PRODUCED BY THE OPERATIONS DIRECTORATE OF ENERGY NETWORKS ASSOCIATION

Technical Specification 35-2

Issue 6 2014

Emergency rated system transformers 66/20.5 kV, 66/11.5 kV and 33/11.5 kV delta/star and star/star connected

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PUBLISHING AND COPYRIGHT INFORMATION

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Issue 5 published, June, 2007.

Amendments since publication

Issue	Date	Amendment
Issue 6	December 2014	Major revision of Issue 5 to: (i) reflect significant changes made to three of the main standards referred to; IEC 60076-1, IEC 60076-2 and IEC 60076-3 (ii) expand the scope to include 66/20.5 kV and 66/11.5 kV transformers (iii) make changes to the temperature conditions for the CER ratings and (iv) amend and extend the testing requirements. This issue includes the following principal technical changes. *NOTE: To avoid confusion due to the extensive re-numbering of existing clauses and addition of new clauses, the Clause numbering below refers to this revised version, Issue 6. The Clause numbers of Issue 5 are given in brackets, where relevant.* 'Foreword' Clause updated to refer to IEC 60076-1:2011 and reference to ISO 9000 amended to ISO 9001:2008. Clause 1 (Issue 5 Clause 1.1): (i) Scope extended to add 66/20.5 kV and 66/11.5 kV transformers. (ii) Text added that the ONAN rating is, as a minimum, 50% of the continuous emergency rating (CER). (iii) Text added on the role of a CER transformer and how the ability to operate at its CER, allows emergency loading situations to be met in a cost-effective manner. (iv) Note added regarding the reduction to the 40 year life expectancy requirement when operating at Continuous Emergency Rating.

		Clause 4.2 (Issue 5 Clause 1.2.1): Ambient temperature requirement for CER amended to be 5 °C unless otherwise specified in the Schedule of Requirements. Clause 5.1.1 (Issue 5 Clause 4.1): Requirements retained with the following amendments: (i) Cross-reference to paragraphs in Clause 5.1.1 of IEC 60076-1:2011 amended to reflect additional paragraphs in IEC 60076-1. (ii) Scope extended to include 20.5 kV secondary voltage transformers. (iii) Ambient temperature requirement amended to be 5 °C to or the value specified in the Schedule of Requirements. (iv) Table 1; • Addition of ratings for a 15 MVA (ONAN)/30 MVA (CER) transformer. • Final column 'Switchgear nominal rated current' and footnote deleted. • Added sub-columns under 'Emergency rated secondary current' to give current ratings at both 11.5 kV and 20.5 kV. (v) Statement of voltage ratio at no-load on the principal tap extended to be 66 000/20 500, 66 000/11 500 or 33 000/11 500 V. Clause 5.1.2 (Issue 5 Clause 4.3): Requirements retained with the requirements from Issue 5 Clause 4.2 added. Clause 5.1.3: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2, with the requirement that the ONAN rating power shall comply with Table 1 of TS 35-2. Clause 5.1.4: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. No specific requirements included in TS 35-2 regarding loading beyond rated power but IEC 60076-1:2011 allows a purchaser to specify additions, if required. Issue 5 Clauses 4.2 and 4.3 deleted as these clause numbers not included in IEC 60076-1:2011. • The requirements of 4.2 are included in Clause 5.1.2. • The requirements of 4.3 are included in Clause 5.1.2. Clause 5.2: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. The required cooling medium to be air unless otherwise agreed. Clause 5.3 (Issue 5 Clause 8.3): No change to the requirements. Clause 5.4.1: Additional Clause in IEC 60076-1:2011 and to apply to TS 35-2, requiring the purchaser to specify requirements. Clause 5.4.2: Additional Clause in IEC 60076-1:2011 and to apply to TS 35-2, requiring the purchaser to specify requirements. Clause 5.4.3 (Issue 5 Clause 4.4): Requirements retained with added text to specify the disturbed frequency conditions to be used for determining the maximum flux density in the core and other magnetic components. Reworded to clarify performance requirements for low frequency events as required by the Grid Code and Distribution Code of GB. Clause 5.5: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. No specific requirements included in TS 35-2 but IEC 60076-1:2011 allows a purchaser to specify additional provisions, if required. Clauses 5.6: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. No specific requirements included in TS 35-2 but IEC 60076-1:2011 allows a purchaser to specify alternative dielectric test levels, if required. Clauses 5.7: An additional Clause in IEC 60076-1:2011 and all sub-clauses to apply to TS 35-2. No specific requirements included in TS 35-2. IEC 60076-1:2011 allows a purchaser to specify specific requirements for transformer classification, winding connection and number of phases, sound level and transport.

