SLOVENSKI STANDARD
SIST EN 60551:1997/A1:1998

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Determination of transformer and reactor sound levels - Amendment A1 (IEC 60551:1987/A1:1995, modified)

Determination of transformer and reactor sound levels

Bestimmung der Geräuschpegel von Transformatoren und Drosselspulen

Détermination des niveaux de bruit des transformateurs et des bobines d'inductance

Ta slovenski standard je istoveten z: **EN 60551:1992/A1:1997**

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Determination of transformer and reactor sound levels
(IEC 60551:1987/A1:1995, modified)

Détermination des niveaux de bruit des transformateurs et des bobines d'inductance
(CEI 60551:1987/A1:1995, modifiée)

Bestimmung der Geräuschpegel von Transformatoren und Drosselspulen
(IEC 60551:1987/A1:1995, modifiziert)

This amendment A1 modifies the European Standard EN 60551:1992; it was approved by CENELEC on 1997-03-11. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This amendment exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

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

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Foreword

The text of amendment 1:1995 to the International Standard IEC 60551:1987, prepared by IEC TC 14 'Power transformers', together with the common modifications prepared by the Technical Committee CENELEC TC 14 'Power transformers', was submitted to the formal vote and was approved by CENELEC as amendment A1 to EN 60551:1992 on 1997-03-11.

In this amendment to EN 60551 the common modifications to the amendment to the International Standard are indicated by a vertical line in the left margin of the text.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1997-12-01

- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1997-12-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annexes A, B, C and ZA are normative.
Annex ZA has been added by CENELEC.

1 Scope

Insert the following new text between the second and third paragraph:

Standard measurements use the A-weighted sound pressure level as a measured variable. In case of difficult measuring conditions, sound intensity measurements are advantageous.

Because of some deviations in the determination of the sound power level value, depending on the type of measurement (sound pressure or sound intensity), the procedure should be agreed upon between manufacturer and purchaser at the time of placing the order. The application of sound intensity measurement is described in annex B.

According to this standard, measurements on transformers are made under no-load. If a transformer has a very low no-load noise, for example in the case of extremely low induction designs, the noise due to load current can also influence the sound level. Annex C specifies the measurement conditions for the determination of the noise due to load current.

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2.3 *Sound power level, L_W*

Add the following new note:

NOTE 2: If the A-weighted sound power level is determined by sound intensity measurements, it is designated L_{WAI} . See annex B.

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6.3 *Calculation of sound power level*

Add immediately after the definitions of the variables of equation (7), the following new note:

NOTE: The A-weighted sound power level of the equipment can also be calculated from the measurement of sound intensity. See annex B.

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Add after annex A, the new annexes B and C:

Annex B (normative)

Derivation of sound power level from sound intensity measurements

B.1 General

The sound power level can be calculated from the measurement of the sound intensity; This annex specifies a method for measuring the component of sound intensity normal to a measurement surface around transformers or reactors, and their associated cooling equipment.

The sound intensity measurement method has the following advantages as compared with the sound pressure measurement method:

- the determination of a correct sound power is possible regardless of whether the measurement surface lies within or outside the near field;
- the determination of the correct sound power is possible in the presence of noise fields where the sound pressure method gives such erroneous results that they are no longer authorised by this standard.

NOTE: When the measurement surface lies in the near field, sound intensity measurement may lead to values of power 2 dB less in comparison with the sound pressure method.

B.2 Definitions

For the purpose of this annex, the definitions in clause 2 and the following definitions apply.

B.2.1 *Normal sound intensity, I_n*

The sound intensity component in the direction normal to a measurement surface is defined by unit normal vector $\vec{n}$.

$$I_n = \vec{I} \times \vec{n} \qquad \text{(B.1)}$$

where

$\vec{I}$ is the active intensity vector;

I is the signed magnitude of $\vec{I}$;

$\vec{n}$ is the unit normal vector directed out of the volume enclosed by the measurement surface.

B.2.2 *Normal sound intensity level, L_{In}*

The value in decibels equal to ten times the logarithm to base 10 of the ratio of the absolute value of the normal sound intensity $|I_n|$ to the reference sound intensity, I_0.

$$L_{In} = 10 \log_{10} \left[\frac{|I_n|}{I_0} \right] \qquad \text{(B.2)}$$

where

I_0 is the reference sound intensity, 10^{-12} W/m^2.

NOTE: When I_0 is negative, the level is expressed as -XX dB.

