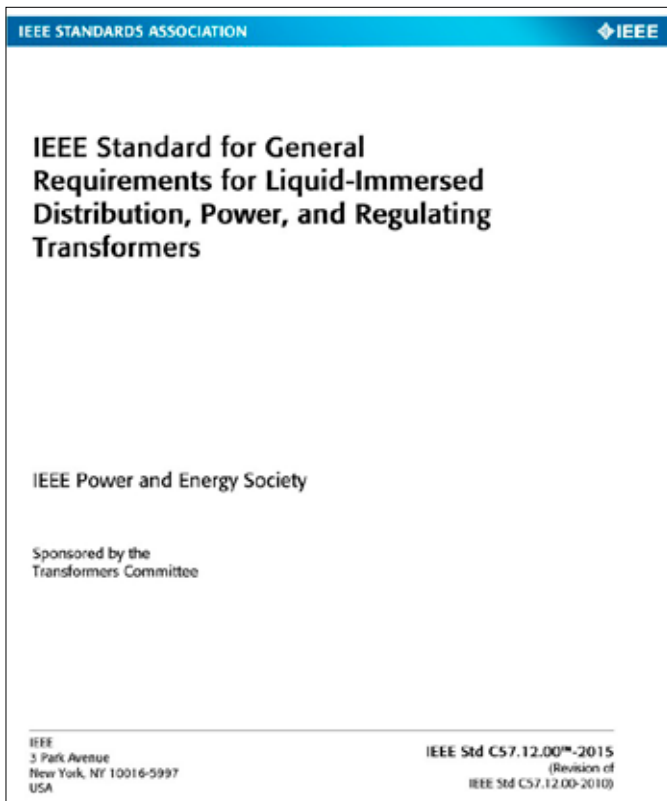
The first step taken by the American Institute of Electrical Engineers (AIEE, formed in 1884) towards the standardisation of electrical apparatus and methods, was a discussion on the standardization of generators, motors and transformers, which took place simultaneously in New York and Chicago on 29 January 1898. A committee was appointed by the Council of the Institute under the chairmanship of Prof. Francis B. Crocker, and included eminent electrical engineers of the day, such as Charles P. Steinmetz, Lewis B. Stillwell (Niagara Power Company) and Elihu Thomson. The first standard (or ‘rules’, as they were called then), was presented and adopted by the Institute on 26 June 1899. This common standard for generators, motors and transformers was

subsequently revised ten times during the next 22 years. In 1907, a standing committee, called the Standards committee, was constituted to continually monitor and revise this standard. This committee continued to grow over the years with several subcommittees to work on individual products required for electric power industry. Over the years, the input into the standardisation rules was also obtained from the Association of Edison Illuminating Companies (AEIC), the Electric Power Club (later to become the National Manufacturers Association, NEMA), the National Electric Light Association (NELA, the forerunner to the Edison Electrical Institute, EEI), and others. In parallel to AIEE, these organisations also began to issue standards. For example, in 1916, NELA issued a report on the standardisation of power ratings, voltages and taps for transformers (probably the first exclusive

standard for transformers from the US), and NEMA standards on transformers that are still in vogue today.

AIEE standards committee formed a separate subcommittee (No. 8) for transformers in 1918. Until 1921, transformer standard was a chapter in the common rules of standardization, titled *Stationary induction apparatus*.

In 1921, a version of this document, renamed into Standards of the American Institute of Electrical Engineers, changed the transformer chapter title into Transformers and other stationary induction apparatus. In 1922, it was decided to separate the common standards of the AIEE into 27 pamphlets (standards), covering each product for the power industry individually. Thus, the first standard, exclusively for transformers, came out in 1925 as AIEE standard No.13 Standards for transformers, induction regulators and reactors, the first version of today’s IEEE standard C57.12.00 General requirements for liquid immersed distribution, power and regulating transformers. Unification of the transformer standards of the American Institute of Electrical Engineers, the National Electrical Manufactur-



ers, and The Edison Electric Institute, resulted when ANSI C57.1, C57.2 & C57.3 American Standards for Transformers, Regulators and Reactors were issued in 1942. In 1963, AIEE merged with the Institute of Radio Engineers (IRE), changing the name of the association to the Institute of Electrical and Electronics Engineers and the standards issued became known as IEEE standards.

