



Technical Specification 35-3

Issue 2 2014

Continuous Maximum Rated (CMR) system transformers (for use on systems up to and including 132 kV)

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Issue 1 published, January, 2009.

Amendments since publication

| Issue | Date | Amendment |
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| Issue 2 | December, 2014 | <p>Minor revision of Issue 5 to reflect significant changes made to three of the main standards referred to; IEC 60076-1, IEC 60076-2 and IEC 60076-3.</p> <p>This issue includes the following principal technical changes.</p> <p><i>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.</i></p> <p>'Foreword' Clause updated to refer to IEC 60076-1:2011 and the 2008 version of ISO 9001.</p> <p>Clause 4.2 (Issue 5 Clause 1.2): No change to the requirements.</p> <p>Clause 5.1.2 (Issue 5 Clause 4.3): Requirement added to supply of graphs of ONAN rating and CMR vs. Ambient Temperature. Values added to Table 1 of rated power values for 66/20 kV and 132/20 kV transformers.</p> <p>Clause 5.1.3: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3.</p> <p>Clause 5.1.4: An additional Clause in IEC 60076-1:2011, requirements of Issue 5 Clause 4.2 included here.</p> <p>(Issue 5) Clauses 4.2 and 4.3 deleted and the requirements moved to other clauses, as follows:</p> <ul style="list-style-type: none">• The requirements of (Issue 5) 4.2 are included in Clause 5.1.4.• The requirements of (Issue 5) 4.3 are included in Clause 5.1.2. <p>Clause 5.2: An additional Clause in IEC 60076-1:2011 and to apply to TS</p> |

