INTERNATIONAL STANDARD

ISO 5135

Second edition
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Acoustics — Determination of sound power levels of noise from air-terminal devices, air-terminal units, dampers and valves by measurement in a reverberation room

Acoustique — Détermination des niveaux de puissance acoustique du bruit émis par les bouches d'air, les unités terminales, les registres et clapets au moyen de mesurages en salle reverbérante

Reference number
ISO 5135:1997(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5135 was prepared by ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 5135:1984), of which it constitutes a technical revision.

Annex A of this International Standard is for information only.

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Introduction

This International Standard defines requirements for acoustic testing in reverberation rooms of the type of equipment listed in clause 1. It is based on the use of ISO 3741, which describes the acoustic test facilities, instrumentation and procedures to be used for precision grade determination of sound power levels in octave or one-third-octave bands of a noise source.

Acoustics — Determination of sound power levels of noise from air-terminal devices, air-terminal units, dampers and valves by measurement in a reverberation room

1 Scope

This International Standard establishes general rules for the acoustic testing of air-terminal units, dampers and valves used in air diffusion and air distribution systems as defined in ISO 3258 in order to determine sound power levels as defined in ISO 3740.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3258:1976, *Air distribution and air diffusion — Vocabulary.*

ISO 3740:1980, *Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards and for the preparation of noise test codes.*

ISO 3741:—[1)] , *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for reverberation rooms.*

ISO 5219:1984, *Air distribution and air diffusion — Laboratory aerodynamic testing and rating of air terminal devices.*

ISO 5220:1981, *Air distribution and air diffusion — Aerodynamic testing and rating of constant and variable dual or single duct boxes and single duct units.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1
sound pressure level
L_p
ten times the logarithm to the base 10 of the ratio of the mean-square sound pressure of a sound to the square of the reference sound pressure, in decibels

NOTE — The reference sound pressure is 20 μPa.

1) To be published. (Revision of ISO 3741:1988 and ISO 3742:1988)

3.2
sound power level
L_W
ten times the logarithm to the base 10 of the ratio of a given sound power to the reference sound power, in decibels

NOTE — The reference sound power is 1 pW (= 10^{-12} W).

3.3
frequency range of interest
the range which includes the octave bands with midband frequencies between 63 Hz and 8 000 Hz or the one-third-octave bands with midband frequencies between 50 Hz and 10 000 Hz

NOTE — Many rooms will not be qualified for measurements below the one-third-octave band centred at 100 Hz and the octave band centred at 125 Hz, respectively. In these cases the result may still be reported provided that all deviations are clearly indicated in the test report.

3.4
reverberant sound field
that portion of the sound field in the test room over which the influence of sound received directly from the source is negligible

4 Acoustic test facilities and procedures

This International Standard is applicable to equipment operating under steady state conditions and with a volume less than 2 % of the volume of the reverberation room.

The acoustic test facilities, instrumentation and procedures to be used, including room qualification tests, are described in ISO 3741. This document offers a choice of two methods for reverberation room measurements for determining sound power levels. The comparison method uses a reference sound source having a known sound power output. The direct method requires knowledge of the reverberation time of the room in which the determination is made.

If there are substantial variations in the reverberant room characteristics due to the presence of the source to be tested, then the test room shall also be qualified according to ISO 3741 with all equipment present in the room.

5 Installation and operation of equipment to be tested

5.1 General

5.1.1 When the equipment is mounted closer than 1 m to one or more reflecting planes the sound power level may depend strongly on the position of the equipment relative to these planes. Therefore, install the equipment to be tested in a position representative of normal usage. Figure 1 illustrates the overall test environment, with the specific details of each type shown in figures 2 to 6.

NOTE — Reflecting planes may, for practical reasons, be simulated by panels with an area-related mass greater than 7 kg/m^2. Such panels should extend at least 1,2 m in all directions measured from any edge of the device under test. These panels should be vibration isolated from the equipment under test.

5.1.2 Supply air to the equipment under test or exhaust air from it through a test installation in accordance with ISO 5219 or ISO 5220.

5.1.3 Include air-flow control accessories (dampers, deflectors, straighteners, equalizers, etc.) normally used in conjunction with the equipment under test in the test set-up. Locate and set them in the same manner as recommended for the application of the equipment.

5.2 Test installation of air-terminal units, dampers and valves for measurement of the sound radiated to the reverberation room

5.2.1 Position air-terminal devices normally installed in a boundary surface no closer than 1 m to the intersection of any adjacent surface and away from any position of boundary surface symmetry, as shown in figure 2.

5.2.2 Mount air-terminal devices normally used at the intersection of two surfaces at the intersection of the two surfaces not closer than 1 m to a third surface as shown in figure 3.

5.2.3 Install air-terminal devices not normally positioned at any boundary surface within the test room no closer than 1 m to any surface and away from any position of room symmetry. Examples are shown in figure 4. Diffusers installed on ducts without adjacent ceiling are typical examples.

