Standards relevant to transformers – Part IV

BSI has more than 100 years of history in covering standards for transformers which make them pioneers in the field

ABSTRACT

Last three parts of this series covered the evolution of Standards / Technical Brochures related to Power Transformers under IEC, IEEE and CIGRE and listed current standards issued by them. Now we see the evolution of transformer standards in Britain and the current position of European Standards (EN) on Transformers.

KEYWORDS

standards, transformers, BSI, BESA, CENELEC

First tentative British standard exclusively for transformers was issued in 1917 as Specification No. 72 'Electrical Performance of Transformers for Power and Lighting'

BSI – British standards institution

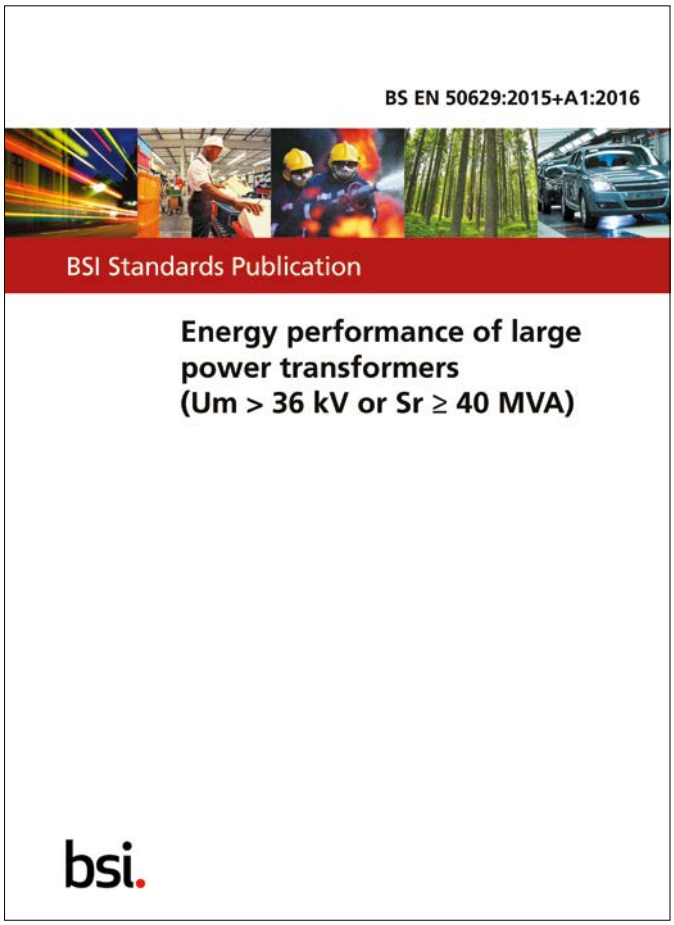
Work on engineering standards started in Britain in 1901 on the initiative of the British Engineering Standards Committee under Sir John Wolfe Barry KCB (the engineer who designed London's famous Tower Bridge). Later, the electrical section committee was constituted under Sir John Snell. British Engineering Standards Association (BESA) issued the "Standardization Rules for Electrical Machinery" during the first decade of the 20th century. A tentative standard exclusively for transformers was issued in 1917 as Specification No. 72 'Electrical Performance of Transformers for Power and Lighting'. A further tentative standard for Transformer oil was issued in 1923 and this was reproduced in full in the first edition of The J & P Transformer Book, published in 1925 [1].

First standards for transformers and oil were issued in 1927 with numbers BSS: 171 "British Standard Specifications for the Electrical Performance of Transformers for Power and Lighting" & BSS: 148 "British Standard Specifications for Insulating Oils for Electrical Purposes (excluding cables)". In the fourth edition of The J & P Transformer Book, published in 1928 [2], these two standards were reproduced in full, under the permission of BESA. In the above book, we can find the first national standards on transformers, as in use 90 years back. These two standards, along with the Code of Practice CP 1010 'Transformer Loading Guide' were widely referred to and used in Britain and its colonies for the next half a century, undergoing several revisions. Later, these British Standards were replaced by individual national standards or IEC standards, as the colonies became independent countries. In 1961, there were nearly 40 British standards relevant to power and distribution transformers.