		Clauses 5.8: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. The Clause specifies that components and materials used in transformer shall comply with relevant IEC standards. Clause 6.4 (Issue 5 Clause 5.4): (i) Additional requirement that the specified category of voltage variation shall remain valid for reverse power flow through the tappings. (ii) Addition of a third tapping range: c) ±16 x 0.625% (±10% in 32 steps). (iii) Amendment that the tapping range can be specified by the purchaser to be different from the values in the document. Clause 6.5 (Issue 5 Clause 5.5): Addition to Figure 1 of impedance graphs specifying limits for 15/30 MVA transformers for both Type A and Type B. Clause 6.6 (Issue 5 Clause 5.6): Following requirements added. (i) Transformers to satisfy the ecodesign requirements of EU Directive 2009/125/EC. (ii) Maximum values of load losses and no-load losses or the Peak Efficiency Index (PEI) for the equivalent CMR rating to comply with values for Tier 1 stated in Annex I of the Ecodesign Regulations (EU) No 548/201. (iii) Manufacturer to state whether the transformer meets values for Tier 2 and, if not, to provide an explanation for the non-compliance. (iv) Manufacturer to provide the necessary information for the purchaser to evaluate losses using a capitalisation approach. Clause 7 (Issue 5 Clause 6): Requirement that stabilised windings are not required on star-star transformers amended to state that stabilised windings are to be provided unless otherwise specified in the Schedule of Requirements. Clause 8.2 (Issue 5 Clause 7.1): Addition to requirements of information on rating plate to provide: • CER rating at the ambient temperature specified in the Schedule of Requirements. • ONAN rating plus ambient temperature at which rating applies. • CMR rating plus ambient temperature at which rating applies. • The nominal tap position. Clause 9.1.1: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. This requires manufacturers to consider the effective containment of the liquid and take effective measures to prevent leakage. Clause 9.1.2: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. This requires manufacturers to consider the safety of operators and maintenance staff with a list of particular aspects. Clause 9.3 (Issue 5 Clause 8.2): Title amended to be 'Liquid preservation system' to match IEC 60076-1:2011. Issue 5 Clause 8.3 deleted. Requirements are included in Clause 5.3. Clause 9.4: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. The level of d.c. currents to be stated in the Schedule of Requirements, as applicable. Clause 9.5: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. This requires manufacturers to mark the centre of gravity of the transformer in the transport configuration. Clause 11.1.1 (Issue 5 Clause 10.1): (i) Scope of U_m extended to include 20 kV and 66 kV.

