



**SLOVENSKI STANDARD**  
**SIST EN 50708-3-4:2022**

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**Močnostni transformatorji - Dodatne evropske zahteve - 3-4. del: Veliki močnostni transformatorji - Posebni preskusi za rezervoarje in hladilnike iz valovite pločevine**

Power transformers - Additional European requirements - Part 3-4: Large power transformer - Special tests for corrugated tank and radiators

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Transformateurs de puissance - Exigences européennes supplémentaires: Partie 3-4: Transformateurs de grande puissance - Essais spéciaux pour cuve ondulée et radiateurs extensibles

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EUROPEAN STANDARD

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## Power transformers - Additional European requirements - Part 3-4: Large power transformer - Special tests for corrugated tank and radiators

Transformateurs de puissance - Exigences européennes  
supplémentaires: Partie 3-4: Transformateurs de grande  
puissance - Essais spéciaux pour cuve ondulée et  
radiateurs extensibles

Leistungstransformatoren - Zusätzliche europäische  
Anforderungen - Teil 3-4: Großleistungstransformatoren -  
Sonderprüfungen für Wellwandkessel und Radiatoren

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European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

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## European foreword

This document (EN 50708-3-4:2022) has been prepared by CLC/TC 14 “Power transformers”.

The following dates are fixed:

- latest date by which this document has to be (dop) 2023-08-15 implemented at national level by publication of an identical national standard or by endorsement
- latest date by which the national standards (dow) 2025-08-15 conflicting with this document have to be withdrawn

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## Introduction

This part of the EN 50708 series deals with a special test for hermetically sealed transformers.

For the purpose of this document, the requirements of the general EN 50708-1-1:2020 apply.

This document contains particular requirements for specific transformers or transformer applications, which are based on the requirements of the general EN 50708-1-1:2020.

This document should be considered in conjunction with the requirements of the general parts.

The particular requirements of the different sub parts of the EN 50708 series supplement, modify or replace certain requirements of the general parts of EN 50708-1 and/or EN 50708-1-X being valid at the time of publication of this document. The absence of references to the exclusion of a part or a clause of a general part means that the corresponding clauses of the general part are applicable (undated reference).

Requirements of other -X parts with X greater than 1 being eventually relevant for cases covered by this document also apply. This document could therefore also supplement, modify or replace certain of these requirements valid at the time of publication of this document.

The main clause numbering of each part follows the pattern and corresponding references of EN 50708-1-1:2020. The numbers following the particular number of this document are those of the corresponding parts, or clauses of the other parts of the EN 50708 series, valid at the time of publication of this document.

In the case where new or amended general parts with modified numbering were published after the sub part was issued, the clause numbers referring to a general part in sub parts might no longer align with the latest edition of the general part. Dated references should be observed.

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## 1 Scope

This document describes a special test for tanks of liquid-immersed transformers which during service are hermetically sealed and fully filled with liquid and volume change of the liquid due to temperature change compensated by elastic deformation of the cooling element for Large Power Transformers having a rated power greater than 3150 kVA.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 50708 (all parts), *Power transformers — Additional European requirements*

EN IEC 60296, *Fluids for electrotechnical applications - Mineral insulating oils for electrical equipment (IEC 60296)*

EN 60836, *Specifications for unused silicone insulating liquids for electrotechnical purposes*

EN 62770, *Fluids for electrotechnical applications - Unused natural esters for transformers and similar electrical equipment (IEC 62770)*

EN IEC 63012, *Insulating liquids - Unused modified or blended esters for electrotechnical applications (IEC 63012)*

IEC 60076-2, *Power transformers — Part 2: Temperature rise for liquid-immersed transformers*

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

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in the EN 50708 (all parts) apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

## 4 Service conditions

Refer to EN 60076-1.

## 5 Special test for corrugated tank and tank with expandable radiators

### 5.1 General information

For liquid immersed transformers with corrugated tank or tank with expandable radiators, a special test to check the reliability of the tank or expandable radiators is described hereafter.

This test is representative of the life cycle of the tank of the transformers under operation and ensures a relevant level of quality. Other kinds of tests may be carried out by agreement between the manufacturer and the customer at the time of the offer. The liquid used for the test shall be of the same type (viscosity and expansion coefficient) as the one used in service.

