# International Standard ISO 5135

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# Acoustics — Determination of sound power levels of noise from air terminal devices, high/low velocity/pressure assemblies, 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 ensembles à haute/basse vitesse et à haute/basse pression, les registres et les clapets par mesurage en salle réverbérante*



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**Descriptors :** acoustics, pressure equipment, air terminal devices, dampers, valves, tests, acoustic tests, determination, noise (sound), sound power.

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been authorized 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 5135 was developed by Technical Committee ISO/TC 43, *Acoustics*, and was circulated to the member bodies in September 1981.



It has been approved by the member bodies of the following countries:

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No member body expressed disapproval of the document.



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# Acoustics — Determination of sound power levels of noise from air terminal devices, high/low velocity/pressure assemblies, dampers and valves by measurement in a reverberation room

## 0 Introduction

This International Standard defines requirements for acoustic testing in reverberation rooms of the type of equipment listed under clause 1. It is based on the use of ISO 3741 and ISO 3742, which describe 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 having a volume preferably less than 1 % of the volume of the reverberation room.

## 1 Scope and field of application

This International Standard establishes general rules for the acoustic testing of air terminal devices, high/low velocity/pressure assemblies and 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.

This International Standard is applicable to equipment operating under steady state conditions.



## 2 References

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

ISO 3740, *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, *Acoustics — Determination of sound power levels of noise sources — Precision methods for broad-band sources in reverberation rooms.*

ISO 3742, *Acoustics — Determination of sound power levels of noise sources — Precision methods for discrete-frequency and narrow-band sources in reverberation rooms.*

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

ISO 5220, *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 purpose of this International Standard, the following definitions apply.

**3.1 sound pressure level, $L_p$, in decibels:** Ten times the common logarithm of the ratio of the mean-square sound pressure of a sound to the square of the reference sound pressure. The reference sound pressure is 20 μPa.

**3.2 sound power level, $L_W$, in decibels:** Ten times the common logarithm of the ratio of a given sound power to the reference sound power. The reference sound power is 1 pW ($= 10^{-12}$ W).

**3.3 frequency range of interest:** The range which includes the octave bands with centre frequencies between 125 and 8 000 Hz or the one-third octave bands with centre frequencies from 100 and 10 000 Hz.

**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 Acoustical test facilities and procedures

### 4.1 General

The acoustical test facilities, instrumentation and procedures including room qualification tests to be used are described in ISO 3741 and ISO 3742. These International Standards offer 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 a 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 a further qualification test with all equipment present shall be undertaken.

### 4.2 Broad-band noise

ISO 3741 is applicable if the noise emitted by the source has a broad frequency spectrum without significant narrow-band or discrete-frequency components. This is, typically, the case for aerodynamic sound of equipment to be tested in accordance with this International Standard. Broad-band sound power levels may be determined either in octave bands or in one-third octave bands.

### 4.3 Noise containing discrete-frequency or narrow-band components

ISO 3742 contains additional provisions necessary for obtaining accurate data if the noise emitted by the source is likely to contain significant narrow-band or discrete-frequency components. The sound power levels of sound sources emitting such components shall be determined in one-third octave bands from the tests described in sub-clause 3.3 of ISO 3742.

## 5 Installation and operation of equipment to be tested

### 5.1 General

**5.1.1** When the equipment is mounted near one or more reflecting planes, the acoustic radiation impedance may differ appreciably from that of free space, and the sound power may depend strongly upon its position and orientation. The equipment to be tested should, therefore, be installed in a position representative of normal usage. Figure 1 illustrates the overall test room environment with the specific details of each type shown in figures 2 to 6.

**5.1.2** Air shall be supplied or exhausted to the equipment under test through a test installation in accordance with ISO 5219 or ISO 5220.

**5.1.3** Air flow control accessories (dampers, deflectors, straighteners, equalizers, etc.) normally used in conjunction with the equipment under test shall be included in the test set-up. They shall be located and set in the same manner recommended for the application of the equipment.