5.2.4 The installation details specified in 5.2.1 to 5.2.3 apply equally to air-terminal devices when integral with air-terminal units. In this case measure a combined total of radiated sounds.

5.3 Test installation of air-terminal units, dampers and valves for the measurement of the sound radiated to the reverberation room by the connecting duct

To measure equipment normally located above the ceiling or in another space adjacent to the room they serve, install the equipment outside the test room and connect it to the test room by an unlined duct 1,5 m long of the same cross-sectional shape and area as the equipment connection in the room (see figure 5). Terminate the duct flush with all surfaces of the test room no closer than 1 m to any adjacent surface and away from any position of room symmetry. Examples are shown in figure 5.

5.4 Test installation of air-terminal units for the determination of casing radiated noise

To determine the sound radiated from the casing, install the unit in the reverberation room with suitable connecting duct or ducts in accordance with 6.2.3 and with ISO 5220. Install the unit within the size limits as shown in figure 6. Carry out the measurements in accordance with the following two methods.

5.4.1 In the case of the two-duct method, two ducts connecting the unit to the outside of the reverberation room are required.

5.4.2 In the case of the one-duct method, one duct connecting the unit to the outside of the reverberation room is required. In order to obtain the casing radiated sound, calculate the difference between the sound power levels, L_W, for each octave band or one-third-octave band, derived from this test, and the corresponding sound power levels derived from the test described in 5.3. This method is only valid if the difference is equal to or greater than 4 dB.

5.5 Test procedures

5.5.1 Carry out acoustic measurements while the equipment is operating over a range of conditions typical of its normal use.

5.5.1.1 For non-adjustable air-terminal devices, carry out sound measurements for a minimum of four air-flow rates over the upper half of the normal range used to determine the air-terminal device pressure requirements given in ISO 5219.

5.5.1.2 For adjustable pattern air-terminal devices, carry out sound measurements for a minimum of four air-flow rates over the upper half of the normal range for each of the adjustment positions for which the test data is required.

5.5.1.3 For air-terminal units with adjustable flow rate, carry out sound measurements for a minimum of four air-flow rates, each at the minimum, maximum and at least two intermediate flow rates.

5.5.2 If the operation of equipment in its normal range generates sound pressure levels below the measurement limit, then higher flow rates may be used and acoustic results recorded at least at the specified number of tests and extrapolated to the normal range.

The following procedure may be used for extrapolation.

a) In the case of tests made at a constant total pressure loss coefficient, plot values of sound power levels, L_W, for each octave or one-third-octave band and of A-weighted sound power levels, L_{WA}, against lg(q_V), where q_V is the volume flow rate.

b) In the case of tests made at a constant flow rate, plot L_W for each octave or one-third-octave band and L_{WA} against lg(Δp_t), where Δp_t is the total pressure loss.

Draw best-fit straight lines through the points for each parameter using the least squares method. The maximum deviation between the measured points and a straight line shall be ± 3 dB. These lines may be extended down to half the minimum and up to twice the maximum values of q_V or Δp_t.

Values of L_W or L_{WA} corresponding to specific values of q_V or Δp_t within the above range may be derived from the graphs [see examples in figures 7 a) and 7 b)].

6 Auxiliary facilities

6.1 General

Any noise due to electrical conduits, piping or air ducts connected to the equipment shall be at least 6 dB, and preferably more than 10 dB, below the sound pressure level to be measured.

6.2 Auxiliary facilities for acoustic testing

6.2.1 Provide a quiet air system so that any background noise lies at least 6 dB, and preferably more than 10 dB, below the sound pressure level to be measured in each frequency band within the frequency range of interest. Correct for background sound pressure levels with differences of 6 dB to 10 dB in accordance with ISO 3741.

NOTE — For the purpose of this International Standard, the background sound pressure level during test with air flow through the air-terminal device should be checked by removing the air-terminal device and measuring the sound pressure levels at approximately the same volume rates of air flow used in the test. However, it should be borne in mind that, in some cases, the noise from the air terminal may be lower than that of the system without terminal.

6.2.2 Vent air to or from the test room through a silencer. Carry out all sound measurements of the equipment under test, the reference sound source and background noise (see the note in 6.2.1) with the sound attenuator in place in a consistent manner. Noise generated by flow through the sound attenuator shall be in accordance with the requirements for background noise (see the note in 6.2.1).

6.2.3 The connecting supply and exhaust ducts for the installation set out in 5.4 (casing radiation) shall radiate noise at least 6 dB, and preferably more than 10 dB, below the sound pressure level to be measured in each frequency band within the frequency range of interest. Correct for background sound pressure levels in accordance with ISO 3741.

7 Measurements and calculations

The determination of the importance of discrete-frequency or narrow-band components, the qualification of the reverberation room, the measurements of the sound pressure levels and the calculation of the sound power levels for all octave bands within the frequency range of interest and the calculation of A-weighted sound power level, L_{WA}, shall be carried out in accordance with ISO 3741.