Attention shall be paid that air pocket are not present when filling and during the test.

Possible limitation of the radiator expansion system during the test shall be the same as that in operation.

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NOTE By agreement between manufacturer and purchaser at the time of the offer, when for dimensional reasons or pressure reasons it is not possible to carry out the test on transformers equipped with radiator, the tests can be carried out on some samples of flexible radiators only.

To avoid accident by overpressure in the tank, the manufacturer shall indicate the maximum value that should not be exceeded. If this pressure is exceeded, then the test has failed, and further evaluations shall be made in order to verify the design.

By passing the test, the radiators are qualified to be used for projects where the design oil variation calculated by radiator is equal or lower than the value of the oil volume variation calculated by radiator according to 5.4.

By passing the test, the corrugated wall tank is qualified to be used for projects where the design oil variation is equal or lower than the value of the oil volume variation calculated according to 5.4.

**5.2 Temperature variation**

For the simulation of the seasonal and daily temperature variations, the average liquid temperature is assumed to vary between minimum ambient temperature as per EN 60076-1:2011, 4.2 and a maximum temperature determined by adding the maximum ambient temperature to the average liquid temperature rise determined by the temperature rise test.

The average liquid temperature shall be determined by the IEC 60076-2 method.

NOTE In general, the following values are used depending on the site conditions.  $-25\text{ °C}$  is the minimum ambient temperature with de-energized transformer for outdoor installation. In case of indoor installation  $-5\text{ °C}$  can be used as minimum ambient temperature with de-energized transformer.

EXAMPLE A top liquid temperature rise of 60 K and bottom liquid temperature rise of 36 K are measured during a temperature rise test. The average liquid temperature rise will be 48 K  $(60 + 36) / 2$ . If the maximum ambient temperature is  $+40\text{ °C}$  then a maximum temperature for test will be  $88\text{ °C}$   $(48 + 40)$ .

**5.3 Sealing temperature**

When sealing the tank, the average liquid temperature shall be chosen between  $15\text{ °C}$  and  $35\text{ °C}$  and recorded. The overpressure or under-pressure inside the tank measured by a relative pressure gauge (Manometer or digital pressure sensor) installed on the tank cover shall indicate neither overpressure nor under-pressure.

**5.4 Calculation of the volume variation**

From the temperature variations described in 5.2, the liquid volume variation from the pressure-less stage at the sealing temperature shall be calculated using a volume expansion coefficient given by supplier of the dielectric fluid. If no information is given by supplier the following list of the volume expansion coefficient shall be applied:

- Mineral Oil according to EN IEC 60296:  $7,5 \times 10^{-4}\text{ K}^{-1}$
- Silicone according to EN 60836:  $10 \times 10^{-4}\text{ K}^{-1}$
- Natural ester according to EN 62770:  $7,4 \times 10^{-4}\text{ K}^{-1}$
- Synthetic ester according to EN IEC 63012:  $7,5 \times 10^{-4}\text{ K}^{-1}$

NOTE 1 The volume expansion coefficients come from the Cigré Brochure 436 published in October 2010.

NOTE 2 Pressure-less tank is the stage at sealing temperature means tank filled of liquid, temperature of liquid stabilized and the overpressure at 0.

If the flexible radiator is tested separately, then volume variation of liquid per radiator shall be at least the total volume variation of the liquid (including tank and radiator) divided by the number of radiators installed on the transformer.



## 5.5 Test procedure

### 5.5.1 General

These tests are considered as special tests.

These tests shall be carried out on a tank or a radiator if tested separately which is considered as representative of a range of designs by agreement between purchaser and supplier.

The tests can be done either with or without active parts.

The volume to be considered for the tests is the one calculated in 5.4.

The liquid used for the tests can be different from the one used in operation.

In the description of the test procedure, the term "tested object" represents either a corrugated wall tank, a tank equipped with expandable radiator or a single radiator.

### 5.5.2 Measurement of pressure range

The increase or decrease of the liquid volume as calculated in paragraph 5.4 shall be added to or extracted from the pressure-less corrugated tank or radiator, and the corresponding overpressure (P+) and under pressure (P-) and ambient temperature shall be registered by a pressure device connected to the tank cover or radiator and a thermometer. The over pressure P+ and under-pressure P- and the ambient temperature shall be recorded during the test at regular intervals.