### 5.2 Test installation of air terminal devices for measurement of the sound radiated to the reverberation room

**5.2.1** Air terminal devices normally used at any single boundary surface shall be positioned against any surface no closer than 1,0 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** Air terminal devices normally used at the junction of two surfaces shall be mounted at the intersection of the two surfaces not closer than 1,0 m to a third surface. Room air induction units intended to be installed at the junction of a wall and ceiling or floor are typical examples of these air terminal devices. (See figure 3.)

**5.2.3** Air terminal devices not normally positioned at any boundary surface shall be installed within the test space no closer than 1,0 m to any surface and away from any position of room symmetry, as shown in figure 4. Diffusers installed on ducts without adjacent ceiling are typical examples.

**5.2.4** The installation details apply equally to air terminal devices when integral with high/low velocity/pressure assemblies.

### 5.3 Test installation of high/low velocity/pressure assemblies, dampers and valves for the measurement of the sound radiated to the reverberation room by the connecting duct

Equipment normally located above the ceiling or in another space adjacent to the room they serve shall be installed outside the test room and connected to the test room by an unlined duct 1,0 m long of the same shape and cross-sectional area as the equipment inlet (outlet) connection. The duct shall terminate flush with any surface of the test room no closer than 1,0 m to any adjacent surface and away from any position of room symmetry, as shown in figure 5.

### 5.4 Test installation of high/low velocity/pressure assemblies for the determination of casing radiated noise

To determine the sound radiated from the casing, the assembly shall be mounted in the reverberation room with suitable connecting duct or ducts in accordance with 6.2.3 and with ISO 5220. The assembly shall be installed within the size limits, as shown in figure 6. The measurements may be carried out in accordance with the following two methods.

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

**5.4.2** In the case of the one-duct method, one duct connecting the assembly to the outside of the reverberation room is required. In order to obtain the casing radiated sound, the difference between each unweighted sound power level derived from this test and the corresponding unweighted sound power level derived from the test described in 5.3 shall be calculated. This method is only valid if the difference is equal to or greater than 4 dB.

### 5.5 Functioning of equipment during tests

**5.5.1** Acoustical measurements shall be made while the equipment is functioning over a range of conditions typical of its normal use.

**5.5.1.1** For non-adjustable air terminal devices, sound measurements shall be made for a minimum of four air flow-rates over the upper half on the normal range used to determine the air terminal device pressure requirements outlined in ISO 5219.

**5.5.1.2** For adjustable pattern air terminal devices, sound measurements shall be made 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 high/low velocity/pressure assembly with adjustable flow-rate capability, sound measurements shall be made for a minimum of four air flow-rates, each at the minimum, maximum and at least one intermediate pressure.

**5.5.2** If the operation of equipment in its normal range generates sound pressure levels outside of the measurement capability, 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.

For extrapolation the following procedure may be used:

a) in the case of assemblies with a total pressure loss coefficient, $\zeta$, plot values of sound power levels, $L_W$, for each octave band and of A-weighted sound power levels, $L_{WA}$, against lg $q_V$, where $q_V$ is the flow-rate;

b) in the case of assemblies with constant flow-rate, plot $L_W$ for each octave band and $L_{WA}$ against lg $\Delta p_t$, where $\Delta p_t$ is the total pressure loss.

Draw the 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 0,5 times the minimum and up to twice the maximum values of $q_V$ or $\Delta p_t$.

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

## 6 Auxiliary facilities

### 6.1 General

Care shall be taken to ensure that 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** A quiet air system shall be provided so that any background noise shall be 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. Correction shall be made for background sound pressure levels within 6 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.

**6.2.2** Air should be vented to or from the test room through a sound attenuator. All sound measurements of equipment under test, reference sound source and background noise (see the note in 6.2.1) shall be made with the sound attenuator in place in a consistent manner. Noise level generated by flow through the sound attenuator shall be in accordance with the requirements for background noise (see the note 6.2.1).

**6.2.3** The connecting supply and exhaust ducts for the installation set out in 5.4 (casing radiation) should 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. Corrections shall be made 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 the A-weighted sound power level, $L_{WA}$, shall be carried out in accordance with ISO 3741 and ISO 3742.

