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Acoustics — Laboratory measurement of sound insulation of building elements —

Part 1: Application rules for specific products

AMENDMENT 2: Rainfall noise

*Acoustique — Mesurage en laboratoire de l'isolation acoustique des éléments de construction —
Partie 1: Règles d'application pour produits particuliers
AMENDEMENT 2: Bruit produit par la pluie*

ICS 91.120.20

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO-lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five-month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

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Amendment 2 to ISO 10140-1:2010 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

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Acoustics — Laboratory measurement of sound insulation of building elements —

Part 1: Application rules for specific products

AMENDMENT 2: Rainfall noise

page v, Introduction

Add the following third paragraph.

Annex K has been developed for the measurement of rainfall sound.

page 31

Insert Annex K, which starts on page 2, before the Bibliography.

page 32, Bibliography

Remove the following entry.

- [6] ISO 140-18, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 18: Laboratory measurement of sound generated by rainfall on building elements*

Add the following entries.

- [20] McLOUGHLIN, J. SAUNDERS D.J. and FORD, R.D. Noise generated by simulated rainfall on profiled steel roof structures, *Applied Acoustics*, **42** (1994), 239-255
- [21] SUGA H. and TACHIBANA, H. Sound radiation characteristics of lightweight roof constructions excited by rain, *Building Acoustics*, **1**, No. 4 (1994), 249-255
- [22] ISO 15186-1:2000, *Acoustics — Measurement of sound insulation in buildings and of building elements using sound intensity — Part 1: Laboratory measurements*
- [23] IEC 60721-2-2, *Classification of environmental conditions – Part 2: Environmental conditions appearing in nature – Precipitation and wind.*

Annex K (normative)

Roofs, roof/ceiling systems and skylights - Rainfall sound

K.1 Application

This annex applies to the impact sound insulation of roofs, roof/ceiling systems and skylights excited by artificial rainfall. The results obtained can be used for assessing the noise to be produced by rainfall on a given building element in the room or space below. The results can also be used to compare rainfall sound insulation capabilities of building elements and to design building elements with appropriate rainfall sound insulation properties.

Real rain can be classified in terms of rainfall rate, typical drop diameters and fall velocities in accordance with IEC 60721-2-2. These values are given in Table K.1.

Table K.1 — Classification of rain type according to IEC 60721-2-2

Rainfall type	Rainfall rate mm/h	Typical drop diameter mm	Fall velocity m/s
Moderate	up to 4	0,5 to 1,0	1 to 2
Intense	up to 15	1 to 2	2 to 4
Heavy	up to 40	2 to 5	5 to 7
Cloudburst	greater than 100	> 3	> 6

However, this part of ISO 10140 is based on measurements with artificial raindrops under controlled conditions using a water tank in a laboratory test facility in which flanking sound transmission is suppressed. Water tanks for two types of rain are specified in ISO 10140-5.

NOTE Measurements using real rain, although a useful means for validation purposes, are not included because of the variable, unpredictable and intermittent nature of real rain. Other mechanical simulation methods under investigation by researchers are not sufficiently well developed at present to adequately simulate real rain both in terms of sound levels and spectra generated.

The quantity to be determined is the radiated sound intensity level in the test room in third octave bands, L_i , the sound power level per unit area referenced to a value of $1 \times 10^{-12} \text{ W/m}^2$. Also the corresponding A-weighted intensity level L_{iA} is to be determined and for comparison purposes these levels as normalized with the results for a reference object, $L_{i,norm}$ and $L_{iA,norm}$.

The general guidelines in the relevant clauses of the basic ISO 10140-2 shall always be followed.

K.2 Test element

K.2.1 Standard element and laboratory configuration

The size of the opening in the roof of the test room shall be between 10 m^2 and 20 m^2 , with the length of the shorter edge being not less than 2,3 m. The test element shall be well sealed at the perimeter so no transmission of sound from the outside to the receiving room takes place through the joint between the test element and the test facility. The joints within the test element, if any, shall be sealed in a manner as similar as possible to the actual construction.

For skylights, the preferred dimensions are 1 500 mm × 1 250 mm with limit deviations of ±50 mm. Skylights shall be installed in a filler slab construction of sufficiently high airborne sound insulation and well sealed at the perimeter so that the sound field measured in the test room is only that generated by the impact excitation of the test element and radiated from the test element.

The minimum slope of the test element is 5° for roofs and 30° for skylights. The slope used shall be the lowest that is feasible to assure water drainage. Unrepresentative niches should be limited as far as is possible in practice for small test elements like skylights, for example by installing the test element in a test opening in a construction having the same slope as the slope of the test element.

The position of a small test opening in the surrounding roof construction shall fulfil the same specifications as for a small test opening in a test wall in accordance with ISO 10140-5.

K.2.2 Other configurations

Elements of surface area less than 1 m² are not recommended. The slope of the test element may be the actual slope for specific situations/systems, if known.

K.3 Boundary and mounting conditions

See ISO 10140-3.

K.4 Test and operating conditions

The standard rainfall type used for comparison between products shall be the heavy type as specified in ISO 10140-5:2010, Table H.1.