		(ii) Data for 1 kV, 7.2 kV, 20 kV and 66 kV added to Table 2. (iii) Rated lightning impulse voltage value in Table 2 for Um =12 kV amended to be 75 or 95 kV. Clause 11.1.2.1 (Issue 5 Clause 10.1.1): (i) Additions to the routine tests in IEC 60076-1:2011 to apply to TS 35-2. (ii) Nomenclature of the dielectric tests amended to match the revised nomenclature of IEC 60076-1:2011. (iii) Lightning impulse chopped on the tail (LIC) included as a Routine test to apply at all voltage levels. (iv) Explicit requirement for 'Pressure test' deleted as it has been added as a Routine test in IEC 60076-1:2011. Note added that the IEC test to be in accordance with Clause 11.8 of TS 35-2. (v) Requirement added to carry out DGA testing of oil samples. (vi) Requirement added to carry out vacuum tightness test for transformers to be vacuum filled at site. (vii) Requirement added for 'Winding insulation resistance measurements' to be Routine tests. Clause 11.1.3 (Issue 5 Clause 10.1.2): Addition of 4 type tests. • Vacuum deflection test. • Pressure deflection test. • Measurement of the power taken by the fan and liquid pump motors. • Measurement of no-loss loss and current at 90% and 110% of rated load. Clause 11.2 (Issue 5 Clause 10.2): Added requirement that resistance to be measured on all tap positions. (Issue 5) Clause 10.6 deleted as this requirement has been removed from IEC 60067-1. The requirement retained in TS 35-2 as Clause 11.16. Clause 11.4 (Issue 5 Clause 10.4): Note added that values of load losses (or the Peak Efficiency Index) are required to satisfy the ecodesign requirements of EU Directive 2009/125/EC. Clause 11.5 (Issue 5 Clause 10.4): Note added that values of no-load losses are required to satisfy the ecodesign requirements of EU Directive 2009/125/EC. Clause 11.6 (Issue 5 Clause 10.7) Table 3: (i) Data for 30 MVA transformer added. (ii) Zero phase sequence impedance entry for 40 MVA amended from "3 to 6" to "3 to 8" (ohms/phase). Clause 11.8 (Issue 5 Clause 10.11): Amended to state that the requirements of IEC 60076-1:2011 Clause 11.8 shall apply. The requirement that the tightness test shall be completed before any electrical tests has been retained. Clause 11.9: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. Defines the vacuum deflection test procedures. Clause 11.10: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. Defines the pressure deflection test procedures. Clause 11.11: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. Defines the vacuum tightness test procedures. Clause 11.12: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2. Defines the check of core and frame insulation test procedures. Clause 11.14 (Issue 5 Clause 10.10): Data for 30 MVA transformer added to Table 4. Issue 5 Clause 10.11 deleted and replaced by IEC 60076-1 Clause 11.8.

		Clause 11.15 (Issue 5 Clause 10.12): Requirement added that FRA testing to be carried out in accordance IEC 60076-18 and a report of FRA tests shall be supplied to the purchaser. Clause 11.16 (Issue 5 Clause 10.6): 'HV winding' replaces '33 kV winding'. Clause 11.17: Additional Clause requiring insulation resistance measurements on each winding with respect to all other windings and earthed metal. Clause 11.18 (Issue 5 Clause 10.13): Addition of 5 test requirements. • Core to frame and earth test. • Vector Group and ratio check. • Pressure release valve switch operation check. • Current transformer polarity and ratio check. • Verification of magnetising characteristics of current transformers. Clause 13: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-2, when specified in Schedule of Requirements. Clause 14.4.1 (Issue 5 Clause 12.4.1): Additional requirement for separate cooler bank to include provision for two main substation earth connections on diametrically opposite ends of structural steelwork. Clause 14.4.2 (Issue 5 Clause 12.4.2): Additional requirements for the anti-vibration mountings. Clause 14.6: Additional Clause giving requirements for the short-circuit withstand ability of transformers. Clause 15.1.1 (Issue 5 Clause 13.1): Additional requirements: (i) For fittings and facilities to allow transportation of transformers. (ii) Design of the tanks and accessories. (iii) For cases where work at height is unavoidable. References to BS 1129 and BS EN 131 added to the 'Normative references' Clause. Clause 15.1.2: Additional requirement to require facilities for lifting the cover. Clause 15.1.4: Additional Clause with requirements for provision of earth connections to the tank. Clause 15.1.5: Additional Clause with requirements for sound attenuation enclosures. Clause 15.3 (Issue 5 Clause 13.3): (i) Additional requirement for 66 kV cable connected transformers. (ii) 'HV winding' replaces '33 kV winding'. (iii) Reference for clearances to enable cable testing revised to be BS 6622 or IEC 60840 as BS 6480 has been withdrawn. Clause 15.3.1: (i) Additional Clause giving details and requirement for cable boxes. (ii) Deleted requirements for 'oil-filled' and 'compound filled' cable boxes. New Table 6 added to specify disconnecting chamber withstand voltages and added requirements for the transformer terminals and cable terminals within the disconnecting chamber to be capable of withstanding the voltages in Table 6. Clause 15.3.2: (i) Additional Clause to giving details and requirement for outdoor bushings.