IEEE operates in 39 different societies and technical committees. Transformers fall into Power and Energy Society (PES). Today, the IEEE PES transformers committee consists of 14 subcommittees:

- Administrative
- Bushing
- Dielectric test
- Dry type
- Distribution transformers
- Meeting planning subcommittee
- HVDC converter transformers and smoothing reactors
- Insulating fluids
- Insulation life
- Instrument transformers
- Performance characteristics
- Power transformers
- Standards
- Underground transformers and network protectors

IEEE Transformer committee has issued about 100 standards related to transformers under the famous C57 series. They are listed in Table 1 [2], along with a few standards which are active but not covered under the C57 series.

Table 1. IEEE standards on transformers

SI No	IEEE standard	Title
1	C57.12.00–2015	General requirements for liquid-immersed distribution, power, and regulating transformers
2	C57.12.01–2015	General requirements for dry-type distribution and power transformers including those with solid cast and/or resin encapsulated windings
3	C57.12.10–2017	Standard requirements for liquid-immersed power transformers
4	C57.12.20–2017	Standard for overhead-type distribution transformers 500 kVA and smaller: high voltage, 34,500 V and below; low voltage, 7970 / 13,800 V and below
5	C57.12.23–2018	Standard for submersible single-phase transformers: 250 kVA and smaller; high voltage 234,500 V GrdY/19 920 V and below; low voltage 600 V and below
6	C57.12.24–2016	Standard for submersible, three-phase transformers, 3,750 kVA and smaller: high voltage, 34,500 GrdY / 19 920 V and below; low voltage, 600 V and below
7	C57.12.28–2014	Standard for pad-mounted equipment - enclosure integrity
8	C57.12.29–2014	Standard for pad-mounted equipment - enclosure integrity for coastal environments
9	C57.12.30–2010	Standard for pole-mounted equipment - enclosure integrity for coastal environments
10	C57.12.31–2010 COR1-2014	Standard for pole-mounted equipment - enclosure integrity
11	C57.12.32–2019	Standard for submersible equipment - enclosure integrity
12	C57.12.34–2015	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
13	C57.12.35–2013	Standard for bar coding for distribution transformers and step-voltage regulators
14	C57.12.36–2017	Standard requirements for liquid-immersed distribution substation transformers
15	C57.12.37–2015	Standard for the electronic reporting of distribution transformer test data
16	C57.12.38–2014 COR1-2016	Standard for pad-mounted-type, self-cooled, single-phase distribution transformers 250 kVA and smaller: high voltage, 34,500 GrdY / 19,920 V and below; low voltage, 480 / 240 V and below
17	C57.12.39–2017	Standard for requirements for distribution transformer tank pressure coordination
18	C57.12.40–2017	Standard for network, three-phase transformers, 2,500 kVA and smaller; high voltage, 34,500 GrdY / 19,920 V and below; low voltage, 600 V and below; sub-way and vault types (liquid immersed)

**In 1921, within the AIEE standard, the chapter covering the transformers was renamed from *Stationary induction apparatus* into *Transformers and other stationary induction apparatus***