CENELEC - European committee for electrotechnical standardization

CENELEC (French: *Comité Européen de Normalisation Électrotechnique*) is the European Committee for Electrotechnical Standardization and is responsible for standardization in the electrotechnical engineering field [3]. CENELEC prepares voluntary standards that facilitate trade between countries, create new markets, cut compliance costs and support the development of a Single European Market.

Designated as European Standards Organization by the European Commission, CENELEC is a non-profit technical organization set up under Belgian law. It was created in 1973 as



a result of the merger of two previous European organizations: CENELCOM and CENEL.

CENELEC concentrates most of its work on two major deliverables: the European Standard (EN) and the Harmonization Document (HD). These two documents are referred to commonly as "standards" and must be implemented in all CENELEC member countries, who must also withdraw any conflicting standards.

There are a few differences in the implementation process of the ENs and HDs. Basically, the EN must be transposed as it is, not adding or deleting anything. The process for the HDs is a bit more flexible. It is the technical content that must be transposed, no matter the wording or how many documents are made of it. In addition to these two major deliverables, CENELEC also produces and approves documents with a different objective and target.

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European Standards (ENs) are based on a consensus, which reflects the economic and social interests of 34 CENELEC member countries channelled through their National Electrotechnical Committees (NCs).

The technical committee responsible for the formulation of EN Power Transformer Standards is CLC/TC 14, and EN Bushing Standards is CLC/TC 36 A. Standards published by these committees are listed below.

CENELEC prepares voluntary standards that facilitate trade between countries, create new markets, cut compliance costs and support the development of a Single European Market

Table 1. EN Standards on Transformers

Serial No.	Standard Number	Title
1	**HD 538.1 S1:1992/AC:2011** (pr=23795)	Three-phase dry-type distribution transformers 50 Hz, from 100 to 2500 kVA, with highest voltage for equipment not exceeding 36 kV - Part 1: General requirements and requirements for transformers with highest voltage for equipment not exceeding 24 kV
2	**EN 50195:1996** (pr=5740)	Code of practice for the safe use of fully enclosed askarel-filled electrical equipment
3	**EN 50216-1:2002** (pr=4783)	Power transformer and reactor fittings - Part 1: General
4	**EN 50216-2:2002** (pr=216)	Power transformer and reactor fittings - Part 2: Gas and oil actuated relay for liquid immersed transformers and reactors with conservator
5	**EN 50216-2:2002/A1:2002** (pr=14853)	Power transformer and reactor fittings - Part 2: Gas and oil actuated relay for liquid immersed transformers and reactors with conservator
6	**EN 50216-3:2002** (pr=5601)	Power transformer and reactor fittings - Part 3: Protective relay for hermetically sealed liquid-immersed transformers and reactors without gaseous cushion
7	**EN 50216-3:2002/A2:2006** (pr=20479)	Power transformer and reactor fittings - Part 3: Protective relay for hermetically sealed liquid-immersed transformers and reactors without gaseous cushion
8	**EN 50216-4:2015** (pr=22810)	Power transformer and reactor fittings - Part 4: Basic accessories (earthing terminal, drain and filling devices, thermometer pocket, wheel assembly)
9	**EN 50216-5:2002/A2:2005/ corrigendum Oct. 2006** (pr=26210)	Power transformer and reactor fittings - Part 5: Liquid level, pressure and flow indicators, pressure relief devices and dehydrating breathers
10	**EN 50216-5:2002** (pr=11501)	Power transformer and reactor fittings - Part 5: Liquid level, pressure and flow indicators, pressure relief devices and dehydrating breathers
11	**EN 50216-5:2002/A2:2005** (pr=14950)	Power transformer and reactor fittings - Part 5: Liquid level, pressure and flow indicators, pressure relief devices and dehydrating breathers
12	**EN 50216-5:2002/A3:2006** (pr=20506)	Power transformer and reactor fittings - Part 5: Liquid level, pressure and flow indicators, pressure relief devices and dehydrating breathers
13	**EN 50216-6:2002** (pr=7656)	Power transformer and reactor fittings - Part 6: Cooling equipment - Removable radiators for oil-immersed transformers