		(ii) Values of 'Air end creepage distance' in Table 8 (re-numbered Table 8) aligned with ENA TS 35-3. Clause 15.3.3: Additional Clause to giving requirement for plug-in separable connectors. Clause 15.3.4 (Issue 5 Clause 13.3.1): (i) Option I) 'A three-pole single gland compound filled box (15 and 24 MVA transformers only)' deleted. (ii) Option v) Amended requirement for 'separable connectors' to be 'plug-in separable connectors'. (iii) Option added to require supply of 'co-ordinating gaps' when specified in the Schedule of Requirements. Table 8 added of data for gap settings. (iv) Addition of an option to provide cable disconnecting links, as per Clause 15.3.1. (v) Data for 24 kV and 72.5 kV transformers added to Table 5 (re-numbered Table 8). (vi) Data for 24 kV transformers added to Table 8. (vii) Title of 1st Column of Tables 5 (now 7) & 6 amended to 'Highest voltage for equipment (kV)' from 'Voltage (kV)'. Clause 15.3.5 (Issue 5 Clause 13.3.2): (i) Scope increased to include 66 kV transformers. (ii) Additional requirement for provision of the HV neutral point to be provided with an accessible isolatable link to allow testing, where specified in the Schedule of Requirements. Clause 15.3.6 (Issue 5 Clause 13.3.3): (i) Option of single pole cable box suitable for compound filling deleted. (ii) Additional requirement for provision of cable disconnecting links to be provided, where specified in the Schedule of Requirements. Clause 15.3.7 (Issue 5 Clause 13.3.4): Additional requirement for provision of an accessible isolatable link to allow testing to be provided, where specified in the Schedule of Requirements. Clause 15.3.8 (Issue 5 Clause 13.3.5): (i) Title amended to be 'Earthing/auxiliary transformer'. (ii) Scope increased to include an additional flange to BS 2562 facing ''J' for 20 kV transformers. (iii) Earthing transformers to be in accordance with ENA TS 35-1 and BS EN 60076-6. (iv) Requirements added of the electrical requirements and connection details of auxiliary transformers. Clause 15.4 (Issue 5 Clause 13.4): Requirement added that the tap-changer shall be fully rated for bi-directional power flow. Clause 15.4.1 (Issue 5 Clause 13.4.1): Additional requirements: (i) For the mounting height and/or provision of an operating platform. (ii) For provision to allow interfacing to control systems and for remote tap position indication. Clause 15.4.2 (Issue 5 Clause 13.4.2): Requirement added that the oil actuated relay shall operate in the event of loss of oil from the system. Clause 15.5 (Issue 5 Clause 13.5): (i) Data of safety clearances from fixed access points or ground level to live metal added to cover 72.5 kV transformers. (ii) Data for 24 kV and 72.5 kV transformers added to Table 8

		(renumbered Table 10). Clause 15.6.1 Conservator (Issue 5 Clause 13.5): Added option for a low oil level alarm, to be specified in the Schedule of Requirements. Clause 15.6.2 (Issue 5 Clause 13.6.2): Requirements for the cooling plant expanded giving additional detail. Clause 15.6.3 (Issue 5 Clause 13.6.3): The Gas-and-oil actuated relay to operate in the event of loss of oil from the system. Clause 15.6.4 (Issue 5 Clause 13.6.4): Additional requirements for the pressure relief device to have a sealed, weatherproof switch to provide alarm/trip functions. Clause 15.6.5 (Issue 5 Clause 13.6.5): Following requirements added. (i) Details for the oil-tight pockets for accommodating the temperature sensors. (ii) For the accuracy of the set point operation and the temperature indication. (iii) Option of an electronic WTI not requiring a thermal gradient boost heater with example wiring diagram (new Figure 4b). (iv) Added option for fitment of a fibre optic sensor, to be specified in the Schedule of Requirements. (v) To provide a certificate of the operating characteristics of the WTI device. Clause 15.6.6 (Issue 5 Clause 13.6.6): Following requirements added. (i) Current transformers to be located to minimise errors. (ii) Where specified, current transformer accommodation to be provided in the HV terminals in accordance the dimensions in the new Table 12. (iii) Where specified, current transformer to be supplied to meet IEC 60044-1. Clause 15.6.8 (Issue 5 Clause 13.6.8): (i) Requirements added of the type and positioning of valves supplied. (ii) Removed specific reference to ‘butterfly’ valves. (iii) Requirement added that valves to meet the operating requirements in Clause 6 of BS EN 50126-8. Manufacturer to state the valve type and relevant BS Standard conformance in the Self-Certification Conformance Declaration. Clause 15.9: Additional Clause giving requirements. (i) For the earthing of the magnetic circuit and the clamping structure of transformers. (ii) That the magnetic circuit arrangement shall minimise mechanical vibration and its transmission to the tank. Clause 15.10: Additional Clause giving requirements. (i) For the core and winding assemblies, and all other internal parts, to be firmly located within the tank and capable of withstanding shocks. (ii) Permitting the fitting of voltage limiting devices to any windings or connections within the transformer main tank only with the written agreement of the purchaser. Clause 15.11: Additional Clause giving requirements for padlocks. The text moved from Clause 15.6.8, with the requirements unchanged. Clause 15.12: Additional Clause requiring transformers to be designed to facilitate the simple retrofit of external industry standard condition monitoring equipment if required in the future. Clause 15.13: An additional Clause to require any LV switchgear supplied as part of an auxiliary transformer and/or the protection/control equipment