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| | | <p>35-3. The required cooling medium to be air unless otherwise agreed.</p> <p>Clause 5.3 (Issue 5 Clause 8.3): No change to the requirements.</p> <p>Clause 5.4.1: Additional Clause in IEC 60076-1:2011 and to apply to TS 35-3, requiring the purchaser to specify required rated voltage.</p> <p>5.4.2: Additional Clause in IEC 60076-1:2011 and to apply to TS 35-3, requiring the purchaser to specify required rated frequency.</p> <p>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.</p> <p>Clause 5.5: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3. No specific requirements included in TS 35-3 but IEC 60076-1:2011 allows a purchaser to specify additional provisions, if required.</p> <p>Clause 5.6: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3. No specific requirements included in TS 35-3 but IEC 60076-1:2011 allows a purchaser to specify additional provisions, if required.</p> <p>Clause 5.7: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3. No specific requirements included in TS 35-3 but IEC 60076-1:2011 allows a purchaser to specify additional provisions, if required.</p> <p>Clauses 5.8: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3. The Clause specifies that components and materials used in transformer shall comply with relevant IEC standards.</p> <p>Clause 6.3 (Issue 5 Clause 5.3): Addition of requirement that criteria shall remain valid for reverse power flow through the tapplings.</p> <p>Clause 6.6 (Issue 5 Clause 5.6): Following requirements added.</p> <p>(i) Transformers to satisfy the ecodesign requirements of EU Directive 2009/125/EC.</p> <p>(ii) Maximum values of load losses and no-load losses or the Peak Efficiency Index (PEI) for the ONAN rating to comply with values for Tier 1 stated in Annex I of the Ecodesign Regulations (EU) No 548/201.</p> <p>(iii) Manufacturer to state whether the transformer meets values for Tier 2 and if not, to provide an explanation for the non-compliance.</p> <p>(iv) Manufacturer to provide the necessary information for the purchaser to evaluate losses using a capitalisation approach.</p> <p>Clause 7 (Issue 5 Clause 6): Requirement added that stabilised windings are to be provided on star-star transformers unless otherwise specified in the Schedule of Requirements.</p> <p>Clause 9.1.1: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3. This requires manufacturers to consider the effective containment of the liquid and take effective measures to prevent leakage.</p> <p>Clause 9.1.2: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3. This requires manufacturers to consider the safety of operators and maintenance staff with a list of particular aspects.</p> <p>(Issue 5) Clauses 8.3: The requirements are included in Clause 5.3.</p> <p>Clause 9.4: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3. The level of d.c. currents to be stated in the Schedule of Requirements, as applicable.</p> <p>Clause 9.5: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3.</p> <p>Clause 11.1.1 (Issue 5 Clause 10.1):</p> <p>(i) Rated lightning impulse voltage value in Table 2 for $U_m = 12$ kV amended to be 75 or 95 kV.</p> <p>(ii) Requirement added that copies of type test results to be made available where requested.</p> |
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| | | <p>Clause 11.1.2.1 (Issue 5 Clause 10.1.1):</p> <p>(i) The additions to routine tests in IEC 60076-1:2011 to apply to TS 35-3.</p> <p>(ii) Nomenclature of the dielectric tests amended to match the revised nomenclature of IEC 60076-1:2011.</p> <p>(iii) 'Lightning impulse chopped on the tail (LIC)' included as a Routine test for all voltage levels.</p> <p>(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 35-3.</p> <p>(v) Requirement added to carry out DGA testing of oil samples.</p> <p>(vi) Requirement added to carry out vacuum tightness test for transformers to be vacuum filled at site.</p> <p>(vii) Requirement added for 'Winding insulation resistance measurements' to be Routine tests.</p> <p>Clause 11.1.2.2: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3, listing additional tests to be performed on for transformers with $U_m > 72.5$ kV.</p> <p>Clause 11.1.3 (Issue 5 Clause 10.1.2): Addition of 3 test requirements that have been added to IEC 60076-1:2011.</p> <ul style="list-style-type: none"> • Measurement of the power taken by the fan and liquid pump motors. • Measurement of no-load loss and current. • Measurement of sound pressure levels at rated continuous maximum power with all relevant cooling in operation. <p>(Issue 5) Clause 10.6 deleted as this requirement has been removed from IEC 60067-1. The requirement retained in TS 35-3 as Clause 11.16.</p> <p>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.</p> <p>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.</p> <p>Clause 11.8 (Issue 5 Clause 10.11): Amended to state that the requirements of IEC 60076-1:2011 Clause 11.8 shall apply with the added requirement that the tightness test shall be completed before any electrical tests has been retained.</p> <p>Clause 11.9: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3. Defines the test procedures. Part replaces (Issue 5) Clause 10.16 'Vacuum test', which has been deleted. Table 6 of (Issue 5) inserted here as Table 4.</p> <p>Clause 11.10: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3. Defines the test procedures. Replaces (Issue 5) Clause 10.11 'Pressure test', which has been deleted.</p> <p>Clause 11.11: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3. Defines the test procedures. Part replaces (Issue 5) Clause 10.16 'Vacuum test', which has been deleted.</p> <p>Clause 11.12: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3.</p> <p>Clause 11.15 (Issue 5 Clause 10.12): Requirement added FRA testing to be carried out in accordance IEC 60076-18 and that a report of FRA tests shall be supplied to the purchaser.</p> <p>Clause 11.18 (Issue 5 Clause 10.15): Additional test requirement to check voltage control equipment.</p> <p>(Issue 5) Clause 10.16 deleted, as this requirement is covered by Clauses 11.9 and 11.11, except for Table 6 which has been retained in</p> |
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| | <p>Clause 11.9 as Table 4.</p> <p>Clause 13: An additional Clause in IEC 60076-1:2011 and to apply to TS 35-3, when specified in Schedule of Requirements.</p> <p>Clause 14.2 (Issue 5 Clause 12.2): Additional requirements that oil used shall be demonstrated to be free from any corrosive sulphur.</p> <p>Clause 14.4.2 (Issue 5 Clause 12.4): Additional requirements for the anti-vibration mountings.</p> <p>Clause 15.1.1 (Issue 5 Clause 13.1): Additional requirements for cases where work at height is unavoidable. References to BS 1129 and/or BS EN 131 in this Clause added to the 'Normative references' Clause.</p> <p>Clause 15.1.2 (Issue 5 Clause 13.1.2): Additional requirements when re-using gaskets.</p> <p>Clause 15.1.4: Additional Clause with requirements for provision of earth connections to the tank.</p> <p>Clause 15.1.5: Additional Clause with requirements for sound attenuation enclosures.</p> <p>Clause 15.3 (Issue 5 Clause 13.3): Additional requirements for provision of capacitor tap for neutral voltage displacement protection purposes when specified by purchaser.</p> <p>Clause 15.3.1 (Issue 5 Clause 13.3.1): Additional requirement.</p> <p>(i) Reference for clearances to enable cable testing revised to be BS 6622 or IEC 60840 as BS 6480 has been withdrawn.</p> <p>(ii) Requirements added for phase markings on cable box.</p> <p>New Table 7 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 7.</p> <p>Clause 15.3.2 (Issue 5 Clause 13.3.3):</p> <p>(i) Title of 1st Column of Tables 8 & 9 amended to 'Highest voltage for equipment (kV)' from 'Voltage (kV)'.</p> <p>(ii) Amended requirement that bushings to be to pollution Site severity class d (heavy) as per the latest IEC 60815-2 to replace pollution level III.</p> <p>Clause 15.3.3: Additional Clause to giving requirement for plug-in separable connectors.</p> <p>Clause 15.3.4: Additional Clause giving requirements for HV terminals.</p> <p>Clause 15.3.5: Additional Clause giving requirements for HV neutral terminals.</p> <p>Clause 15.3.6: Additional Clause giving requirements for LV terminations.</p> <p>Clause 15.3.7: Additional Clause giving requirements for LV neutral terminals.</p> <p>Clause 15.3.8 (Issue 5 Clause 13.3.4):</p> <p>(i) Title amended to be 'Earthing/auxiliary transformer'.</p> <p>(ii) Scope increased to include an additional flange to BS 2562 facing 'J' for 20 kV transformers.</p> <p>(iii) Earthing transformers to be in accordance with ENA TS 35-1 and BS EN 60076-6.</p> <p>(iv) Requirements added of electrical requirements and the connection details of auxiliary transformer.</p> <p>Clause 15.4 (Issue 5 Clause 13.4): Requirement added that the tap-changer shall be fully rated for bi-directional power flow.</p> <p>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.</p> <p>Clause 15.6.3 (Issue 5 Clause 13.6.3): The Gas-and-oil actuated relay to</p> |
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| | <p>operate in the event of loss of oil from the system.</p> <p>Clause 15.6.5 (Issue 5 Clause 13.6.5): Additional requirements.</p> <p>(i) For the contacts of dial type indicators.</p> <p>(ii) Option of an electronic WTI not requiring a thermal gradient boost heater with example wiring diagram (new Figure 4b).</p> <p>(iii) Option for fitment of a fibre optic sensor, to be specified in the Schedule of Requirements.</p> <p>(iv) Provision of second winding temperature indicator or temperature sensor when specified by purchaser.</p> <p>Clause 15.6.6 (Issue 5 Clause 13.6.6): Additional requirements.</p> <p>(i) Second winding temperature indicator or temperature sensor, if fitted.</p> <p>(ii) For supply of current transformer for voltage compounding purposes.</p> <p>Clause 15.6.7 (Issue 5 Clause 13.6.7): Added requirement for 15 mm holes to be provided for earthing purposes on a suitable part of the main tank structure.</p> <p>Clause 15.6.8 (Issue 5 Clause 13.6.8):</p> <p>(i) Removed specific reference to 'butterfly' valves.</p> <p>(ii) 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.</p> <p>Clause 15.12 (Issue 5 Clause 13.12):</p> <p>(i) Removed requirement that condition monitoring equipment' to be fitted only to transformers with $U_m > 36$ kV</p> <p>(ii) Requirements added for a 'digital interface' to interface to SCADA system.</p> <p>(iii) Requirement added for future provision of fibre optic winding temperature sensors to be fitted.</p> <p>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.</p> <p>Clause 16.1 (Issue 5 Clause 14.1): Requirement added to supply a drawing of the dimensioned combined general arrangement and schematic of the oil flow, valve locations and valve functions, where applicable.</p> <p>Figure 1:</p> <p>(i) Amendments to show option of a changeover switch as an alternative arrangement to links (Figure 1a).</p> <p>(ii) Figure 1b added, showing example wiring for an electronic WTI not requiring a thermal gradient boost heater.</p> <p>Figure 3: Amendments to cover 20 kV auxiliary transformers.</p> <p>Annex A (Issue 5 Appendix 1): Schedule of Requirements updated to reflect the changes made to the requirement in the main body of TS 35-3.</p> <p>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 35-3.</p> <p>Bibliography Clause added: 7 references from the 'Normative references' of Issue 5 listed here. These documents provide additional information useful to users of TS 35-3 but are not explicitly referenced in it.</p> <p>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).</p> |
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Contents