## 8 Information to be reported

a) Date of tests.

b) Description of the equipment under test.

c) Location and mounting of the equipment under test. A sketch shall be included.

d) Description and qualification of reverberation room (including dimensions).

e) Confirmation of test method used.

f) The bandwidth of frequency analysis.

g) Operating conditions of the source related to the sound power levels for all frequency bands within the frequency range of interest (see 3.3). The A-weighted sound power level, $L_{WA}$, for all operating conditions of the source.

h) The correction, in decibels, if any, applied in each frequency band for the frequency response of the total instrumentation system and background noise.

j) Air temperature (expressed in degrees Celsius), relative humidity (expressed in percentage terms) and barometric pressure (expressed in millibars) 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 direct measurement range.

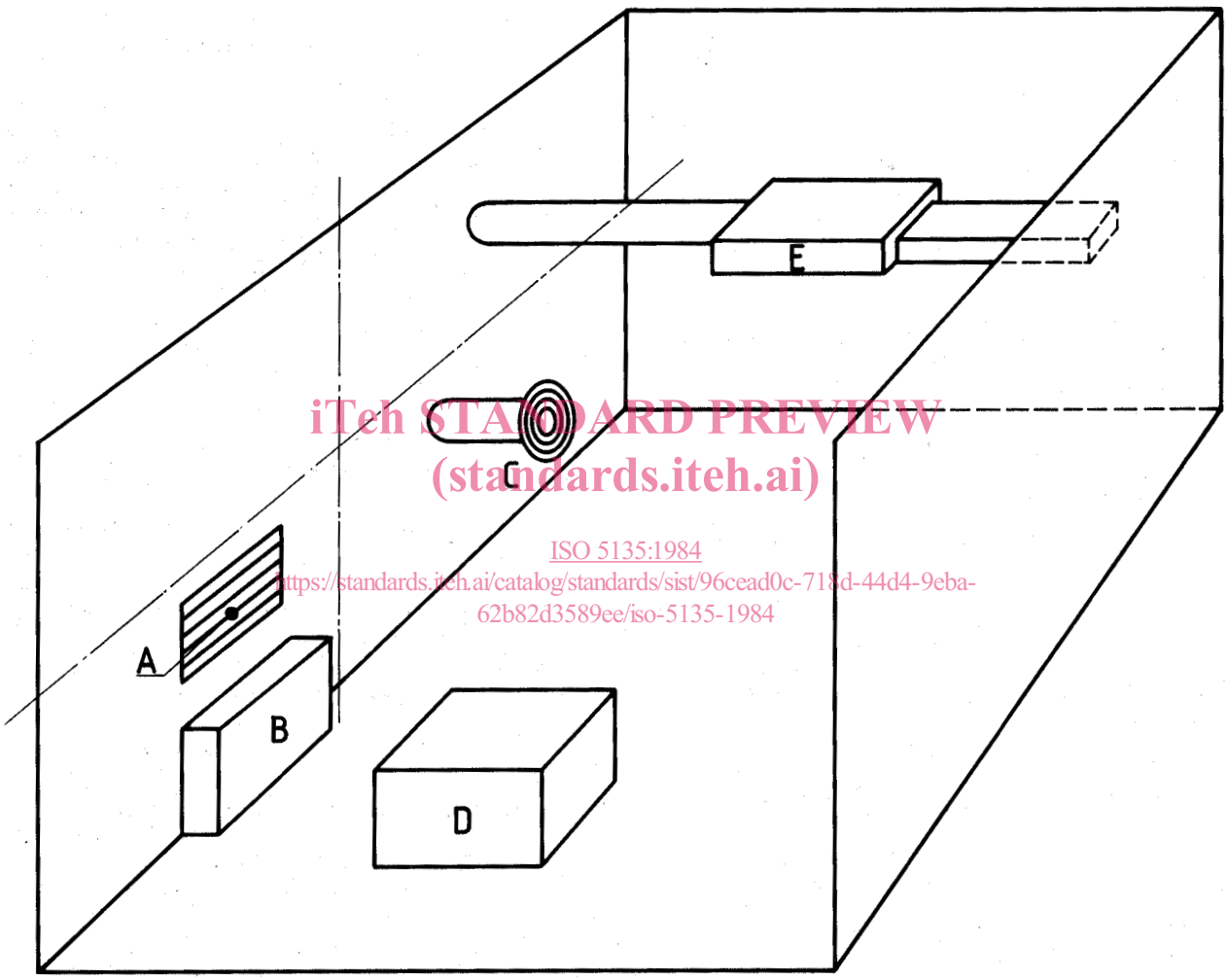




**Figure 1 — Location of equipment in test room**
(Refer to 5.2, 5.3 and 5.4 for mounting details.)

Dimensions in metres

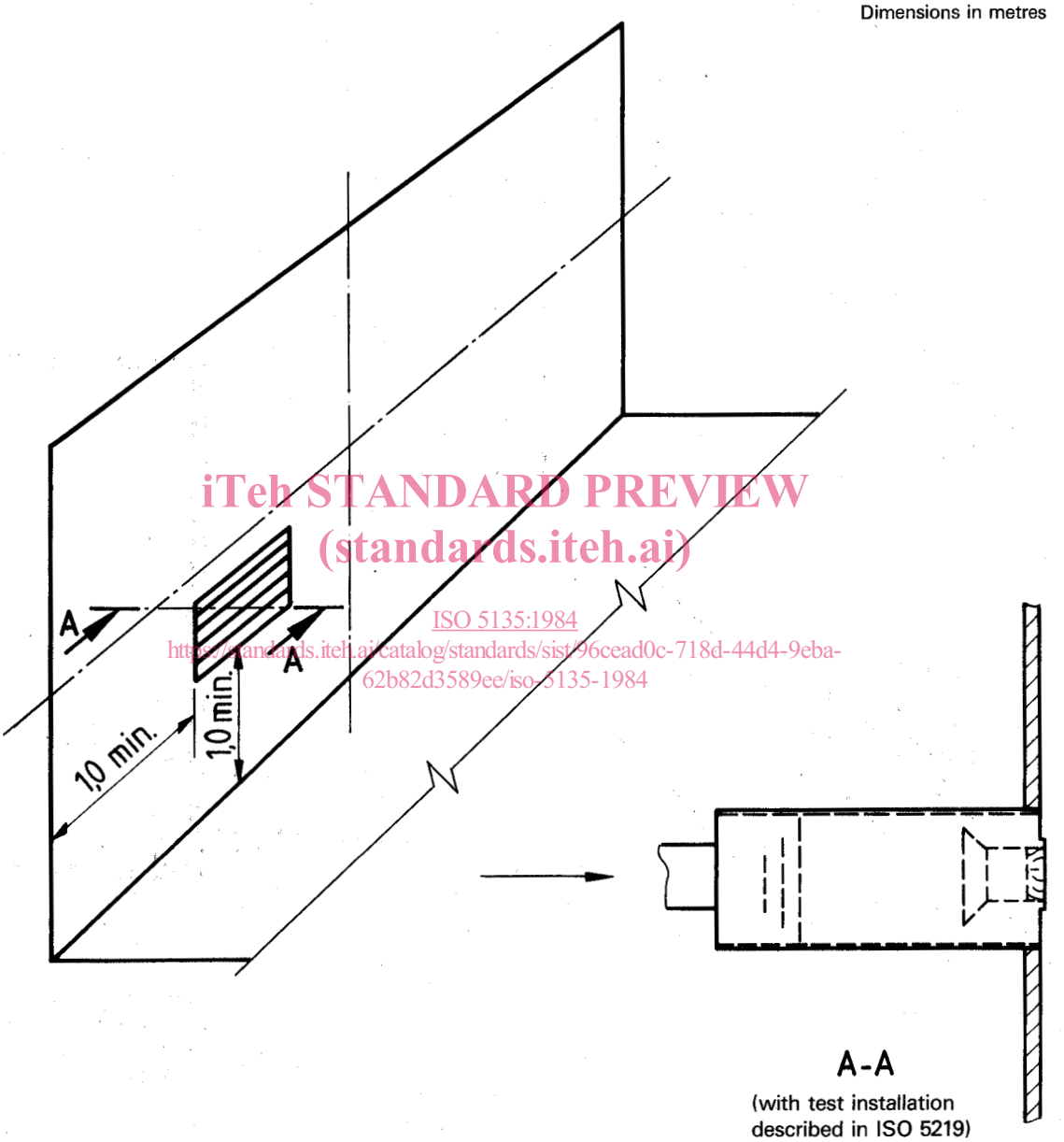




