Requirements Classification: Internal

Status: Relevant

Version: 4.0

# TR3123 Transformers

Project development

Requirements, TR3123, Version 4.0,

Document replaces version 3.02

### Relevant versions:

- 3.01 (2017-09-08 14:41)
- 3.02 (2019-06-05 13:56)
- 4.0 (2021-07-09 18:30)

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# 1 Objective, target group and provision

## 1.1 Objective

The specification establishes requirements for design, construction and testing of high voltage transformers for onshore and offshore service.

The specification contains three parts. Section 2 is valid for all transformers, section 3 is applicable to liquid-immersed transformers, and section 4 is applicable for dry insulated transformers.

The referred standards are either based on IEC or based on IEEE. The standards have been referred to by one common number as shown in section 5.3. The IEEE standards are applicable in US or Canada, while IEC standards are applicable elsewhere.

SR-47869 - The requirements in this document shall be used in addition to IOGP S-720 specification and datasheet ST518

The specification can be used for low voltage transformers, such as 690 - 400 V transformers.

## 1.2 Target group

The target group for this document is personnel involved in preparing technical and operational requirements and standards to be applied in project development work for oil and gas.

## 1.3 Provision

Provision is made in Management System (TR3020 Electrical, Technical Requirements and Standards).

# 2 Common design requirements

### 2.1 Neutral points

For Neutral Earth Resistors (NER), see requirements in TR3120.

### 2.2 Terminals and wiring

Reference is made to TR3120 section 4.11 regarding marking of internal components and wiring.

Reference is made to TR3120 section 4.17 regarding light fixture and space heaters inside cabinets.

Reference is made to TR3120 section 4.8 regarding earthing of the transformer (high voltage equipment).

### 2.3 Labelling

Reference is made to TR3120 regarding the requirements for labelling.

### 2.4 Vibration damper

**SR-47917 -** Use of vibration dampers shall be evaluated to ensure that transformers do not cause unwanted vibration and noise to their surroundings.

### 2.5 Painting

**SR-98074 -** Painting shall be in accordance to TR0042 and IOGP S-715.

## 3 Liquid-immersed transformers

### 3.1 Insulating liquid

**SR-98075 -** Use of insulation liquids for allowing temperatures above 105°C, e.g. listed in IEC 60076-14, shall not be used for transformers with $U_m$ equal to or above 170 kV for IEC specifications due to the limited experience of dielectric withstand capability of such insulating liquids.

The high temperature design should be based on hybrid insulation system. The average temperature rise of the transformer windings at rated power should not exceed 95 K, and the top oil temperature should not exceed 60 K. Reference to other requirements in IEC 60076-14.

Minimum thermal class for the high-temperature solid insulation should be 155 °C.

### 3.2 Access to internals

**SR-47936 -** Liquid filled units shall be equipped with man holes to perform access to OLTC, bushings and other internal inspection points if relevant.

### 3.3 Bushings

Type of bushings will be described in datasheet.

**SR-47958 -** For plug-in type bushing or equivalent touch proof solution, a portable earthing device shall be delivered, if not otherwise stated.

**SR-47959 -** It shall be provision for measuring voltage at the bushing to be able to check if the transformer is energized.

### 3.4 Tank

Transformers with $U_m$ equal to or above 24 kV should have a diaphragm-type oil preservation system to avoid direct contact between the transformer oil and air. A flexible diaphragm or bladder should be used for this purpose.

**SR-47972 -** 316L stainless steel shall be used for fasteners (screws, bolts, nuts, etc.) up to and including a diameter of 10 mm. For diameters above 10 mm fasteners shall be hot dip galvanised in accordance with ASTM A153 or coated with PTFE with anticorrosion pre-treatment.

The requirement for fasteners does not apply to fasteners inside the transformer tank.

## 4 Dry insulated transformers

### 4.1 Windings

See section 2.3 in this document for general requirements.