Other types of rainfall are permitted as long as their characteristics as rainfall rate, volume median drop diameter and drop velocity are indicated, however, if a rainfall rate lower than the heavy rain is needed, then the intense type described in ISO 10140-5:2010, Table H.1 is recommended.

After impacting on the test specimen, the water shall be drained to eliminate extraneous noise generation. The water supply pump shall either be located well away from the test room, or shall be housed in an acoustic enclosure so that its contribution to the background noise does not make rainfall measurements invalid. For smaller test specimens such as skylights, a single position for the artificial raindrop generation system is sufficient. For larger test specimens (10 m² to 20 m², see K.2.1), three positions for the artificial raindrop generation system shall be chosen. The location of the impact of artificial raindrops on the test specimen should be slightly off-centre to avoid symmetry. For non-uniform smaller test specimens (size close to 1,25 m × 1,5 m, see K.2.1) the whole surface shall be excited.

Prior to the commencement of acoustic measurements, a steady artificial rainfall rate shall be maintained over the test specimen for at least 5 min.

K.4.1 Determination of the sound intensity level (indirect method)

While maintaining the steady artificial rainfall rate, the average sound-pressure level in the test room shall be determined and corrected for background noise following ISO 10140-3. When using three positions of the rain generation system (i.e. for large tests specimen) the three corresponding sound pressure levels shall be added energetically. Also the reverberation time of the test room follows from ISO 10104-3.

The sound intensity level, L_I , is determined from the average sound pressure level for each one-third-octave band by equation (K.1):

$$L_I = L_{pr} - 10 \lg (T/T_0) + 10 \lg (V/V_0) - 14 - 10 \lg (S_e/S_0) \text{ dB} \quad (\text{K.1})$$

where

L_{pr} is the averaged sound-pressure level in the test room, in decibels;

T is the reverberation time of the test room, in seconds;

T_0 is the reference time (= 1 s);

V is the volume of the test room, in cubic metres (m^3);

V_0 is the reference volume (= 1 m^3);

S_e is the area of the test specimen directly excited by the rainfall, in square metres; it corresponds to the specimen size for smaller test specimens and to three times the perforated area of the tank (see ISO 10140-5:2010, Figure H.1) for larger test specimens.

S_0 is the reference area (= 1 m^2).

The one-third-octave band levels, L_j , can be combined and converted to yield the A-weighted sound intensity level, L_{IA} , by applying the standardized A-weighting factors as given in equation (K.2):

$$L_{IA} = 10 \lg \sum_{j=1}^{j_{\max}} 10^{0,1(L_{Ij} + C_j)} \text{ dB} \quad (\text{K.2})$$

where

L_{Ij} is the level in the j th one-third-octave band;

$j_{\max} = 18$

C_j values for one-third-octave band centre frequencies between 100 Hz and 5 000 Hz are given in Table K.2.

NOTE The sound power level radiated by the whole test specimen (of area S) could then be calculated as:

$$L_W = L_I + 10 \lg(S/S_0) \text{ dB} \quad (\text{K.3})$$

If octave band levels L_{Ioct} are to be determined, these values must be calculated for each octave band based on the three values of the corresponding third octave bands, as follows:

$$L_{Ioct} = 10 \lg \left[\sum_{j=1}^3 10^{0,1 \times (L_{I1/3octj})} \right] \text{ dB} \quad (\text{K.4})$$

Table K.2 — Values of j and C_j for one-third-octave bands

j	One-third-octave band centre frequency	C_j dB
	Hz	
1	100	-19,1
2	125	-16,1
3	160	-13,4
4	200	-10,9
5	250	-8,6
6	315	-6,6
7	400	-4,8
8	500	-3,2
9	630	-1,9
10	800	-0,8
11	1 000	0
12	1 250	0,6
13	1 600	1
14	2 000	1,2
15	2 500	1,3
16	3 150	1,2
17	4 000	1
18	5 000	0,5

K.4.2 Direct measurement of sound intensity

As an alternative to using the sound pressure level measurement method, the sound intensity method may be employed to directly determine the sound intensity levels (see ISO 15186-1). The test room, referred to as the receiving room throughout the whole ISO 15186-1, shall then be any room meeting the requirements of the field indicator, F_{pl} , with the background noise as specified in ISO 15186-1:2000, 6.4.2 and 6.5.

If L_{Im} is the sound intensity level directly measured over a measuring surface S_m for each one-third-octave band centre frequency, then the sound intensity level L_I radiated by the test specimen shall be given by the following equation:

$$L_I = L_{Im} + 10 \lg(S_m / S_e) \text{ dB} \quad (\text{J.5})$$

From this the A-weighted value and octave band values can be deduced in the same way as given in K.4.1.

K.5 Test report

See ISO 10140-3. The following additional information shall also be reported:

- equipment and methodology used for measurements of sound pressure levels and rainfall rates;
- description of the artificial rainfall generation system, including its characteristics and, if the system differs from the water tank described in ISO 10140-5, Annex H, the methodology used for the measurements of the rainfall rate, fall velocity and drop diameter (and spread angle if applicable), as well as the results and date of these measurements;
- rainfall type and rainfall rate in millimetres per hour (mm/h);