In the case of the installation described in 5.3, calculate the sound power level in the connecting duct, $L_{W\text{duct}}$, by adding the end reflection loss of the open duct, ΔL_r, to the sound power level, L_W, radiated into the room according to the following formula:

$$L_{W\text{duct}} = L_W + \Delta L_r \quad (1)$$

where

$$\Delta L_r = 10 \lg \left[1 + \left(\frac{c}{4\pi f} \right)^2 \cdot \frac{\Omega}{S} \right] \text{ dB} \quad (2)$$

where

c is the speed of sound;

f is the band centre frequency;

S is the area of the duct opening in the room;

Ω is the solid angle of the radiation path from the test opening (see table 1).

Table 1 — Values of Ω for the configurations illustrated in figure 1

Configuration	Ω
A	2π
B	π
C	4π
D	2π
E	4π

NOTE — As an alternative to the correction according to equation (2), a transmission element according to ISO 7235 may be used without any corrections.

8 Test report

The following information shall be included in the test report:

a) date of tests;

b) description of the equipment under test;

c) location and mounting of the equipment under test, including a sketch;

d) description and qualification of reverberation room (including dimensions);

e) a statement that all reported results have been obtained in full conformity with this International Standard;

f) volume flow rate, temperature and gauge pressure of the air flow entering the test unit;

g) the bandwidth of frequency analysis;

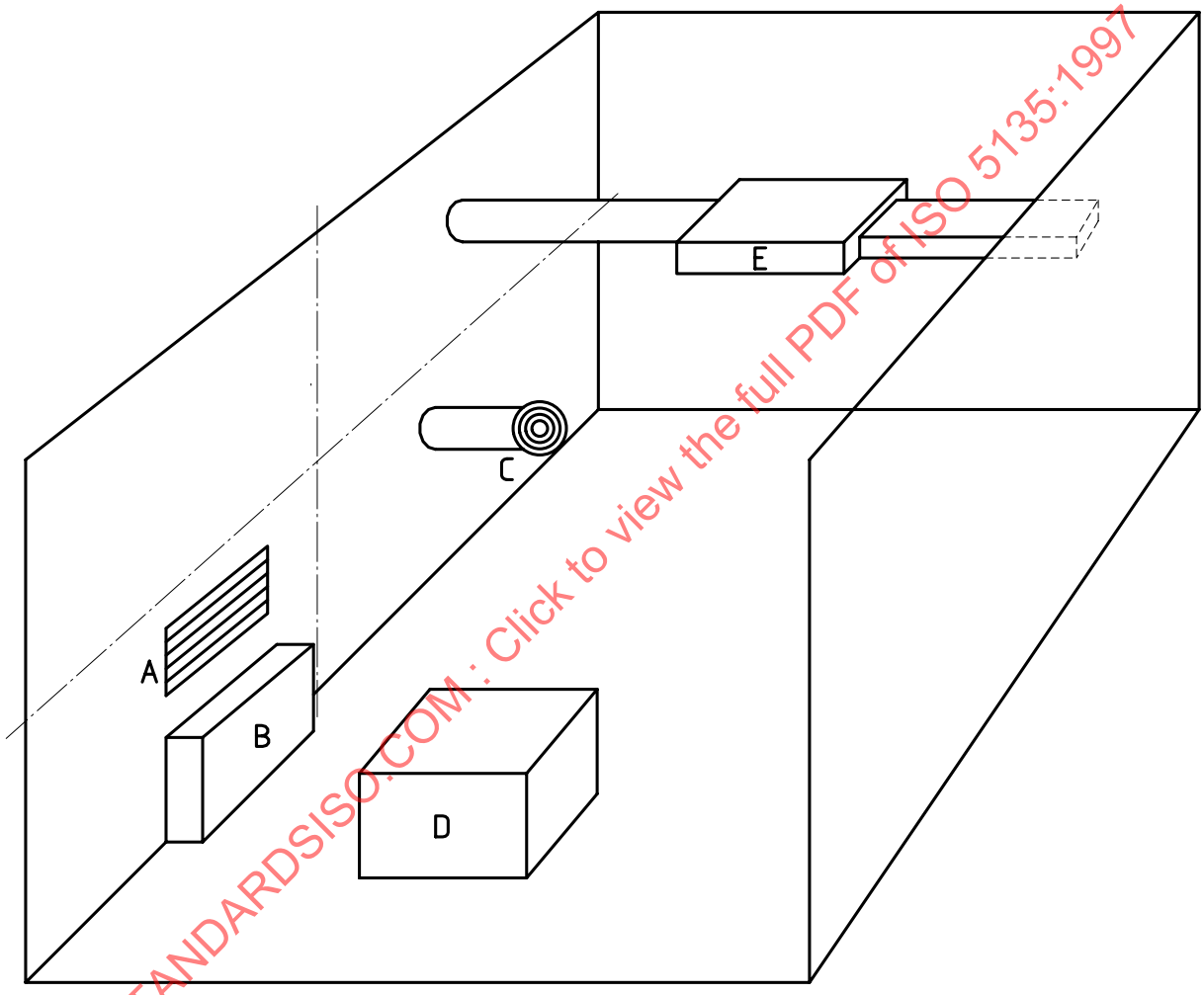
h) operating conditions of the source related to the sound power levels for all frequency bands within the frequency range of interest (see 3.3);

