



SLOVENSKI STANDARD
SIST EN 50209:1999

01-april-1999

Test of insulation of bars and coils of high-voltage machines

Test of insulation of bars and coils of high-voltage machines

Prüfung der Isolierung von Stäben und Spulen von Hochspannungsmaschinen

Essai de l'isolation des barres et des bobines des machines à haute tension

Ta slovenski standard je istoveten z: EN 50209:1998

[SIST EN 50209:1999](https://standards.iteh.ai/catalog/standards/sist/40d7a703-a8fd-4f74-8e01-5cfd73c5b09c/sist-en-50209-1999)

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ICS:

29.080.01	Električna izolacija na splošno	Electrical insulation in general
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EUROPEAN STANDARD
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EN 50209

March 1998

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Descriptors: High-voltage machines, tests of insulation, bars and coils of high-voltage machines, insulation of bars and coils, manufacturing control of insulations, loss tangent

English version

Test of insulation of bars and coils of high-voltage machines

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CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The Harmonization Document HD 345 S1, prepared by the Technical Committee CENELEC TC 2, Rotating machinery, was approved by CENELEC on 1976-03-30.

This Harmonization Document was submitted to the formal vote for conversion into a European Standard and was approved by CENELEC as EN 50209 on 1995-09-20.

The following date was fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-10-01

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Introduction

The purpose of this standard is to assess the uniform quality of manufacturing and determine the dielectric behaviour of the insulation of machines having rated voltages from 5 kV to 24 kV. It applies to conductor bars and coils.

EN 60034-15 relates to impulse voltage withstand levels of rotating machines with form-wound stator coils and having rated voltages from 3 kV to 15 kV inclusive.

Scope

This specification applies to rotating electrical machines with rated voltages (U_N) from 5 kV to 24 kV inclusive and with rated output from 5 MVA upwards for generators and from 5 MW upwards for motors.

Requirements for machines with rated voltage above 24 kV should remain the subject of individual agreement.

This specification is also applicable to machines with rated outputs between 1 MVA (1 MW) and 5 MVA (5 MW) and with rated voltages of 5 kV and above, provided its use has been agreed beforehand.

In the case of machines whose windings are cured in the stator, tests on the separate winding elements are not possible; for these machines the requirements in Part B apply. The test of the conductor lamination insulation must however be carried out in accordance with 2.3 of Part A.

Part A – Tests on conductors bars and coils

1 Tests

As a manufacturer quality control of the insulation, bars and coils of high voltage windings shall undergo a routine test in accordance with clause 2, and, where it has been agreed, an additional random sample test in accordance with clause 3.

These tests serve to assess the uniformity of manufacture as well as to determine the dielectric behaviour of the insulation.

NOTE: In the routine test, the uniformity of the manufacture is judged by measurement of the dielectric loss angle as a function of voltage. In the random sample test, the behaviour of the slot insulation under thermal stress is determined by measurement of the dielectric loss angle before and after heating.

The random sample test also serves to determine by means of a.c. voltage tests, the dielectric strength of the insulation between the laminations of the conductor as well as the inter-turn insulation, the end winding insulation and the slot insulation. In the case of the last three insulations the breakdown voltage is also determined.

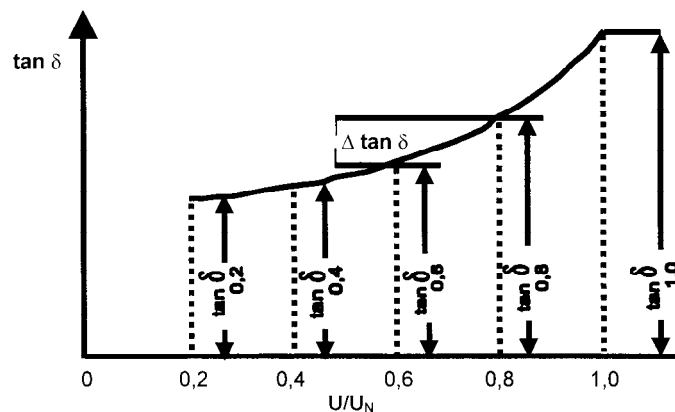
2 Routine test

2.1 The routine test shall be carried out on the number of bars or coil sides, including any spare bars or coils, as shown in Table 1.