| | |
|--|----|
| Foreword..... | 11 |
| Quality assurance..... | 11 |
| 1 Scope | 13 |
| 2 Normative references..... | 13 |
| 3 Terms and definitions..... | 15 |
| 3.1 General..... | 15 |
| 3.2 Terminals and neutral point..... | 15 |
| 3.3 Windings..... | 15 |
| 3.4 Rating | 15 |
| 3.5 Tappings..... | 16 |
| 3.6 Losses and no-load current..... | 16 |
| 3.7 Short-circuit impedance and voltage drop | 16 |
| 3.8 Temperature rise | 16 |
| 3.9 Insulation | 16 |
| 3.10 Connections..... | 16 |
| 3.11 Test classification..... | 16 |
| 3.12 Meteorological data with respect to cooling..... | 16 |
| 4 Service conditions..... | 16 |
| 4.1 General..... | 16 |
| 4.2 Normal service conditions..... | 16 |
| 5 Rating and general requirements | 16 |
| 5.1 Rated power | 16 |
| 5.1.1 General..... | 16 |
| 5.1.2 Preferred values of rated power | 16 |
| 5.1.3 Minimum power under alternative cooling modes..... | 17 |
| 5.1.4 Loading beyond rated power | 17 |
| 5.2 Cooling mode..... | 17 |
| 5.3 Load rejection on transformers directly connected to generators | 17 |
| 5.4 Rated voltage and frequency | 18 |
| 5.4.1 Rated voltage..... | 18 |
| 5.4.2 Rated frequency..... | 18 |
| 5.4.3 Operation at higher than rated voltage and/or at other than rated frequency | 18 |
| 5.5 Provision for unusual service conditions | 18 |
| 5.6 Highest voltage for equipment U_m and dielectric test levels..... | 18 |
| 5.7 Additional information required for enquiry..... | 18 |
| 5.8 Components and materials | 18 |
| 6 Requirements for transformers having a tapped winding..... | 18 |
| 6.1 General – notation of tapping range..... | 18 |
| 6.2 Tapping voltage – tapping current – standard categories of tapping voltage variation – maximum voltage tapping..... | 18 |