i) the corrections, if any, applied in each frequency band for the frequency response of the total instrumentation system, background noise and end reflection, in decibels;

j) air temperature, relative humidity and barometric pressure during the measurements;

k) at selected operating points of interest for the equipment tested, the fully corrected and computed sound power levels, in decibels, tabulated or plotted to the nearest half decibel for each frequency band considered — it shall be clearly stated whether extrapolated values are reported or if all points fall within the range measured directly;

l) the A-weighted sound power level, L_{WA}, for all operating conditions of the source.



NOTE — Refer to 5.2, 5.3 and 5.4 for mounting details.

Figure 1 — Location of equipment in test room

Dimensions in metres

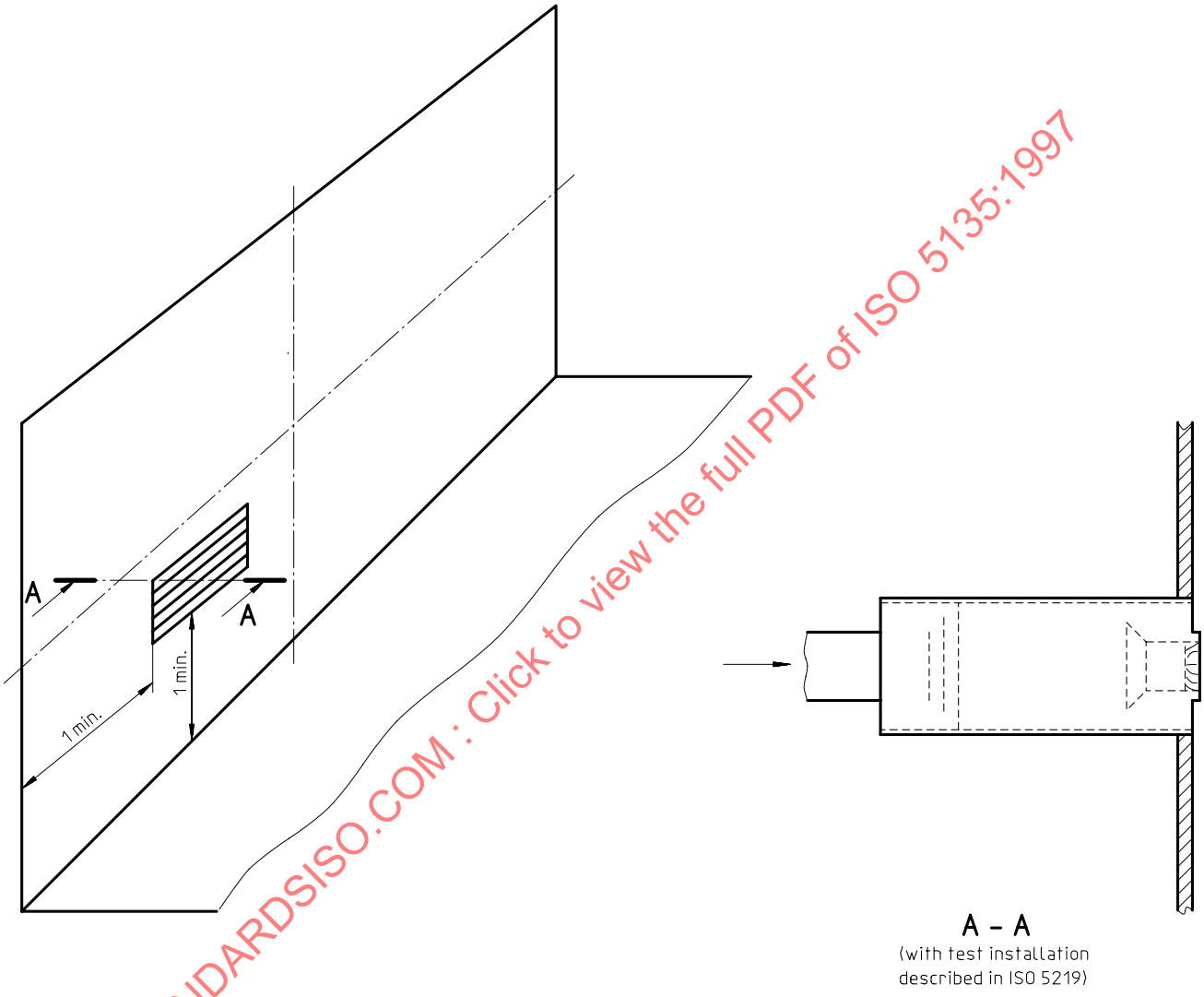


Figure 2 — Mounting detail for air-terminal device installed on or against a surface