Table 1

Number of poles	Rated output	Number of test samples
all polarities	< 5 MVA (MW)	10 % of bars or coil sides with a minimum of 20
two and four	≥ 50 MVA (MW)	all bars or coil sides
	< 50 MVA (MW) but not less than 5 MVA (MW)	at least 60 bars or 60 coil sides and, in addition, 10 % of all bars or coil sides
six and more	≥ 5 MVA (MW)	

2.2 The loss tangent shall be measured on the samples at room temperature in relation to voltage (see Figure 1) over the range of $0,2 U_N$ to $1,0 U_N$ at intervals of $0,2 U_N$.



**Figure 1: Curve of $\tan \delta$ against the ratio U/ U_N
(example of a series of measurements)**

The measurements shall be carried out by means of a Schering Bridge or an equivalent type of bridge, using a guard ring arrangement.

The length of the test foil shall be about equal to the axial length of the stator core.

The guard ring arrangement shall lie outside this zone.

The initial value of $\tan \delta_{0,2}$, the increment $\frac{1}{2} (\tan \delta_{0,6} - \tan \delta_{0,2})$ and the increment $\Delta \tan \delta$ per measuring step must not exceed the values in Table 2 for rated voltages up to 11 kV.

For rated voltages above 11 kV the values should be fixed by special agreement.

If more than 5% of the samples show test results in the ranges between columns 2 and 3 or between columns 4 and 5 of Table 2, or in a different range of agreed values, the testing shall be continued with an equal number of further samples, if necessary up to the total number of bars or coil sides. If during these tests the values of Table 2 or the agreed values are not exceeded, the test of insulation shall be regarded as satisfactory.

**Table 2: Highest permissible values of loss tangent
(rated voltage ≤ 11 kV)**

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1	2 (standards.iteh.ai)		4	5
$\tan \delta_{0,2}$	$\frac{1}{2} (\tan \delta_{0,6} - \tan \delta_{0,2})$		$\Delta \tan \delta$ per step of $0,2 U_N$	
all samples	95 %	Remaining 5 %	95 %	remaining 5 %
	samples		samples	
30×10^{-3}	$2,5 \times 10^{-3}$	3×10^{-3}	5×10^{-3}	6×10^{-3}

2.3 The conductor lamination insulation of all bars of the machine shall be tested using a.c. 110 V, 50 Hz before applying the high voltage insulation. Interlaminar short-circuits must be eliminated.

3 Random test

3.1 Sampling

If a random sample test has been agreed it shall be carried out on two samples (two bars or two coil sides) chosen at random from the winding in the sequence shown below.

3.2 General

The loss tangent shall be measured as a function of the voltage (voltage range $0,2 U_N$ to $1,0 U_N$, at steps of $0,2 U_N$) at room temperature before and after heating to at least 90°C .

The test samples may be fitted into a model of the slot. The temperature of the insulation, which must be as uniform as possible, shall be measured at the surface of the insulation. After cooling the test samples to room temperature, the loss tangent shall be measured again in relation to voltage as described above.

For voltages equal to or below 11 kV, the maximum value of $\Delta \tan \delta$ per measuring interval of $0,2 U_N$ measured at room temperature after heating the sample, shall not exceed the maximum value measured before heating by more than 2×10^{-3} and shall not in any case exceed 7×10^{-3} .

In the case of rated voltages above 11 kV up to 24 kV the maximum values per measuring interval of $0,2 U_N$ shall not exceed values fixed by special agreement.

3.3 Insulation of conductor laminations

In the case of bars, the conductor lamination insulation shall be tested with a.c. 110 V, 50 Hz. In the case of transposed conductors, no short-circuits shall occur between the laminations within the slot portion.

3.4 Insulation of turns

3.4.1 To check the interturn insulation of coils, a test shall be carried out on the opened coil with a.c. at $0,3 U_N$, applied between adjacent turns for a period of 1 min. During this test no breakdown shall occur. Immediately after this, the voltage shall be increased at the rate of 0,5 kV/s until breakdown of the interturn insulation occurs.

The breakdown voltage shall be recorded.

3.4.2 Alternatively, the following high-frequency method may be used.

A voltage with a peak value equal to the effective voltage of the machine, U_N , shall be applied for 15 seconds to the end of the coil from a high-frequency source (sinusoidal or non-sinusoidal).