The intervals for the recording shall be greater or equal to one measurement every 100 cycles.

The liquid temperature of the tested object shall be stabilized at the ambient temperature of the laboratory which may differ from the filling temperature.

If different from the filling temperature the stabilization at the test laboratory temperature changes the pressure inside the tested object: if hotter, the pressure increases and if colder the pressure decreases.

The liquid temperature during the measurement shall be the same as the one used for sealing  $\pm 3$  K as described in the 5.3. If it is not possible to maintain an initial testing temperature within  $\pm 3$  K of the sealing temperature, the needed amount of liquid to ensure pressure-less in the tested object shall be added or removed from the tank of the tested object at the beginning of the test.

**NOTE** It is a common practice to eliminate shifting of internal pressure caused by change of liquid temperature and/or by uncertainty of the flow-measuring instrument by control of internal pressure at neutral point of the cycles. The solution is to start pumping of desired volume in both direction when internal pressure is zero.

### 5.5.3 Endurance test

To simulate the volume expansion, the tested object shall be subjected to 2 000 cycles with overpressure and under pressure. Each cycle comprises one overpressure and one under pressure. To achieve the overpressure and under pressure, the volume of liquid calculated in 5.4 shall be added into the tested object or extracted from the tested object. The maximum over pressure P+ and under-pressure P- shall be recorded during the test at regular intervals, see 5.5.2.

The reading of the pressure device with the tank pressure-less shall be recorded before (P0) and after the test (P1) and the tested object shall be topped up with liquid to reach the initial pressure-less pressure P0, the added volume shall be recorded. The value of added volume shall be corrected by the difference between ambient temperature at the beginning and the end of the test.

Alternatively, the volume change of the test object caused by permanent deformations can be determined by weight measurement of the test object before and after the test. To minimize uncertainty of the determination of volume of permanent deformations it is recommended to measure average liquid temperature of the test object before and after the test also and consider in the calculation. Specific weight of the liquid can be taken from the shipping document.

If pauses are needed, it shall be done at sealing pressure to avoid affecting the result of the test.

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To avoid mechanical impulses, the test duration may not be too short. A minimum cycle duration of 120 s may be sufficient.

**5.5.4 Leakage test**

After the endurance test, the same tested object shall be subjected to a 24 h static leakage test with an overpressure equal to the lowest value of the maximum value given by the manufacturer defined in 5.1 or 1,2 times the maximum value recorded during the endurance test.

**5.5.5 Acceptance criteria**

Unless otherwise agreed between manufacturer and customer at the time of the offer, the test is accepted as passed, if the following criteria are fulfilled:

- the tested object shall not show leakages as observed by appropriate detecting means (visual inspection or by application of fluorescent product sprayed on the tested object...) at room temperature;
- no cracks shall occur in the tested object;
- discrepancies on the pressure readings taken before, during and after the tests shall be explained. Unexplained discrepancies are considered as indications of abnormal events and the test cannot be validated.

NOTE Discrepancies can be explained by temperatures differences, and or uncertainties of measuring equipment for example.

- for checking the permanent deformations of the tank, a limit for the volume of liquid to be added at the end of the test according to 5.5.3 shall be specified before the test is performed and not exceeded;
- during the static leakage test according to 5.5.4 no pressure drop and no leakage shall occur.

**6 Optional additional test**

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An additional optional test can be requested at the stage of the offer by the customer to check if the expandable components withstand the overload conditions either defined in IEC 60076-7 or by the customer's specifications.

In this case the manufacturer shall indicate the additional volume of liquid that shall be added in the test defined in 5.5. Thirty additional tests cycles should be performed with this additional volume which shall be calculated in the conditions of paragraph 5.4.

The maximum temperature used for this test shall be at least 40 °C plus the average liquid temperature rise extrapolated for the overloading conditions from the temperature rise test or guaranteed value if no temperature rise-test is performed. Unless otherwise agreed, the extrapolation formulas shall be that of IEC 60076-7.

The acceptance criteria are those defined in 5.5.5.