B.2.3 *Partial sound power, P_i*

The time-averaged rate of flow of sound energy through an element (segment) of a measurement surface, calculated by the formula:

$$P_i = I_{ni} \times S_i \qquad \text{(B.3)}$$

where

I_{ni} is the signed magnitude of the normal sound intensity component measured at position i on the measurement surface;

S_i is the area of the segment of surface associated with point i.

B.2.4 *Sound power, P_I*

The sound power P_I generated by a source is calculated by the formula:

$$P_I = \sum_{i=1}^{N} P_i \qquad \text{(B.4)}$$

where

N is the total number of segments of the measurement surface.

NOTE: This part of ISO 9614 is not applicable if the value of P_I of the source is found to be negative.

B.2.5 *Sound power level, L_{WI}*

The value in decibels equal to ten times the logarithm to base 10 of the ratio of the absolute value of the sound power level $|P_I|$ to the reference sound power, P_0.

$$L_{WI} = 10 \log_{10} \left[\frac{|P_I|}{P_0} \right] \qquad \text{(B.5)}$$

where

$|P_I|$ is the magnitude of the sound power of the source;

P_0 is the reference sound power, 10^{-12} W.

A-weighted values of L_{WI} are used for calculating the A-weighted sound power level L_{WAI}.

NOTE: When P_I is negative, L_{WI} is expressed as -XX dB for record purposes only.

B.3 Instruments

B.3.1 *General*

Sound intensity measurement equipment shall meet the requirements of IEC 61043:1993. The frequency range of the measurement equipment shall be adapted to the frequency spectrum of the transformer operating condition (with/without forced air cooling auxiliaries).

B.3.2 *Calibration and field check*

The instrument and probe calibration shall be checked at least once a year according to IEC 61043:1993.

Instruments shall be checked in the field prior to each series of measurements using either the field calibration procedure specified by the manufacturer or the following procedure.

Each microphone shall be calibrated. Afterwards, the probe shall be rotated 180° about a normal to its measurement axis, while maintaining its acoustic centre at a fixed point, which shall be one of the selected measurement positions. The average absolute difference between the magnitude of the two levels shall be less than 1,5 dB.

B.4 Conditions for measurement

B.4.1 *Criteria for adequacy of the test environment*

The measurements conditions shall meet the requirements specified in B.5.1.

B.4.2 *Operating conditions of equipment during measurement*

Conditions as described in 4.2.

B.5 Measurement of sound intensity

Sound intensity can be measured using either one of the following two methods:

- method I: A-weighted sound intensity level;
- method II: narrow-band intensity measurement.

B.5.1 *Test environment and background noise*

The environment and background noise influence the results of measurements.

A criterion for the influence of the test environment and the background noise is ΔL defined as:

$$\Delta L = \overline{L}_{pA} - \overline{L}_{IA} \qquad \text{(B.6)}$$

where

$\overline{L}_{pA}$ is the A-weighted surface sound pressure level, defined as:

$$\overline{L}_{\mathrm{pA}} = 10\log_{10}\left[\frac{1}{N}\sum_{i=1}^{N}10^{0,1L_{pAi}}\right] \qquad \text{(B.7)}$$

and where

$\overline{L}_{IA}$ is the A-weighted surface sound intensity level, defined as:

$$\overline{L}_{IA} = 10\log_{10}\left[\frac{1}{N}\sum_{i=1}^{N}10^{0,1L_{IAi}}\right] \qquad \text{(B.8)}$$

where

L_{pAi} is the A-weighted local sound pressure level at measurement position i in decibels (reference: 20 μPa);

L_{IAi} is the A-weighted local normal sound intensity level at measurement position i in decibels (reference 10^{-12} W/m^2);

N is the total number of segments of the measurement surface.

NOTE: Negative signs shall be taken into account in conformity with ISO 9614-1.

Acceptable limits for values of ΔL are identified in B.5.2.1.

B.5.2 *Transformer sound intensity level measurements*

Transformer or reactor sound intensity levels shall be measured in conformity with 5.2.

Two methods can be used for the measurement of sound intensity.

- method I: A-weighted sound intensity level;
- method II: narrow-band intensity measurement.

The choice of the method shall be agreed between the user and the manufacturer.

The narrow-band spectrum analysis measurement method shall be permitted only when the fans and/or oil pumps of the transformer cooling equipment are not activated.

For narrow-band intensity measurements, the bandwidth of the measurement equipment shall be less than or equal to 5 Hz.