The insulation level will be according to:

- List 2 in table 3 of section 12.1 for the IEC-based specification IEC 60076-11.
- The highest indicated basic lightning impulse level stated in table 5 in section 5.10 for the IEEE based specification IEEE C57.12.01 and IEEE C57.12.91.

The minimum winding insulation class should be:

- 155°C (insulation class F) for IEC based specifications (IEC 60076-11)
- 150°C for IEEE based specifications (IEEE C57.12.01 and IEEE C57.12.91).

The windings should be solid-casted or VPI. Reference is made to IOGP S-720 datasheet.

**SR-47991 -** All terminals shall be of copper type. This also applies when aluminium windings is specified.

### 4.2 Protective housing

See requirements in TR3120.

**SR-48004 -** The transformer shall be in a housing that is cooled by external air or water

**SR-48006 -** Doors and panels shall be hinged. There shall be isolating bars behind the doors. The bars shall be coloured yellow and black (zebra stripes) if not otherwise required by national regulation.

### 4.3 Testing

**SR-48016 -** The following non-routine tests shall always be performed (ref IEC 60076-11 or IEEE C57.12.01 and IEEE C57.12.91 respectively):

- Temperature-rise test together with the planned protective housing unless otherwise agreed upon.
- Partial discharge measurement special test.
- Determination of capacitances windings-to-earth and between windings for all converter transformers.

If several identical transformers are ordered, the non-routine test can be performed on one transformer only.

# 5 Additional information

## 5.1 Definitions and abbreviations

| | |
|---|---|
| Shall (requirement) | Requirement strictly to be followed in order to confirm to the document and from which no deviation is permitted, unless a deviation permit is approved. |
| Should (recommendation) | Indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form) possibility or course of action is deprecated but not prohibited. |
| May | Indicates a course of action permissible within the limits of the document. |
| Can | Statements of possibility and capability, whether material, physical or causal. |
| AC | Alternating current |
| AF | Air Forced |
| AN | Air Natural |
| Converter transformer | Transformer feeding a converter load |
| CT | Current Transformer |
| DEH | Direct Electric Heating |
| IP | Ingress Protection |
| NER | Neutral Earth Resistor |
| OCTC | Off Circuit Tap Changer |
| OFWF | Oil Forced Water Forced |
| OLTC | On Load Tap Changer |
| ONAF | Oil Natural Air Forced |
| ONAN | Oil Natural Air Natural |
| $U_m$ | Highest voltage for equipment |
| VPI | Vacuum Pressure Impregnation |

## 5.2 Changes from previous version

Changes in version 4.0

- Consolidated with latest versions og IEC standards and IOGP standard S-720
- Reference update latest versions og IEC standards.
- Removed requirement who is covered in standards.
- Created and implementet an datasheet ST518 in Docmap for in accordance with IOGP S-720

Changed some requirement to information element to understand the purpose of some of the requirement.

Changes in version 3.02:

Document updated from template to template. Wording " hanged to

"". Insignificant changes, performed by system administrator, on behalf of author/owner.

Changes in version 3.01:

Published in new minor version as part of the GEM-project (Governing Element Management). TR-document is digitalized, and each requirement element is now identified with a unique ID.

Changes in version 3:

- General: Editorial changes, updated IEC / IEEE references and added references to TR3120
- Section 2.1: Deleted requirements for base case transformers
- Section 2.3: Deleted requirement for uniform winding insulation and included reference to IEC 61378-1
- Section 2.5: Removed requirement for 110 % core dimensioning is required for all type of transformers
- Section 2.9: Non-technical information removed
- Section 2.11: New section added for vibration dampers
- Section 3.6: Updated text and that bushing type will be described in datasheet
- Section 3.7: Removed requirement for CT for thermal image
- Section 4.3: The transformer core shall be dimensioned for continuous operation at 110 % of rated voltage referred to the principal tapping and rated power.
- Section 4.6: Fire class updated from F0 to F1

## 5.3 References

The documents listed below include provisions and guidelines which, through reference in this specification, constitute provisions and guidelines of this specification.