		to meet the requirements of IEC 60947, ENA TS 37-1, ENA TS 37-2, ENA TS 50-18 & ENA TS 50-19. Clause 16.1 (Issue 5 Clause 14.1): Requirement added to supply drawings of the foundation plan and combined general arrangement and schematic of the oil flow, valve locations and valve functions, where applicable. Clause 16.2 (Issue 5 Clause 14.2): Requirements added to supply a comprehensive set of instructions and other documentation to be provided. Figure 1: Addition of impedance envelopes for 15/30 MVA transformer. Figure 2: Amendments to cover 15/30 MVA transformer. Figure 3: Amendments to cover 20 kV auxiliary transformers. Figure 4: (i) Amendments to show option of a changeover switch as an alternative arrangement to links (Figure 4a). (ii) Figure 4b added, showing example wiring for an electronic WTI not requiring a thermal gradient boost heater. Annex A (Issue 5 Appendix 1): Schedule of Requirements updated to reflect the changes made to the requirement in the main body of TS 35-2. Annex B (Issue 5 Appendix 2): Clause by clause conformance statements updated to reflect the changes made to the requirement in the main body of TS 35-2. Bibliography Clause added: 5 references previously in the 'Normative references' listed here. These documents provide additional information useful to users of TS 35-2 but not explicitly referenced in it. Details of all other technical, general and editorial amendments are included in the associated Document Amendment Summary for this Issue (available on request from the Operations Directorate of ENA).

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Foreword

This Technical Specification (TS) is published by the Energy Networks Association (ENA) and comes into effect from the date of publication. It has been prepared under the authority of the ENA Engineering Policy and Standards Manager and has been approved for publication by the ENA Electricity Networks and Futures Group (ENFG). The approved abbreviated title of this engineering document is “ENA TS 35-2”.

This document replaces and supersedes Technical Specification 35-2 Issue 5 2007.

This Technical Specification has been prepared by the Energy Networks Association.

Transformers covered by this Technical Specification shall comply with the International and British Standards listed. This Technical Specification amplifies and/or clarifies the requirements of IEC 60076 where alternative arrangements are permitted and where additional information is required. The Technical Specification shall be read, therefore, in conjunction with IEC 60076-1.

The clause numbering of this Technical Specification to the second level is in accordance with IEC 60076-1, with clauses added of information or requirements required for the transformers covered by this Technical Specification that is not provided by IEC 60076-1. The document structure has been designed to mirror that of IEC 60076-1 (Issued 2011). All references to IEC 60076-1 shall be to the year 2011 issue only.

Annex B of the document includes ‘Self-Certification Conformance Declaration’ sheets to enable manufacturers to declare conformance or otherwise, clause by clause, with the relevant parts of the document. Manufacturers are also requested to provide supporting information by completing the additional schedules detailed in Annexes C and D of this document.

Quality assurance

Quality assurance schemes shall be in accordance with ISO 9001:2008 Quality Management Systems - Requirements.

