SLOVENSKI STANDARD
SIST EN 15657:2017

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Nadomešča:
SIST EN 15657-1:2009

Akustične lastnosti gradbenih elementov in stavb - Laboratorijsko merjenje strukturalnega zvoka v gradbenih elementih servisne opreme za vse načine namestitve

Acoustic properties of building elements and of buildings - Laboratory measurement of structure-borne sound from building service equipment for all installation conditions

Akustische Eigenschaften von Bauteilen und von Gebäuden - Messung des Körperschalls von haustechnischen Anlagen im Prüfstand für alle Installationsbedingungen

Propriétés acoustiques des éléments de construction et des bâtiments - Mesurage en laboratoire des bruits structuraux des équipements de bâtiment pour toute condition d'installation

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English Version

Acoustic properties of building elements and of buildings - Laboratory measurement of structure-borne sound from building service equipment for all installation conditions

Propriétés acoustiques des éléments de construction et des bâtiments - Mesurage en laboratoire des bruits structuraux des équipements de bâtiment pour toute condition d'installation

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (EN 15657:2017) has been prepared by Technical Committee CEN/TC 126 “Acoustic properties of building elements and of buildings”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2018, and conflicting national standards shall be withdrawn at the latest by January 2018.

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This document supersedes EN 15657-1:2009.

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Introduction

This European Standard is the result of merging two documents dealing with laboratory characterization of service equipment: former standard EN 15657-1:2009, which was restricted to receivers of mobility much lower than the source mobility, and draft prEN 15657-2, valid for all installation conditions.

The characterization leads to the determination of the equipment installed structure-borne power, which depends on the source and the receiver, using expressions which have been simplified and approximated in order to use 1/3 octave single equivalent quantities, easily measurable in laboratories for input data for predictions.

The laboratory method for measuring airborne sound, part of former EN 15657-1, is not included in this revised standard. If a measurement of the airborne sound power of the equipment is required, then the methods described in EN ISO 3740 to EN ISO 3747 should be used.

1 Scope

This European Standard specifies methods for estimating the structure-borne sound power produced in buildings by services equipment (sources) from measurements under laboratory conditions. The data can be used as explained in Annex D, as input for EN 12354-5, or under certain conditions for EN ISO 12354-2, to calculate the sound pressure levels produced by the same equipment when installed in buildings. The data can also be used to compare the performance of products as explained in Annex E.

As for the document predicting the structure-borne sound levels produced in the buildings by service equipment (EN 12354-5), this European Standard covers water supply and sanitary installations, mechanical ventilation, heating and cooling devices, service equipment, lifts, rubbish chutes, boilers, blowers, pumps, motors and other auxiliary service equipment, such as motor driven car park doors; it can also be applied to other vibrating equipment attached to or installed in buildings. This standard is so far restricted to steady-state vibrating sources.

This revised European Standard:

— specifies laboratory measuring methods for determining the source input data required to calculate the source installed power, i.e. the equipment free velocity, the equipment blocked force and the equipment mobility;

— applies to equipment, which can be connected to isolated plates in the laboratory. For equipment, such as pipe systems or impacted lightweight stairs [16], which are connected to at least two building elements (wall and floor), a coupled reception plate system is specified, which requires the use of a power substitution method. The later method can also be used *in situ* when the equipment, such as lifts, can only be tested *in situ*;

— defines the expression of the source installed structure-borne power for any source-receiver mobility conditions, including lightweight and heavyweight receiving building elements. This power is used as input data in EN 12354-5, which predicts the sound pressure level generated by the source installed *in situ* in a building;

— defines a method to calculate the total structure-borne sound power generated by the equipment fictively mounted on two sets of reference test plates (respectively of low mobility and of high mobility); the two results will inform the manufacturers on the difference in the equipment performance between these two common but very different situations;

— does not specify any method for the measurement of the source airborne sound power. If measurements of the equipment airborne sound power are required, then refer to EN ISO 3740 to EN ISO 3747 and use the same source mounting conditions and operating conditions as in measuring using EN 15657.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 10140-3, *Acoustics - Laboratory measurement of sound insulation of building elements - Part 3: Measurement of impact sound insulation (ISO 10140-3)*