Serial No.	Standard Number	Title
14	**EN 50216-7:2002** (pr=4784)	Power transformer and reactor fittings - Part 7: Electric pumps for transformer oil
15	**EN 50216-8:2005** (pr=14952)	Power transformer and reactor fittings - Part 8: Butterfly valves for insulating liquid circuits
16	**EN 50216-9:2009** (pr=15198)	Power transformer and reactor fittings - Part 9: Oil-to-water heat exchangers
17	**EN 50216-10:2009** (pr=15199)	Power transformer and reactor fittings - Part 10: Oil-to-air heat exchangers
18	**EN 50216-11:2008** (pr=20505)	Power transformer and reactor fittings - Part 11: Oil and winding temperature indicators
19	**EN 50216-12:2011** (pr=20478)	Power transformer and reactor fittings - Part 12: Fans
20	**EN 50225:1996** (pr=5741)	Code of practice for the safe use of fully enclosed oil-filled electrical equipment which may be contaminated with PCBs
21	**EN 50299-1:2014** (pr=24705)	Oil-immersed cable connection assemblies for transformers and reactors having highest voltage for equipment Um from 72,5 kV to 550 kV - Part 1: Fluid-filled cable terminations
22	**EN 50299-2:2014** (pr=24706)	Oil-immersed cable connection assemblies for transformers and reactors having highest voltage for equipment Um from 72,5 kV to 550 kV - Part 2: Dry-type cable terminations
23	**CLC/TR 50453:2007/ corrigendum Dec. 2007** (pr=26124)	Evaluation of electromagnetic fields around power transformers
24	**CLC/TR 50453:2007** pr=16657)	Evaluation of electromagnetic fields around power transformers
25	**CLC/TR 50462:2008** (pr=15968)	Rules for the determination of uncertainties in the measurement of the losses on power transformers and reactors
26	**EN 50464-2-1:2007** (pr=14815)	Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2 500 kVA with highest voltage for equipment not exceeding 36 kV - Part 2-1: Distribution transformers with cable boxes on the high-voltage and/or low-voltage side - General requirements
27	**EN 50464-2-2:2007** (pr=14816)	Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2 500 kVA with highest voltage for equipment not exceeding 36 kV - Part 2-2: Distribution transformers with cable boxes on the high-voltage and / or low-voltage side - Cable boxes type 1 for use on distribution transformers meeting the requirements of EN 50464-2-1
28	**EN 50464-2-3:2007** (pr=14817)	Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2 500 kVA with highest voltage for equipment not exceeding 36 kV - Part 2-3: Distribution transformers with cable boxes on the high-voltage and / or low-voltage side - Cable boxes type 2 for use on distribution transformers meeting the requirements of EN 50464-2-1
29	**EN 50588-1:2017** (pr=64220)	Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV - Part 1: General requirements
30	**EN 50588-2:2018** (pr=65066)	Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV - Part 2: Transformers with cable boxes on the high-voltage and / or low-voltage side - General requirements for transformers with rated power less than or equal to 3 150 kVA
31	**EN 50588-3:2018** (pr=65067)	Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV - Part 3: Transformers with cable boxes on the high-voltage and / or low-voltage side - Cable boxes type 1 for use on transformers meeting the requirements of EN 50588-2
32	**EN 50588-4:2018** (pr=65069)	Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV - Part 4: Transformers with cable boxes on the high-voltage and / or low-voltage side - Cable boxes type 2 for use on transformers meeting the requirements of EN 50588-2
33	**EN 50629:2015** (pr=25005)	Energy performance of large power transformers (Um > 36 kV or Sr ≥ 40 MVA)
34	**EN 50629:2015/A1:2016** (pr=60895)	Energy performance of large power transformers (Um > 36 kV or Sr ≥ 40 MVA)
35	**EN 50629:2015/A2:2018** (pr=64553)	Energy performance of large power transformers (Um > 36 kV or Sr ≥ 40 MVA)
36	**EN 50708-1-1:2020** (pr=69509)	Power transformers - Additional European requirements: Part 1-1: Common part - General requirements