| | | |
|----------|---|----|
| 6.3 | Tapping power – full-power tappings – reduced-power tappings..... | 18 |
| 6.4 | Specification of tappings in enquiry and order..... | 19 |
| 6.5 | Specification of short-circuit impedance..... | 19 |
| 6.6 | Load loss and temperature rise..... | 19 |
| 7 | Connection and phase displacement symbols for three-phase transformers..... | 19 |
| 8 | Rating plates..... | 20 |
| 8.1 | General..... | 20 |
| 8.2 | Information to be given in all cases..... | 20 |
| 8.3 | Additional information to be given when applicable..... | 20 |
| 9 | Safety, environmental and other requirements..... | 20 |
| 9.1 | Safety and environmental requirements..... | 20 |
| 9.1.1 | Liquid leaks..... | 20 |
| 9.1.2 | Safety considerations..... | 20 |
| 9.2 | Dimensioning of neutral connection..... | 20 |
| 9.3 | Liquid preservation system..... | 20 |
| 9.4 | D.C. currents in neutral circuits..... | 20 |
| 9.5 | Centre of gravity marking..... | 21 |
| 10 | Tolerances..... | 21 |
| 11 | Tests..... | 21 |
| 11.1 | General requirements for routine, type and special tests..... | 21 |
| 11.1.1 | General..... | 21 |
| 11.1.2 | Routine tests..... | 21 |
| 11.1.2.1 | Routine tests for all transformers..... | 21 |
| 11.1.2.2 | Additional routine tests for transformers with $U_m > 72.5$ kV..... | 22 |
| 11.1.3 | Type tests..... | 22 |
| 11.1.4 | Special tests..... | 23 |
| 11.2 | Measurement of winding resistance..... | 23 |
| 11.3 | Measurement of voltage ratio and check of phase displacement..... | 23 |
| 11.4 | Measurement of short-circuit impedance and load loss..... | 23 |
| 11.5 | Measurement of no-load loss and current..... | 23 |
| 11.6 | Measurement of zero-sequence impedance(s) on three-phase transformers..... | 23 |
| 11.7 | Tests on on-load tap-changers..... | 24 |
| 11.8 | Leak testing with pressure for liquid immersed transformers (tightness test)..... | 24 |
| 11.9 | Vacuum deflection test..... | 24 |
| 11.10 | Pressure deflection test for liquid immersed transformers..... | 25 |
| 11.11 | Vacuum tightness on site for liquid immersed transformers..... | 25 |
| 11.12 | Check of core and frame insulation..... | 25 |
| 11.13 | Temperature rise test..... | 25 |
| 11.14 | Determination of sound levels..... | 25 |
| 11.15 | Frequency Response Analysis (FRA)..... | 25 |
| 11.16 | Measurement of the harmonics of the no-load current and voltage..... | 26 |
| 11.17 | Insulation resistance measurements..... | 26 |
| 11.18 | Site tests..... | 26 |