1 Scope

This Specification covers the technical requirements for three-phase, oil-immersed, 66/20.5 kV, 66/11.5 kV and 33/11.5 kV, 50 Hz, emergency rated system transformers for use on systems having the 11.5 kV or 20.5 kV neutral earthed directly or through resistance or reactance at one or more points. The design shall be such that the ONAN rating of the transformer is, as a minimum, 50% of the continuous emergency rating (CER). The normal usage envisaged for these transformers is for two units operating in parallel. The life expectancy of the transformers shall be not less than 40 years, and the choice of components and accessories shall not limit the life expectancy.

The CER rating of both units is identical, where one unit is capable of supplying the total maximum demand during an outage of the other unit. Under this emergency loading condition the winding temperature and top oil temperature of the in-service unit will remain within upper limits specified in this document for an ambient temperature not exceeding +5 °C; this will result in accelerated loss of life but no permanent damage to the unit. The intention is that any loss of life that takes place during emergency loading conditions will be compensated by any extension of life that results when both transformers are in service sharing the load. CER transformers are distinct from continuous maximum rated (CMR) transformers, which are designed for continuous operation at their maximum rating with no loss of life.

NOTE: it is understood that the 40 year life expectancy requirement applies when operation is within the limits of IEC 60076, oil is maintained in accordance with IEC 60422 and the transformer and its components are maintained in accordance with the manufacturer's recommendations. It is acknowledged in Clause 3.1.1 that when operating at the Continuous Emergency Rating, loss of life will be accelerated and so reduce the overall life expectancy of the transformer, dependent on the extent of operation at the Continuous Emergency Rating.

2 Normative references

The following referenced documents, in whole or part, are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

Clause 2 of IEC 60076-1:2011 is applicable, along with the following additions:

IEC 60044-1: 1999, *Instrument transformers. Current transformers*

IEC 60076-1:2011, *Power transformers, Part 1: General*

IEC 60076-2:2011, *Power transformers, Part 2: Temperature rise*

IEC 60076-3:2013, *Power transformers, Part 3: Insulation levels, dielectric tests and clearances in air*

IEC 60076-5:2006, *Power transformers, Part 5: Ability to withstand short-circuit*

IEC 60076-6:2007, *Reactors*

IEC 60076-7:2005, *Power transformers, Part 7: Loading guide for oil-immersed power transformers*

IEC 60076-10:2001, *Power transformers, Part 10: Determination of sound level*

IEC 60076-10-1:2005, *Power transformers, Part 10: Determination of sound level – Application guide*

IEC 60076-18:2012, *Power transformers. Measurement of frequency response*

IEC 60137:2008, *Insulated bushings for alternating voltages above 1000V*

IEC 60214-1:2003, *Tap-changers – Part 1: Performance requirements and test methods*

IEC 60214-2:2004, *Tap-changers – Part 2: Application guide*

IEC 60296:2012, *Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear*

IEC 60529:1989, *Specification for degrees of protection provided by enclosures (IP code)*

IEC 60616:1978, *Terminal and tapping markings for power transformers*

IEC 62271-1:2007, *High-voltage switchgear and controlgear - Part 1: Common specifications*

IEC/TS 60815-1:2008, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles*

IEC/TS 60815-2:2008, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 2: Ceramic and glass insulators for a.c. systems*

IEC/TS 60815-3:2008, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 3: Polymer insulators for a.c. systems*

IEC 60840:2011, *Power cables with extruded insulation and their accessories for rated voltages above 30kV up to 150kV - Test methods and requirements*

IEC 60947-1:2011, *Low-voltage switchgear and control gear - Part 1: General rules*

IEC 60947-2:2003, *Low-voltage switchgear and control gear - Part 2: Circuit-breakers*

IEC 60947-3:2008, *Low-voltage switchgear and control gear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

ISO 9001:2008, *Quality management systems - requirements*

BS EN 131-1:2007+A1:2011, *Ladders. Terms, types, functional sizes*

BS EN 593:2009+A1:2011, *Industrial valves. Metallic butterfly valves*

BS EN 50216-1:2002, *Power transformer and reactor fittings – General*

BS EN 50216-2:2002, *Power transformer and reactor fittings – Gas and oil actuated relay for liquid immersed transformers and reactors with conservator*

BS EN 50216-3: 2002, *Power transformer and reactor fittings – Protective relay for hermetically sealed liquid immersed transformers and reactors without gaseous cushion*

BS EN 50216-4:2002, *Power transformer and reactor fittings – Basic accessories (earthing terminal, drain and filling devices, thermometer pocket, wheel assembly)*