**Figure 2 — Mounting detail for air terminal device installed on or against a surface**

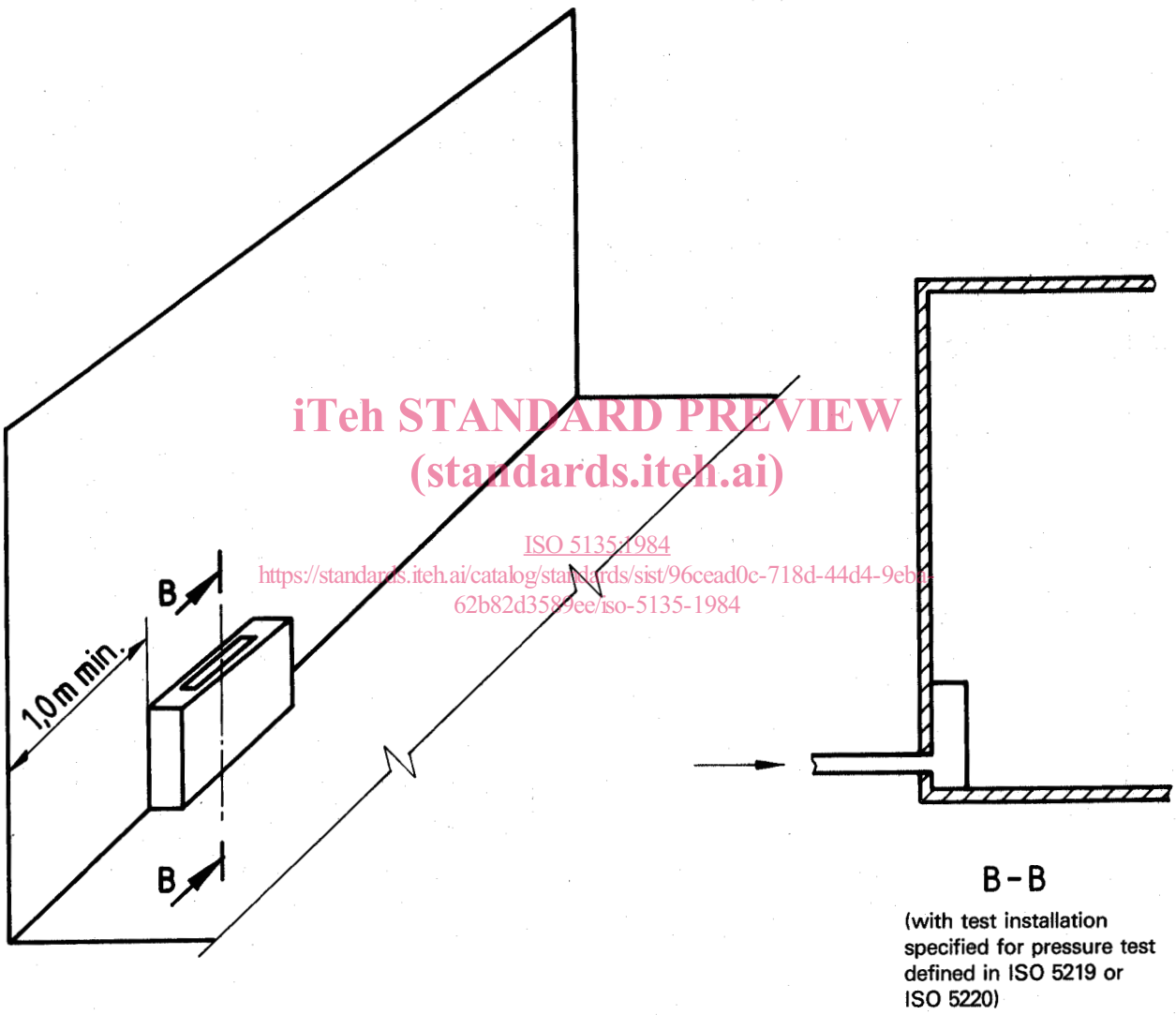




**Figure 3 — Mounting detail for equipment installed at intersection of two surfaces**

Dimensions in metres

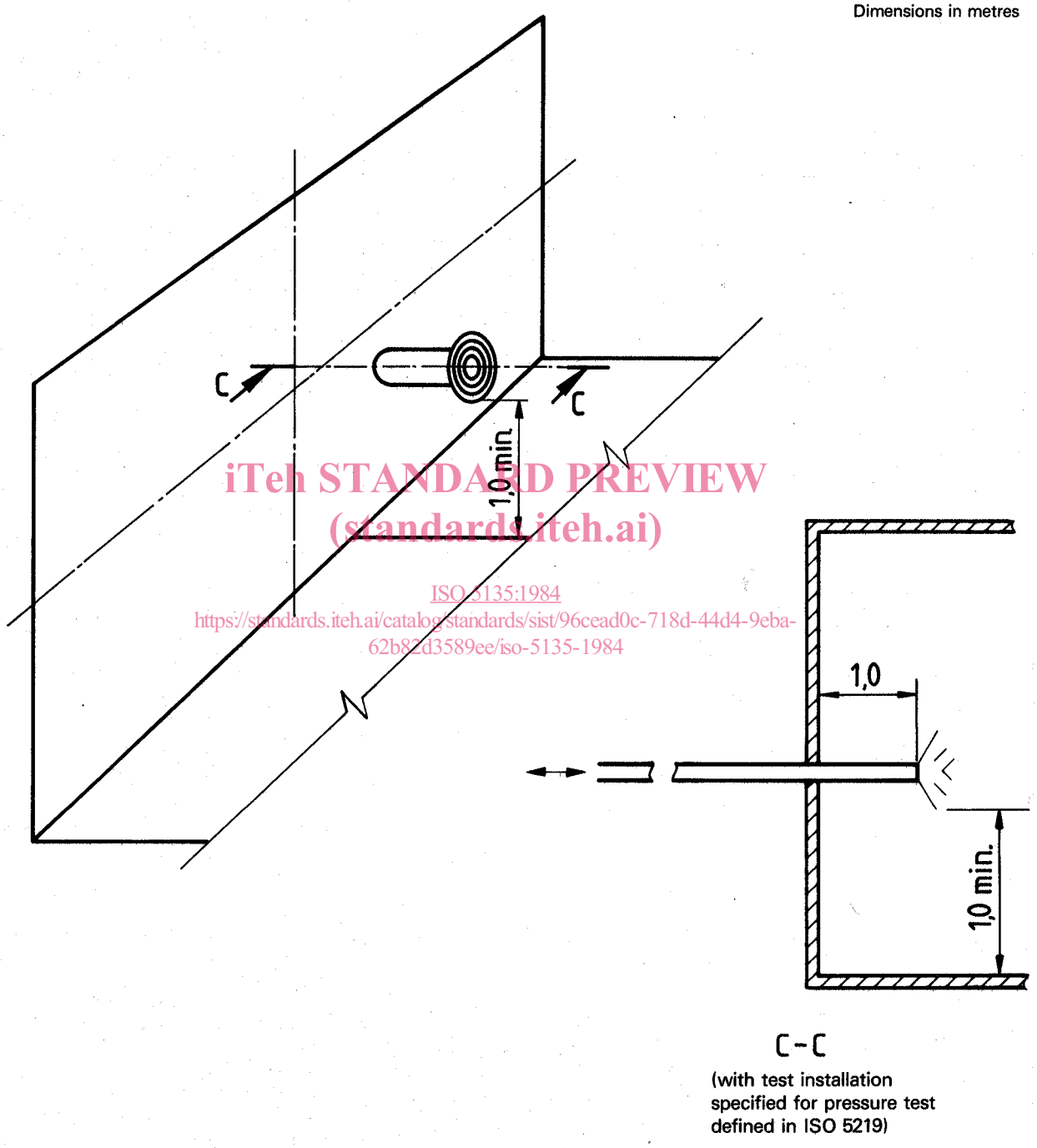




**Figure 4 — Mounting detail for air terminal device installed away from surface**