Dimensions in metres

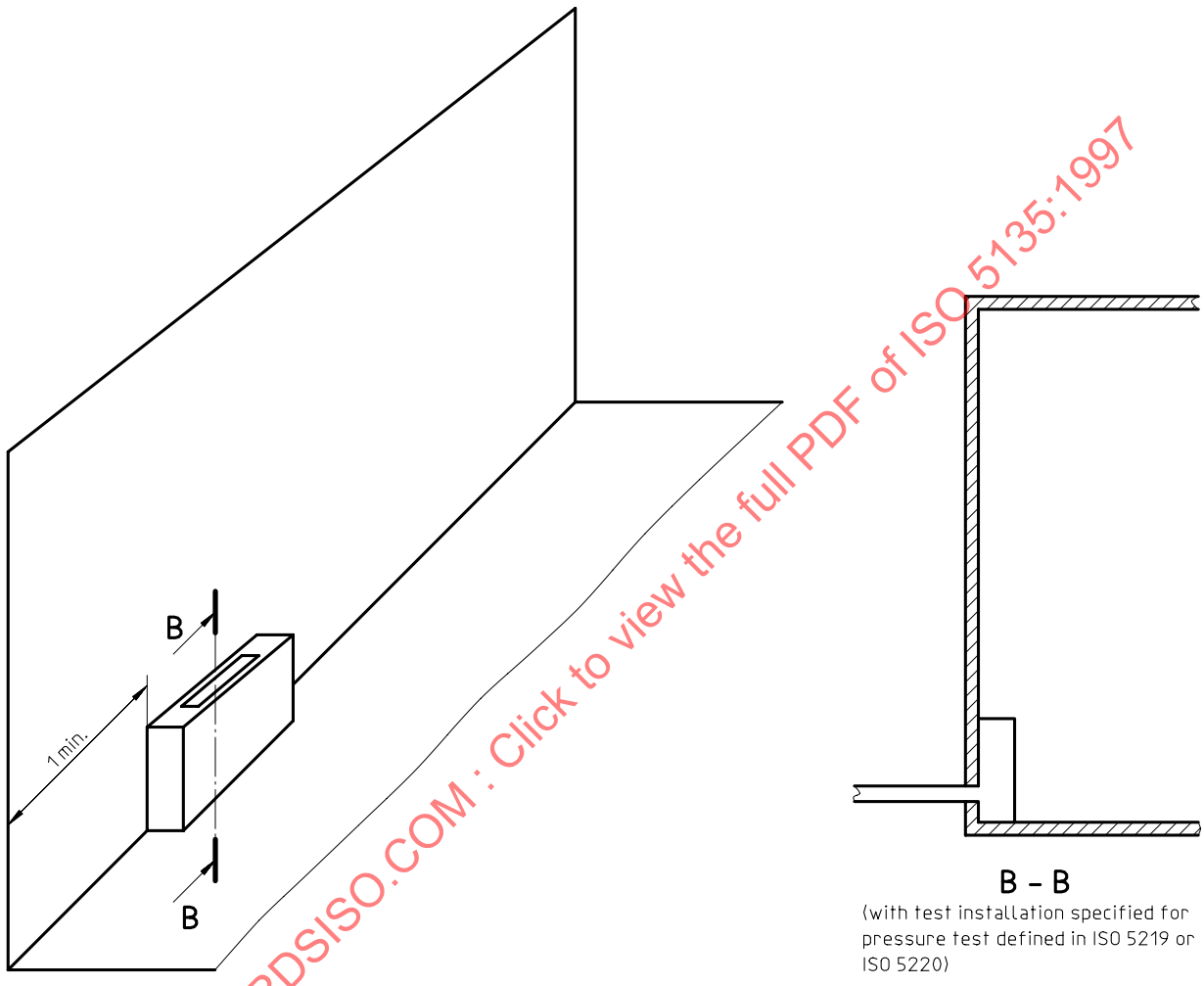


Figure 3 — Mounting detail for equipment installed at intersection of two surfaces