19	C57.12.44–2014	Standard requirements for secondary network protectors
20	C57.12.50–1981 (R1998)	Requirements for ventilated dry-type distribution transformers, 1 to 500 kVA, single-phase, and 15 to 500 kVA, three-phase, with high-voltage 601 to 34,500 volts, low-voltage 120 to 600 V
21	C57.12.51–2019	IEEE Guide for mechanical interchangeability of ventilated dry-type transformers
22	C57.12.52–2012	Standard for sealed dry-type power transformers, 501 kVA and higher, three-phase, with high-voltage 601 to 34,500 V, low-voltage 208Y / 120 to 4,160 V general requirements
23	C57.12.55–1987 (R 1998)	Standard for transformers - used in unit installations, including unit substations-conformance standard
24	C57.12.56–1986 (R1998)	Standard test procedure for thermal evaluation of insulation systems for ventilated dry-type power and distribution transformers
25	C57.12.58–2017	Guide for conducting a transient voltage analysis of a dry-type transformer coil
26	C57.12.59–2015	Guide for dry-type transformer through-fault current duration
27	C57.12.60–2020	Standard test procedure for thermal evaluation of insulation systems for dry-type power and distribution transformers
28	C57.12.70–2011	Standard terminal markings and connections for distribution and power transformers
29	C57.12.80–2010	Standard terminology for power and distribution transformers
30	C57.12.90–2015 COR1-2017	Standard test code for liquid-immersed distribution, power, and regulating transformers
31	C57.12.91–2011	Standard test code for dry-type distribution and power transformers
32	C57.13–2016	Standard requirements for instrument transformers
33	C57.13.1–2017	Guide for field testing of relaying current transformers
34	C57.13.2–2005	Standard conformance test procedure for instrument transformers
35	C57.13.3–2014	Guide for grounding of instrument transformer secondary circuits and cases
36	C57.13.5–2019	Standard of performance and test requirements for instrument transformers of a nominal system voltage of 115 kV and above
37	C57.13.6–2005	Standard for high-accuracy instrument transformers
38	C57.13.7-2018	IEEE Standard for current transformers with maximum milliampere secondary current of 250 mA
39	C57.15–2017	Standard requirements, terminology, and test code for step-voltage regulators
40	C57.16–2011	Standard requirements, terminology, and test code for dry-type air-core series-connected reactors
41	C57.17–2012	Standard requirements for arc furnace transformers
42	C57.18.10–1998	Standard practices and requirements for semiconductor power rectifier transformers
43	C57.19.00–2004	Standard general requirements and test procedure for outdoor power apparatus bushings
44	C57.19.01–2017	Standard performance characteristics and dimensions for outdoor apparatus bushings

45	C57.19.03–1996 COR1 2005	Standard requirements, terminology, and test code for bushings for DC applications
46	C57.19.04–2018	Standard for performance characteristics and dimensions for high current power transformer bushings with rated continuous current in excess of 5,000 A in bus enclosures
47	C57.19.100–2012	Guide for application of power apparatus bushings
48	C57.21–2008	standard requirements, terminology, and test code for shunt reactors rated over 500 kVA
49	C57.32–2015	Standard for requirements, terminology, and test procedures for neutral grounding devices
50	C57.91–2011	Guide for loading mineral-oil-immersed transformers
51	C57.93–2019	Guide for installation and maintenance of liquid-immersed power transformers
52	C57.94–2015	Recommended practice for installation, application, operation, and maintenance of dry-type general purpose distribution and power transformers
53	C57.96–2013	Guide for loading dry-type distribution and power transformers
54	C57.98–2011	Guide for transformer impulse tests
55	C57.100 -2011	Standard test procedure for thermal evaluation of liquid-immersed distribution and power transformers
56	C57.104 -2019	Guide for the interpretation of gases generated in oil-immersed transformers
57	C57.105-2019	Guide for application of transformer connections in three-phase electrical systems
58	C57.106–2015	Guide for acceptance and maintenance of insulating oil in equipment
59	C57.109–2018	Guide for liquid-immersed transformers through-fault-current duration
60	C57.110–2018	Recommended practice for establishing liquid-filled and dry-type power and distribution transformer capability when supplying non-sinusoidal load currents
61	C57.111–1989	Guide for acceptance of silicone insulating fluid and its maintenance in transformers
62	C57.113–2010	Guide for partial discharge measurement in liquid-filled power transformers and shunt reactors
63	C57.116–2014	Guide for transformers directly connected to generators
64	C57.119–2018	Recommended practice for performing temperature rise tests on oil-immersed power transformers at loads beyond nameplate ratings
65	C57.120–2017	Loss evaluation guide for power transformers and reactors
66	C57.121–1998	Guide for acceptance and maintenance of less flammable hydrocarbon fluid in transformers
67	C57.123–2019	Guide for transformer loss measurement
68	C57.124–1991	Recommended practice for the detection of partial discharge and the measurement of apparent charge in dry-type transformers
69	C57.125–2015	Guide for failure investigation, documentation, analysis, and reporting for power transformers and shunt reactors
70	C57.127–2018	EEE Guide for the detection, location and interpretation of sources of acoustic emissions from electrical discharges in power transformers and power reactors
71	60076–57–129–2017	IEC/IEEE International standard - Power transformers - Part 57-129: Transformers for HVDC applications