Serial No.	Standard Number	Title
37	**EN 50708-2-1:2020** (pr=69510)	Power transformers - Additional European requirements: Part 2-1 Medium power transformer - General requirements
38	**EN 50708-3-1:2020** (pr=69511)	Power transformers - Additional European requirements: Part 3-1 Large power transformer - General requirements
39	**EN 60076-1:2011** (pr=22467)	Power transformers - Part 1: General
40	**EN 60076-2:2011** (pr=22468)	Power transformers - Part 2: Temperature rise for liquid-immersed transformers
41	**EN 60076-3:2013** (pr=24097)	Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air
42	**EN 60076-3:2013/A1:2018** (pr=64726)	Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air
43	**EN 60076-4:2002** (pr=14207)	Power transformers - Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors
44	**EN 60076-5:2006** (pr=16426)	Power transformers - Part 5: Ability to withstand short-circuit
45	**EN 60076-6:2008** (pr=20669)	Power transformers - Part 6: Reactors
46	**EN 60076-10:2016** (pr=25043)	Power transformers - Part 10: Determination of sound levels
47	**EN IEC 60076-11:2018/ AC:2019-06** (pr=69410)	Power transformers - Part 11: Dry-type transformers
48	**EN 60076-11:2004** (pr=15242)	Power transformers - Part 11: Dry-type transformers
49	**EN IEC 60076-11:2018** (pr=63478)	Power transformers - Part 11: Dry-type transformers
50	**EN 60076-13:2006** (pr=16727)	Power transformers - Part 13: Self-protected liquid-filled transformers
51	**EN 60076-14:2013** (pr=24171)	Power transformers - Part 14: Liquid-immersed power transformers using high-temperature insulation materials
52	**EN 60076-16:2011** (pr=22613)	Power transformers - Part 16: Transformers for wind turbines applications
53	**EN 60076-18:2012** (pr=23523)	Power transformers - Part 18: Measurement of frequency response
54	**EN 60076-19:2015** (pr=58616)	Power transformers - Part 19: Rules for the determination of uncertainties in the measurement of the losses on power transformers and reactors
55	**EN IEC 60076-22-1:2019** (pr=63125)	Power transformers - Part 22-1: Power transformer and reactor fittings – Protective devices
56	**EN IEC 60076-22-2:2019** (pr=63126)	Power transformers - Part 22-2: Power transformer and reactor fittings - Removable radiators
57	**EN IEC 60076-22-3:2019** (pr=63127)	Power transformers - Part 22-3: Power transformer and reactor fittings - Insulating liquid to air heat exchangers
58	**EN IEC 60076-22-4:2019** (pr=63128)	Power transformers - Part 22-4: Power transformer and reactor fittings - Insulating liquid to water heat exchangers
59	**EN IEC 60076-22-7:2020** (pr=67592)	Power transformers - Part 22-7: Power transformer and reactor fittings - Accessories and fittings
60	**EN IEC 60076-24:2020** (pr=66214)	Power transformers - Part 24: Specification of voltage regulating distribution transformers (VRDT)
61	**EN 60214-1:2014** (pr=24779)	Tap-changers - Part 1: Performance requirements and test methods
62	**EN 61378-1:2011** (pr=22426)	Convertor transformers - Part 1: Transformers for industrial applications
63	**EN 61378-2:2001** (pr=13165)	Convertor transformers - Part 2: Transformers for HVDC applications