Dimensions in metres

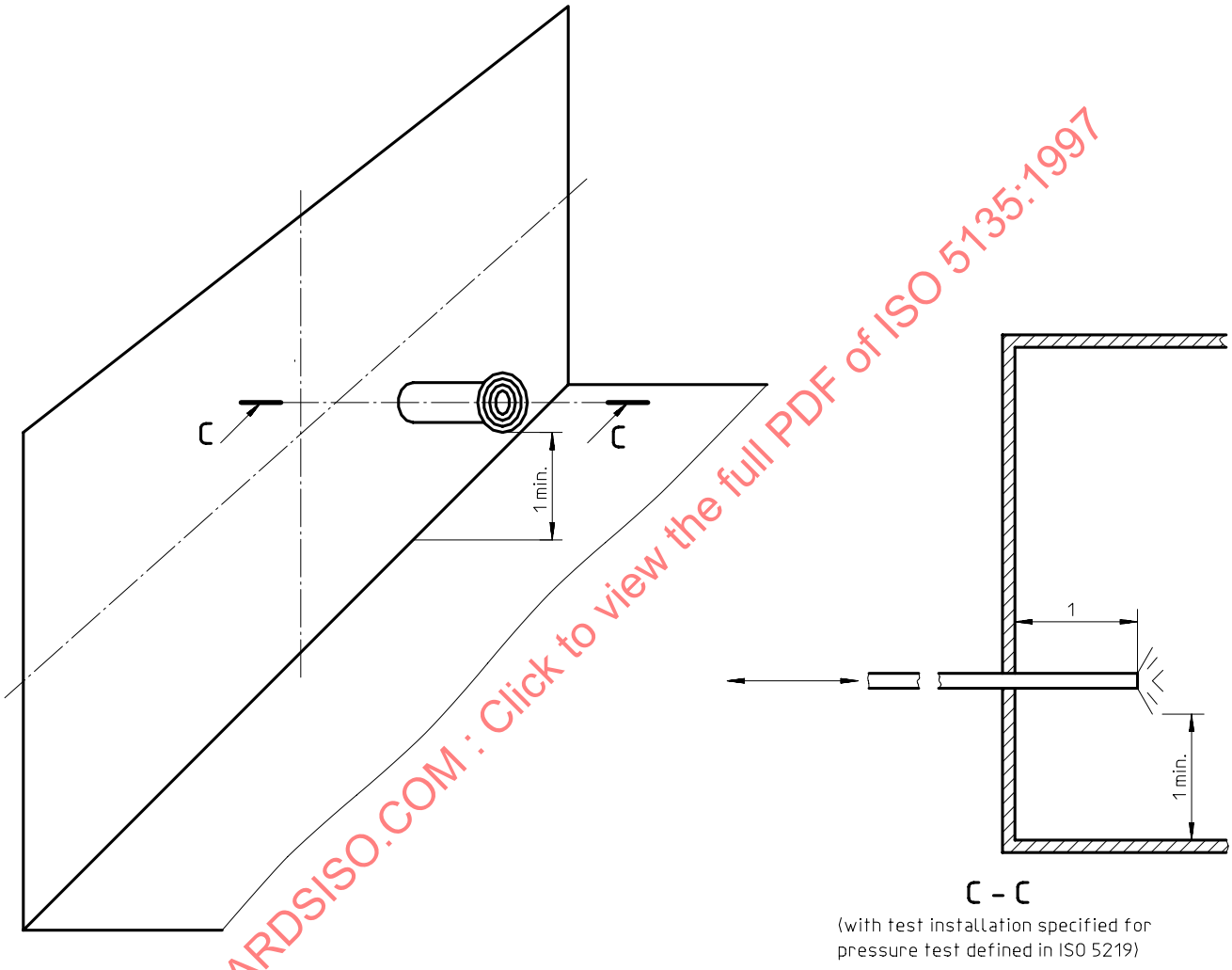


Figure 4 — Mounting detail for air-terminal device installed away from surface

Dimensions in metres

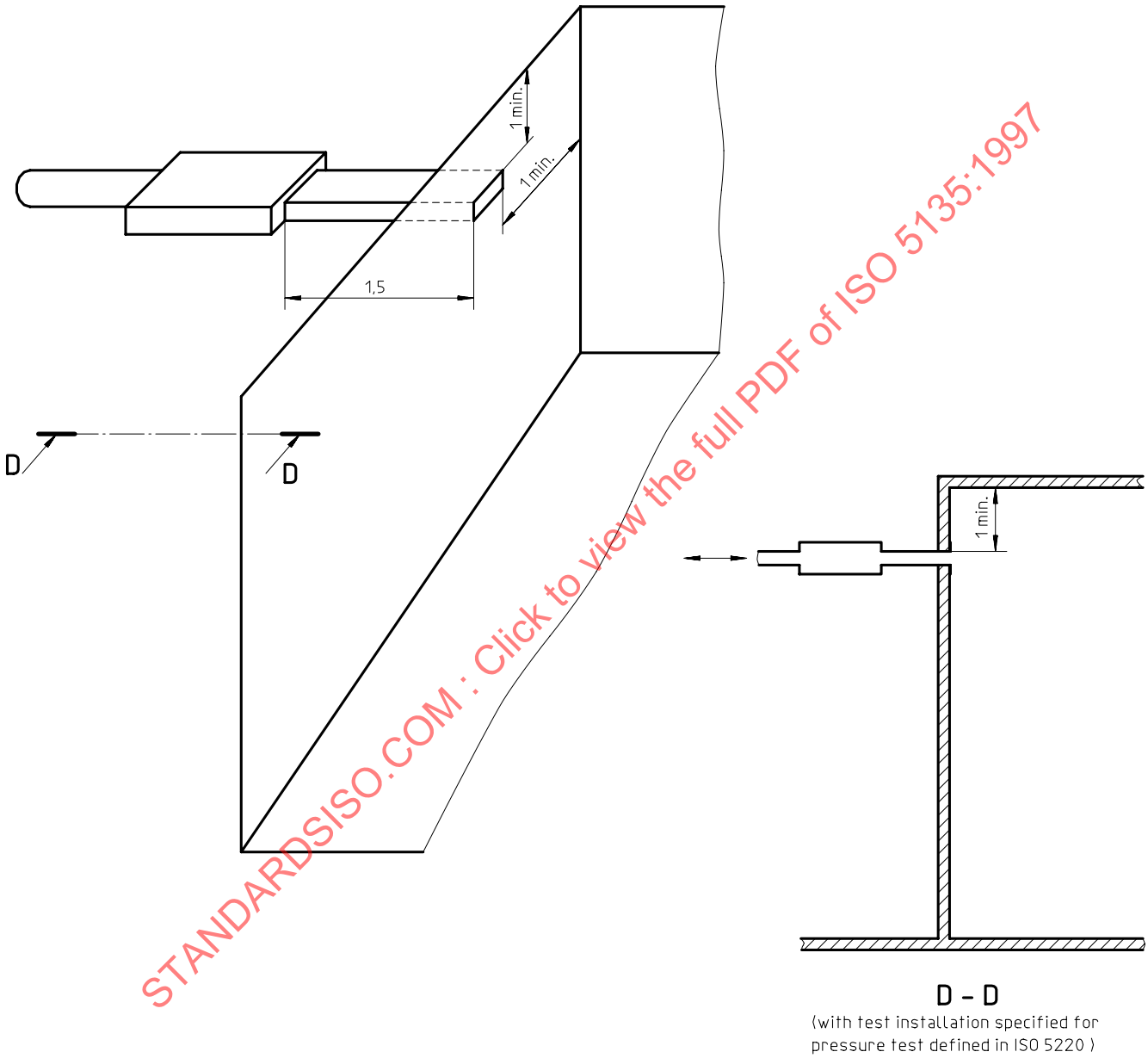


Figure 5 — Mounting detail for air-terminal units installed outside room boundary