**SR-48025 -** Latest issue of the referred document shall be used unless otherwise agreed.

Other recognized standards may be used provided it can be shown that they meet or exceed the requirements and guidelines of the standards referenced below.

Note that references in this specification (e.g. references to clause numbers in standards) are based on year of issue as listed below.

*Table 1: Standards that are the basis for transformer specification*

| | | | | | |
|---|---|---|---|---|---|
| IEC 60076-1 | 2011 | Power transformers, Part 1: General | IEEE C57.12.00<br><br>IEEE C57.12.90 | 2010<br><br>2010 | General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers<br><br>Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEC 60076-2 | 2011 | Power transformers, Part 2: Temperature rise | IEEE C57.12.00 | 2010 | General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEC 60076-3 | 2013 | Power transformers, Part 3: Insulation levels, dielectric tests and external clearances in air | IEEE C57.12.00 | 2010 | General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEC 60076-5 | 2006 | Power transformers, Part 5: Ability to withstand short circuit | IEEE C57.12.00 | 2010 | General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEC 60076-7 | 2005 | Power transformers, Part 7: Loading guide for oil-immersed power transformers | IEEE C57.12.00 | 2010 | General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEC 60076-10 | 2005 | Power transformers, Part 10: Determination of sound levels | IEEE C57.12.90 | 2010 | Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers |

| | | | | | |
|---|---|---|---|---|---|
| | | | IEEE C57.12.91 | 2011 | Test Code for Dry-Type Distribution and Power Transformers |
| IEC 60076-11 | 2004 | Power transformers, Part 11: Dry-type transformers | IEEE C57.12.01<br><br>IEEE C57.12.91 | 2005<br><br>2011 | General Requirements for Dry-Type Distribution and Power Transformers, Including Those with Solid-Cast and/or Resin Encapsulated Windings.<br><br>Test Code for Dry-Type Distribution and Power Transformers |
| IEC 60076-12 | 2008 | Power transformers, Part 12: Loading guide for dry-type power transformers | IEEE C57.12.01 | 2005 | General Requirements for Dry-Type Distribution and Power Transformers, Including Those with Solid-Cast and/or Resin Encapsulated Windings |
| IEC 60076-14 | 2013 | Power transformers, Part 14: Design and application of liquid-immersed power transformers using high-temperature insulation materials | IEEE 1276 | 2000 | IEEE Guide for the application of High-Temperature Insulation Materials in Liquid-Immersed Power Transformers |
| IEC 60214-1 | 2003 | Tap-changers, Part 1: Performance requirements and test methods | IEEE C57.131 | 2012 | Requirements for Load Tap Changers |
| IEC 61378-1 | 2011 | Converter Transformers, Part 1: Transformers for industrial applications | IEEE C57.18.10 | 1998 | Practices and Requirements for Semiconductor Power Rectifier Transformers |
| IEC 60137 | 2008 | Insulated bushings for alternating voltages above 1000 V | IEEE C57.19.00 | 2004 | General Requirements and Test Procedure for Power Apparatus Bushings |
| IEC 60296 | 2012 | Fluids for electrotechnical applications – unused mineral insulating oils for | IEEE C57.106 | 2006 | Guide for Acceptance and Maintenance of Insulating Oil in Equipment |

| | | | | | |
|---|---|---|---|---|---|
| | | transformers and switchgear | | | |
| IEC 61869-2 | 2012 | Instrument transformers – Part 2: Additional requirements for current transformers | IEEE C57.13 | 2008 | Requirements for Instrument Transformers |
| IEC 60076-16 | 2011 | Power transformers, Part 16: Transformers for wind turbine applications | NA | NA | NA |

*Table 2: Other technical requirements*

| | |
|---|---|
| TR0042 | Surface preparation and protective coating |
| | |
| TR3120 | Electrical equipment, general requirements |