Pr = Project number

Table 2. EN Standards on Bushings

Serial No.	Standard Number	Title
1	**EN 50180-1-2015** (pr=23286)	Bushings above 1 KV to 52 kV 250A-3.15 kA for liquid filled transformers –Part 1: General requirements for bushings
2	**EN 50180-2-2015** (pr=25234)	Bushings above 1 KV to 52 kV 250A-3.15 kA for liquid filled transformers- Part 2: Requirements for bushing components
3	**EN 50180-3-2015** (pr=25235)	Bushings above 1 KV to 52 kV 250A-3.15 kA for liquid filled transformers- Part 3: Requirements for bushing fixations
4	**EN 50180-3:2015/A1:2017** (pr=61704)	Bushings above 1 KV to 52 kV 250A-3.15 kA for liquid filled transformers- Part 3: Requirements for bushing fixations
5	**EN 50181-2010** (pr=21119)	Plug-in-type bushings above 1 kV -52 kV 250A-2.5 kA for equipment other than liquid filled transformers
6	**EN 50243-2002** (pr=7135)	Outdoor bushings for 24 & 36 KV, 5kA & 8 kA
7	**EN 50299-2002**	Oil-immersed cable connection assemblies for transformers and reactors having voltage for equipment Um 72.5 kV – 550 kV
8	**EN 50336-2002** (pr=6219)	Bushings for transformer and reactor cable boxes not exceeding 36 kV
9	**EN 50386-2010** (pr=21708)	Bushings up to 1 kV and from 250 A to 5 kA, for liquid filled transformers
10	**EN 50386:2010/A1:2013** (pr=23287)	Bushings up to 1 kV and from 250 A to 5 kA, for liquid filled transformers
11	**EN 50387-2002** (pr=14940)	Bus bar Bushings up to 1 kV, 1.25 kA – 5 kA, for liquid filled transformers
12	**CLC/TS 50458:2006** (pr=3760)	Capacitance graded outdoor bushing 52 kV up to 420 kV for oil immersed transformers
13	**EN 50673:2019** (pr=63364)	Plug-in type bushings for 72,5 kV with 630 A and 1,250 A for electrical equipment
14	**EN 60137:2017/AC:2018-08** (pr=67231)	Insulated bushings for alternating voltages above 1,000 V
15	**EN 60137:2017** (pr=62435)	Insulated bushings for alternating voltages above 1,000 V
16	**EN IEC/IEEE 65700-19-03: 2018/AC:2019-03** (pr=69149)	Bushings for DC application
17	**EN IEC/IEEE 65700-19-03:2018** (pr=64163)	Bushings for DC application

***Note**: Standards having IEC number designation after EN are adopted from IEC by CENELEC without modification as per IEC/CENELEC agreement.*

Conclusion

Transformer engineers frequently refer to national standards during the selection, manufacture, operation and maintenance of transformers. It is hoped the list of National Standards on Power Transformers covered in this column will help engineers to appreciate the extent of standards available today for their work connected with transformers. Historical evolution of these standard bodies and BSI/CENELEC is covered till it reached present levels. With the march of Industrial Revolution 4.0, transformers will get connected with more and more new horizons like power electronics, artificial intelligence, machine learning, big data, sensors and digitalization. Power engineers working on standardization committees for transformers will have to reflect these new developments in future revisions of standards.

Bibliography

[1] S. Austin Stigant & H. Morgan Lacey, *The J & P Transformer Book*, Johnson & Philips, London, Edition 1, 1925

[2] S. Austin Stigant &H. Morgan Lacey, *The J & P Transformer Book*, Johnson & Philips, London, Edition 4, 1928

[3] http://www.cenelec.eu/index.html

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