Dimensions in metres

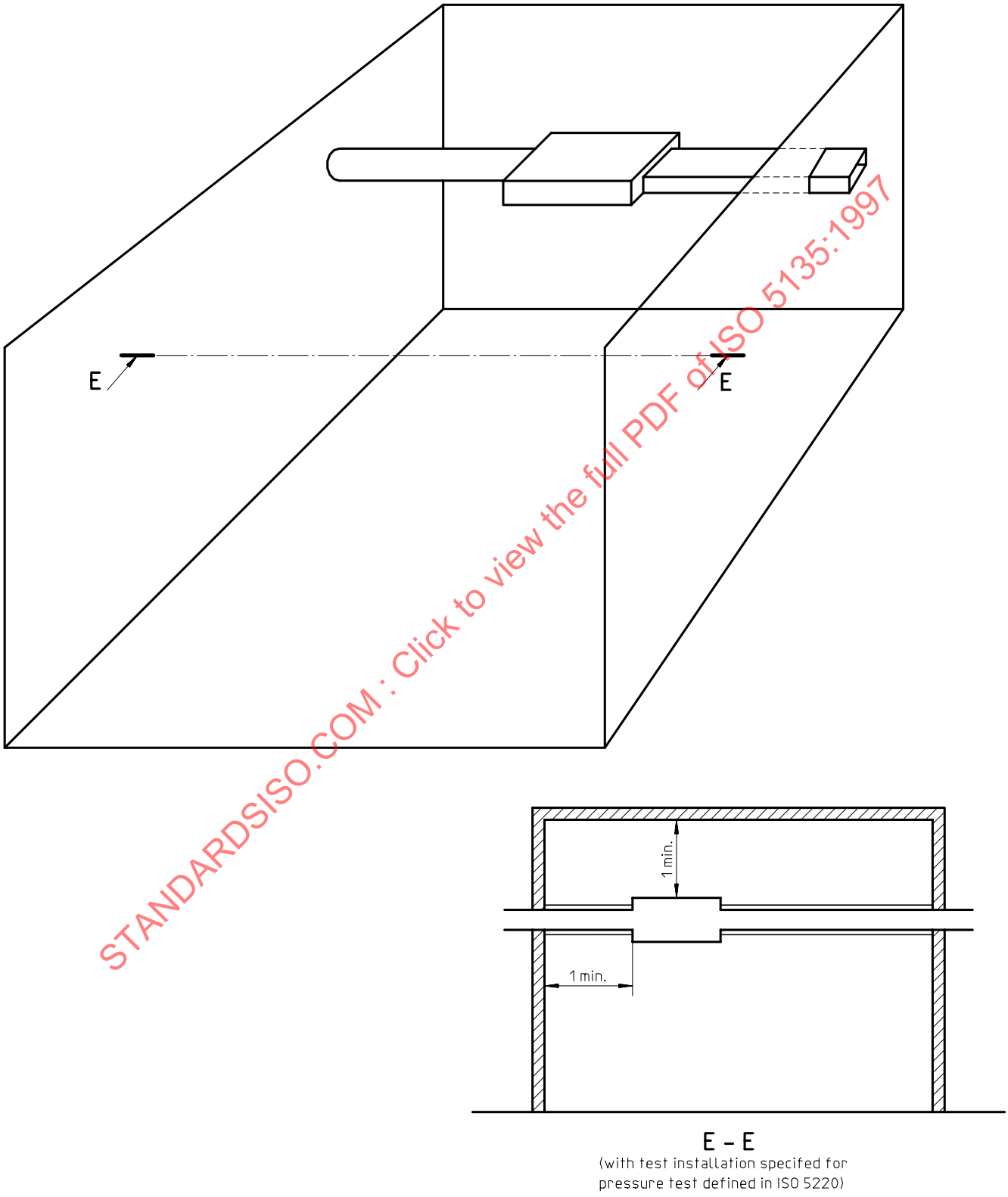


Figure 6 — Mounting detail for air-terminal unit to determine casing radiated sound