| | | |
|----------|---|----|
| 12 | Electromagnetic compatibility (EMC) | 26 |
| 13 | High frequency switching transients | 26 |
| 14 | Transformer details | 27 |
| 14.1 | Number of phases and frequency | 27 |
| 14.2 | Cooling medium | 27 |
| 14.3 | Cooling | 27 |
| 14.4 | Anti-vibration mountings | 27 |
| 14.5 | Auxiliary supply voltage | 27 |
| 14.6 | Duty under fault conditions | 27 |
| 15 | Construction details | 28 |
| 15.1 | Tanks and covers | 28 |
| 15.1.1 | Tanks | 28 |
| 15.1.2 | Covers | 29 |
| 15.1.3 | Gaskets | 29 |
| 15.1.4 | Earthing connections | 30 |
| 15.1.5 | Sound attenuation enclosures | 30 |
| 15.2 | Surface finish | 31 |
| 15.3 | Terminals | 31 |
| 15.3.1 | Cable boxes and unfilled cable enclosures | 31 |
| 15.3.1.1 | Cable termination chambers | 32 |
| 15.3.2 | Outdoor bushings | 33 |
| 15.3.3 | Plug-in separable connectors | 34 |
| 15.3.4 | HV terminals | 34 |
| 15.3.5 | HV neutral | 34 |
| 15.3.6 | LV terminations | 35 |
| 15.3.7 | LV neutral | 35 |
| 15.3.8 | Earthing/auxiliary transformer | 35 |
| 15.4 | On-load tap-changer | 36 |
| 15.4.1 | Operating mechanisms | 36 |
| 15.4.2 | Segregation of compartments | 37 |
| 15.4.3 | Method of operation | 37 |
| 15.5 | Clearances to exposed conductors | 37 |
| 15.6 | Fittings | 38 |
| 15.6.1 | Conservator | 38 |
| 15.6.2 | Cooling Plant | 39 |
| 15.6.3 | Gas and oil actuated relay | 39 |
| 15.6.4 | Pressure relief device | 39 |
| 15.6.5 | Winding Temperature Indicators (WTI) | 39 |
| 15.6.6 | Current transformers | 41 |
| 15.6.7 | Other fittings | 42 |
| 15.6.8 | Valves | 42 |
| 15.7 | Marshalling and/or control box | 42 |
| 15.8 | Interconnecting cables | 43 |

- 15.9 Magnetic circuit.....43
- 15.10 Core and winding assemblies43
- 15.11 Padlocks44
- 15.12 Condition monitoring equipment.....44
- 15.13 LV switchgear and controlgear.....44
- 16 Documentation.....44
- 16.1 Drawings.....44
- 16.2 Assembly, operating and maintenance instructions.....45
- Annex A (normative) Schedule of Requirements for continuous maximum rated transformers.....50
- A.1 Schedule of Requirements (to be completed by purchaser)50
- Annex B (normative) Self-Certification Conformance Declaration.....53
- Annex C (normative) Technical Schedules (to be completed by the manufacturer for continuous maximum rated system transformers)66
- C.1 Manufacturers and places of manufacture, testing and inspection66
- Annex D (normative) Additional Technical Schedules (to be completed by manufacturer)68
- Bibliography74

Figures

- Figure 1a — Typical Winding Temperature Indicator circuit for a WTI requiring a thermal gradient boost heater.....46
- Figure 1b — Typical winding temperature indicator circuit for an electronic WTI not requiring a thermal gradient boost heater47
- Figure 2 — Test connection for primary injection of protection current transformers.....48
- Figure 3 — Dimensions relating to provision for mounting unit auxiliary transformer49

Tables

- Table 1 — Preferred values of rated power17
- Table 2 — Insulation levels21
- Table 3 — Zero-phase sequence impedance test connections.....24
- Table 4 — Vacuum test24
- Table 5 — Standard sound power level limits25
- Table 6 — Minimum height of jacking and transport lugs above the tank base28
- Table 8 — Bushing details.....34
- Table 9 — Co-ordinating gap settings34
- Table 10 — External air clearances.....38
- Table 11 — Winding Temperature Indicator sensor positions.....40
- Table 12 — Dimensions for current transformer accommodation41
- Table B.1 — Self-Certification Conformance Declaration54

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 35-3”.

This document replaces and supersedes Technical Specification 35-3 Issue 1 2009.

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, 50 Hz, continuously maximum rated (CMR) system transformers for use on systems up to and including 132 kV having highest rated voltage up to and including 145 kV. 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.

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 60076-4:2002, *Guide to the lightning impulse and switching impulse testing – Power transformers and reactors*

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 1000 V*

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 control gear – 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 30 kV ($U_m = 36$ kV) up to 150 kV ($U_m = 170$ kV) – 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*

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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 37-1, *400 V a.c. switchgear, controlgear and fusegear assemblies*

[N5] ENA TS 37-2, *Substation cable distribution boards*

[N6] ENA TS 50-18, *Application of auxiliary electrical equipment*

[N7] ENA TS 50-19, *Standard numbering for small wiring (for switchgear and transformers together with their associated relay panels)*

[N8] 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 35-3.

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.

3.2 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.

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