EN ISO 10848-1, *Acoustics - Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms - Part 1: Frame document (ISO 10848-1:2006)*

ISO 5348, *Mechanical vibration and shock — Mechanical mounting of accelerometers*

ISO 7626-1:2011, *Mechanical vibration and shock — Experimental determination of mechanical mobility — Part 1: Basic terms and definitions, and transducer specifications*

ISO 7626-2, *Mechanical vibration and shock — Experimental determination of mechanical mobility — Part 2: Measurements using single-point translation excitation with an attached vibration exciter*

ISO 7626-5, *Vibration and shock — Experimental determination of mechanical mobility — Part 5: Measurements using impact excitation with an exciter which is not attached to the structure*

ISO 9611, *Acoustics — Characterization of sources of structure-borne sound with respect to sound radiation from connected structures — Measurement of velocity at the contact points of machinery when resiliently mounted*

ISO 16063-21, *Methods for the calibration of vibration and shock transducers — Part 21: Vibration calibration by comparison to a reference transducer*

ISO 18312-1, *Mechanical vibration and shock — Measurement of vibration power flow from machines into connected support structures — Part 1: Direct method*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. A list of the symbols and units used in this standard is given in Annex A.

3.1
source
service equipment or component of service equipment under test

3.2
receiver
building element to which the service equipment is to be attached, that can be a floor or a wall or a combination of floor and walls

Note 1 to entry: For the laboratory test, the receivers are reception plates, details of which are described in Clause 7.

3.3
source free velocity squared
$v_{f,RMS}^2$
expression of source activity, in terms of RMS value, at each of the contacts (the connections with the receiver building elements when installed), with the source either freely suspended (disconnected from the receiver) or connected to a much higher mobility receiver called high mobility reception plate (see Clause 7), when operating under conditions described in the test report

3.4
single equivalent source free velocity squared
$v_{f,RMS,eq}^2$
expression of the source activity, in terms of RMS value, which is obtained either as the sum of the squared RMS free velocities over the *N* contacts,

$$v_{f,RMS,eq}^2 = \sum_{i}^{N} v_{f,RMS,i}^2 \quad (1)$$

or approximately from the high mobility reception plate power defined in 7.3.2

3.5
source blocked force squared
$F^2_{b,RMS}$
expression of the source activity, in terms of RMS value, as the force at each of the contacts (the connections with the receiver building elements when installed), with the source connected to a much lower mobility receiver, called low mobility reception plate (see 7.2.2), also when operating under the same conditions described in the report

3.6
single equivalent blocked force squared
$F^2_{b,RMS,eq}$
expression of the source activity, in terms of RMS value, as the single equivalent blocked force, which is defined as the sum of the squared RMS blocked forces over the N contacts,

$$F^2_{b,RMS,eq} = \sum_{i}^{N} F^2_{b,RMS,i} \tag{2}$$

and obtained approximately from the low mobility reception plate power defined in 7.2

3.7
point mobility
Y_i

ratio of the complex (magnitude and phase) vibrational velocity that a point force produces at its point of application i, to the complex force applied, both force and velocity being normal to the receiver

3.8

single equivalent mobility
Y_{eq}
quantity approximated as the mean value of the point mobility at each contact i, averaged over the N contacts, which for the magnitude, is according to:

$$\left|Y_{eq}\right| \approx \frac{1}{N}\sum_{i}^{N}\left|Y_i\right| \tag{3}$$

and for the real part, is according to:

$$\mathrm{Re}(Y_{eq}) \approx \frac{1}{N}\sum_{i}^{N}\mathrm{Re}(Y_i) \tag{4}$$

Note 1 to entry: For receiver structures, the mean values are over the contact locations, if known. If the contact locations are not known, then the mean values are over the plate area.