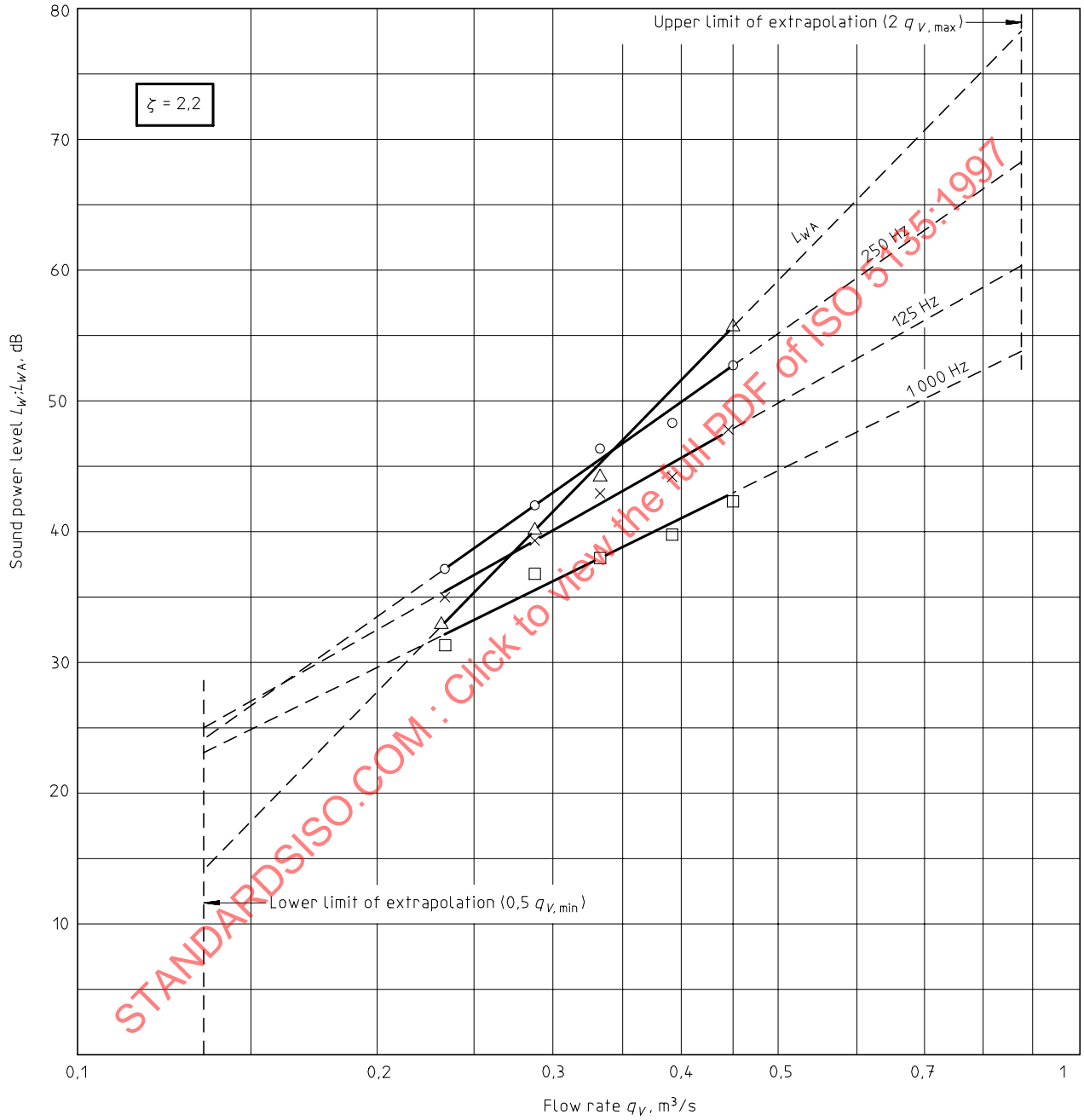


Figure 7 a) — Examples of L_W and L_{WA} plotted against lg(q_V) for a test with constant total pressure loss coefficient