## IEEE Transformer committee has issued about 100 standards related to transformers under the so-called C57 series



## IEEE standards widely cover transformers, addressing all the relevant topics from the practice for the various types of transformers

72	60076-57-1202-2016	IEC/IEEE International standard - Power transformers - Part 57-1202: Liquid immersed phase-shifting transformers
73	C57.130-2015	Guide for the use of dissolved gas analysis applied to factory temperature rise tests for the evaluation of mineral oil-immersed transformers and reactors
74	C57.131-2012	Standard requirements for tap changers
75	C57.134-2013	Guide for determination of hottest-spot temperature in dry-type transformers
76	C57.135-2011	Guide for the application, specification, and testing of phase-shifting transformers
77	C57.136-2000	Guide for sound level abatement and determination for liquid-immersed power transformers and shunt reactors rated over 500 kVa
78	C57.138-2016	Recommended practice for routine impulse test for distribution transformers
79	C57.139-2015	Guide for dissolved gas analysis in transformer load tap changers
80	C57.140-2017	Guide for evaluation and reconditioning of liquid immersed power transformers
81	C57.142-2010	Guide to describe the occurrence and mitigation of switching transients induced by transformers, switching device, and system interaction
82	C57.143-2012	Guide for application for monitoring equipment to liquid-immersed transformers and components
83	C57.144-2004	Guide for metric conversion of transformer standards
84	C57.146-2005	Guide for interpretation of gasses generated in silicone-immersed transformers
85	C57.147-2018	Guide for acceptance and maintenance of natural ester fluids in transformers
86	C57.148-2011	Standard for control cabinets for power transformers
87	C57.149-2012	Guide for the application and interpretation of frequency response analysis for oil-immersed transformers
88	C57.150-2012	Guide for the transportation of transformers and reactors rated 10,000 kVA or higher

89	C57.152–2013	Guide for diagnostic field testing of fluid filled power transformers, regulators, and reactors
90	C57.153–2015	Guide for paralleling regulating transformers
91	C57.154–2012	IEEE standard for the design, testing, and application of liquid-immersed distribution, power, and regulating transformers using high-temperature insulation systems and operating at elevated temperatures
92	C57.155–2014	Guide for interpretation of gases generated in natural ester and synthetic ester-immersed transformers
93	C57.156–2016	Guide for tank rupture mitigation of liquid-immersed power transformers and reactors
94	C57.157–2015	Guide for conducting functional life tests on switch contacts used in insulating liquid transformers
95	C57.158–2017	Guide for the application of tertiary and stabilizing windings in power transformers
96	C57.159–2016	Guide on transformers for application in distributed photovoltaic (DPV) power generation systems
97	C57.161–2018	Guide for dielectric frequency response test
98	C57.163–2015 COR1-2016	Guide for establishing power transformer capability while under geomagnetic disturbances
99	C57.200–2000	PD detection by acoustic monitoring
100	C57.637–2015	Guide for the reclamation of mineral insulating oil and criteria for its use
101	259–1999	Standard test procedure for evaluation of systems of insulation for dry-type specialty and general-purpose transformers
102	638–2013	Standard for qualification of class 1E transformers for nuclear power generating stations
103	1276–2020	Guide for the application of high-temperature insulation materials in liquid-immersed distribution, power and regulating transformers
104	1277–2010	Standard general requirements and test code for dry-type and oil-immersed smoothing reactors for dc power transmission
105	1538–2000/AMD1538a–2015	Guide for determination of maximum winding temperature rise in liquid-filled transformers
106	1653.1–2016	Standard for traction power rectifier transformers for substations
107	60214-2-2019	IEEE/IEC International Standard for TAP-changers - Part 2: Application guidelines
108	60076-16-2018	IEC/IEEE International Standard - Power transformers - Part 16: Transformers for wind turbine applications

## Bibliography

[1] *Standardization Rules of American Institute of Electrical Engineers*, AIEE Vol 30, Issue 3, pp. 2535-2585, 1911

[2] C.LeMaistre, *Standardization*, AIEE, pp. 489-500, 1916

[3] IEEE Standards Association, <https://standards.ieee.org/standard/index.html>

## Author



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