BS EN 50216-5:2002, *Power transformer and reactor fittings. Liquid level, pressure and flow indicators, pressure relief devices and dehydrating breathers*

BS EN 50216-6:2002, *Power transformer and reactor fittings –Cooling equipment – Removable radiators for oil-immersed transformers*

BS EN 50216-7:2002, *Power transformer and reactor fittings – Electric pumps for transformer oil*

BS EN 50216-8:2005+A1:2007, *Power transformer and reactor fittings – Butterfly valves for insulating liquid circuits*

BS EN ISO 780:1999, *Packaging. Pictorial marking for handling of goods*

BS EN ISO 14122:2010, (All Parts) *Safety of machinery. Permanent means of access to machinery*

EN ISO 12944 -2:1998, *Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments*

BS 1129:1990, *Specification for portable timber ladders, steps, trestles and lightweight stagings*

BS 2562:1979, *Specification for cable boxes for transformers and reactors*

BS 6622:2007, *Electric cables. Armoured cables with thermosetting insulation for rated voltages from 3.8/6.6 kV to 19/33 kV. Requirements and test methods*

BS 7354: 1990, *Code of practice for design of high-voltage open-terminal stations*[1]

Other publications

[N1] The Working at Height Regulations 2005

[N2] DIRECTIVE 2009/125/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a framework for the setting of ecodesign requirements for energy-related products

[N3] COMMISSION REGULATION (EU) No 548/201 on implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers

[N4] ENA TS 12-11, *Dry cable terminations in HV switchgear for service at rated voltages 12, 24 and 36 kV*

[N5] ENA TS 37-1, *400 V a.c. switchgear, controlgear and fusegear assemblies*

[N6] ENA TS 37-2, *Substation cable distribution boards*

[N7] ENA TS 50-18, *Application of auxiliary electrical equipment*

[N8] ENA TS 50-19, *Standard numbering for small wiring (for switchgear and transformers together with their associated relay panels)*

[N9] ENA TS 98-1, *Environmental classification and corrosion protection of structures, plant and equipment*

NOTE: This document was under review at the time of publication of ENA TS 35-2.

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1 Although BS 7354 has been withdrawn, the information on phase-to-phase clearances given in it is remains relevant for Table 9 of this specification.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 General

The definitions as described in IEC 60076-1 Clause 3.1 shall apply.

3.1.1 Continuous Emergency Rating (CER)

The continuous emergency rating of these transformers is the rating at which the transformer can operate on a continuous load within the specified temperature limitations as detailed in Clause 5.1 of this Specification. It is accepted that at this CER rating, loss of life will be significantly accelerated, but it is also expected that the transformer will be required to run at its CER for only a small proportion of its whole operating life. Operation overall should not therefore seriously reduce the life of the transformer.

3.2 Terminals and neutral point

The definitions as described in IEC 60076-1 Clause 3.2 and all sub-clauses shall apply.

3.3 Windings

The definitions as described in IEC 60076-1 Clause 3.3 and all sub-clauses shall apply.

3.4 Rating

The definitions as described in IEC 60076-1 Clause 3.4 and all sub-clauses shall apply.

3.5 Tappings

The definitions as described in IEC 60076-1 Clause 3.5 and all sub-clauses shall apply.

3.6 Losses and no-load current

The definitions as described in IEC 60076-1 Clause 3.6 and all sub-clauses apply.

3.7 Short-circuit impedance and voltage drop

The definitions as described in IEC 60076-1 Clause 3.7 and all sub-clauses apply.

3.8 Temperature rise

The definitions as described in IEC 60076-1 Clause 3.8 apply.

3.9 Insulation

The definitions as described in IEC 60076-1 Clause 3.9 apply.

3.10 Connections

The definitions as described in IEC 60076-1 Clause 3.10 and all sub-clauses apply.

3.11 Test classification

The definitions as described in IEC 60076-1 Clause 3.11 and all sub-clauses apply.

3.12 Meteorological data with respect to cooling

The definitions as described in IEC 60076-1 Clause 3.12 and all sub-clauses apply.

4 Service conditions

4.1 General

The general requirements of IEC 60076-1 Clause 4.1 shall apply.