3.9
mobility in 1/3 octave bands
$Y_{1/3\ oct}$
value obtained from direct measurement in narrow frequency bands (see 6.2); 1/3 octave values of both mobility magnitude and real part are obtained as the mean value of the narrow band data averaged over the frequencies within the band considered (assuming M frequency components k):

$$\left|Y\right|_{1/3\text{oct}} = \frac{1}{M}\sum_{k}^{M}\left|Y_k\right| \tag{5}$$

$$\mathrm{Re}(Y)_{1/3\text{oct}} = \frac{1}{M}\sum_{k}^{M}\mathrm{Re}(Y_k) \tag{6}$$

Note 1 to entry: The magnitude of source mobility only is required and can be measured directly as the ratio of velocity to applied force, both in 1/3 octave. For the receiver mobility, both the magnitude and real part are required, and shall be measured as complex values.

3.10
characteristic mobility of a plate
***Y*∞**
point mobility of an infinite plate having the same thickness and made of the same material as the plate considered

$$Y_\infty = 1/(8\sqrt{m \cdot B}) \tag{7}$$

Note 1 to entry: The characteristic input mobility is a real value, independent of frequency and dependent on the mass per unit area *m* and the bending stiffness *B* of the plate.

3.11
installed power P_{inst}
calculated structural power injected to each building element to which the equipment is connected; this power is the equipment input data for the prediction according to EN 12354-5

Note 1 to entry: The characterization of equipment connected to two or three building elements (e.g. pipes connected to floor and walls) will lead to two or three installed power components respectively.

4 Frequency range of measurement

The measurements and calculation shall be performed using the one-third octave bands having the following centre frequencies in Hz:

Table 1 — Centre frequencies in Hz

50	63	80	100	125
160	200	250	315	400
500	630	800	1 000	1 250
1 600	2 000	2 500	3 150	

The frequency bands where measured values show signal to noise ratio problems, shall be reported in the test report.

5 Installed power determination

For all installation conditions, the installed power level in dB re 10^{-12} Watt is approximated from the single equivalent free velocity level in dB re 10^{-9} m/s of the source and the single equivalent mobilities of the source and the receiver, using $Y_0 = 1\text{m/(Ns)}$ as reference, and all quantities being evaluated in 1/3 octave bands, according to:

$$L_{Winst} \approx \left(10 \lg \left[\frac{\mathrm{Re}(Y_{R,eq}) \ .Y_0}{\left|Y_{S,eq}\right|^2 + \left|Y_{R,eq}\right|^2} \right] \right)_{dB} + L_{vf,eq} - 60\ dB \tag{8}$$

Explanations about how this approximated expression of the installed power has been obtained can be found in references [1] to [4]. It should be noted that the single equivalent mobilities in Formula (8) are approximated from point mobilities, as defined in 3.9.

The approximation given in Formula (8) can be reduced for the case when the receiver mobility is much lower than the source mobility (by a factor of 10 at least). The only required source quantity is then the equivalent blocked force, leading to the following expression in terms of power levels in dB re 10^{-12} Watt and force levels in dB re 10^{-6} N:

$$L_{Winst} \approx \left(10 \lg \left(\frac{\mathrm{Re}(Y_{R,eq})}{Y_0} \right) \right) dB + L_{Fb,eq} \tag{9}$$

For any other mobility conditions, Formula (8) shall be used.

NOTE Power levels are calculated as $10 \lg(P/P_0)$, P_0 being the reference, as velocity and force levels are calculated as $20 \lg(v_{RMS}/v_0)$ and $20 \lg(F_{RMS}/F_0)$ respectively.

The following Clauses 6 and 7 specify methods for the measurements of the input quantities used in Formulae (8) and (9). Only direct measurements of the receiver mobilities are proposed. There are three ways of obtaining the input quantities for the source:

— direct measurements of the source free velocity squared and mobility, leading in principle to more precise results;

— indirect measurements of the source free velocity squared and blocked force squared using the reception plate method, which is a more robust laboratory approach to estimate the source single equivalent quantities (free velocity and blocked force, from which the mobility magnitude is deduced), but not as accurate in principle as direct measurements;

— combination of direct and indirect measurements, e.g. direct measurement of source free velocity squared and indirect measurement of blocked force squared using the reception plate method. This standard does not consider direct measurements of contact forces, because of possible changes to the contact conditions, when inserting force transducers between the source and receiver. However, ISO 18312-1 gives guidance on direct measurement of force required for direct measurement of power.