INTERNATIONAL STANDARD

ISO 13475-1

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Acoustics — Stationary audible warning devices used outdoors —

Part 1:
Field measurements for determination of sound emission quantities

Acoustique — Dispositifs d'alarme sonore fixes utilisés à l'extérieur

Partie 1: Mesurages sur le terrain des grandeurs d'émission acoustique

Reference number
ISO 13475-1:1999(E)

Contents

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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 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 13475-1 was prepared by ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

ISO 13475 consists of the following parts, under the general title *Acoustics — Stationary audible warning devices used outdoors*:

— *Part 1: Field measurements for determination of sound emission quantities*

— *Part 2: Test room measurements*

— *Part 3: Outdoor propagation of warning signals over built-up areas*

Annexes A and B form a normative part of this part of ISO 13475.

Introduction

ISO 13475-1 describes field measurements. The test methods are intended to produce field test values of the sound emission level of a siren as it is installed in an outdoor situation. These field test values may, together with the stated measurement uncertainties, be used to check the specifications of delivered sirens or to compare the performance of different sirens under the same conditions, emitting the same signals.

ISO 13475-2 describes precision measurements. This method is intended to produce a generally valid specification of sirens for type tests, acceptance tests, or for use in the design of outdoor warning systems, etc.

In part 1 of ISO 13475, two types of field measurements are discussed. They are:

a) **Flat-plate measurements:** this method uses a microphone placed on a flat plate which is located on the ground. During the measurement, the intended main sound radiation pattern of the warning devices is tilted toward the microphone and plate assembly.

b) **Horizontal measurements:** this method is performed with the microphone placed at the same elevation as the centre of the audible warning device (at a preferred height of 10 m).

Measurements made under optimal conditions in conformity with this part of ISO 13475 should result in standard uncertainties equal to or less than the values given in Table 1. The standard uncertainty for actual measurement conditions taking into account the cumulative effect of all causes of measurement uncertainty are treated in parts 1 and 2 of ISO 13475.

Table 1 — Uncertainty in determining immission-relevant C-weighted sound power levels for stationary audible warning devices

Reference	Measurement method	Expected expanded uncertainty
Part 1: Field measurements	Flat plate	2 dB
	Horizontal	4 dB
Part 2: Precision measurements	—	1 dB

Acoustics — Stationary audible warning devices used outdoors — Part 1:
Field measurements for determination of sound emission quantities

1 Scope

This part of ISO 13475 specifies the test conditions by which the sound emission level of stationary audible warning devices can be obtained. The methods are applicable to sirens for use in public outdoor warning systems and sound signalling devices for use outdoors.

The purpose of this test code is to be able to produce reliable sound emission level measurements for stationary sirens used for warning outdoors.

This part of ISO 13475 does not cover spoken messages and contains no recommendations for specific warning signals.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 13475. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 13475 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

IEC 60651[1)], *Sound level meters.*

IEC 60804[1)], *Integrating-averaging sound level meters.*

IEC 60942, *Sound calibrators.*

IEC 61260, *Octave-band and fractional-octave-band filters.*

3 Terms and definitions

For the purposes of this part of ISO 13475, the following terms and definitions apply.

3.1
siren
audible warning device for use outdoors

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1) These will be revised and combined as IEC 61672.

3.2
electronic siren
siren that produces tonal sounds by amplifying the output of an electronic signal generator and broadcasting the amplified signal from one or more electrodynamic loudspeakers

NOTE Such sirens may also be used for giving voice messages.

3.3
electromechanical siren
siren that produces tonal sounds by flow interruptions generated in a rotating wheel

NOTE Electromechanical sirens are mechanical sirens driven by an electric motor.

3.4
pneumatic siren
siren that produces sound by periodically interrupting or modulating a flow of compressed air

NOTE The air compressor may be integral with or separate from the flow interrupter.

3.5
horizontally omnidirectional siren
siren that radiates sound approximately uniformly (within a specified tolerance) in all horizontal directions from the siren at the specified frequency of the sound

3.6
directional siren
siren that radiates most of its sound in one or more specific directions

3.7
rotating or oscillating siren
directional siren that contains a mechanism which slowly rotates its beam of sound about a vertical axis

3.8
immission-relevant sound power level
$L_{W,\mathrm{imm}}$
sound power level from a monopole source that would give the same sound pressure level in the far field as the actual source

NOTE It is expressed in decibels (dB).

Table 2 — Symbols

Symbol	Definition	Unit
L_p	Sound pressure level, ref. 20 µPa	dB
$L_{p\mathrm{C}}$	C-Weighted sound pressure level, ref. 20 µPa	dB
$L_{p\mathrm{Cmax,F}}$	Maximum C-weighted sound pressure level, measured with time weighting F according to 4.5.3	dB
$L_{p\mathrm{Ceq},T}$	Equivalent C-weighted sound pressure level over a time period T	dB
$L_{W,\mathrm{imm}}$	Immission-relevant sound power level, ref. 1 pW	dB
$L_{W\mathrm{C,imm}}$	C-Weighted immission-relevant sound power level, ref. 1 pW	dB

4 Test conditions

4.1 Test site

The ground surface between the siren and the microphone shall be flat to within ±1,0 m.

The surface between the warning device and the microphone may be covered with grass and/or pavement. There shall be no sound-reflecting object (e.g. building walls or roofs) within the horizontal plane containing the base of the sound source that are closer than twice the measurement distance from the source.

All structures within three times the measurement distance from both the source and the microphone shall be described.

NOTE All surfaces near the sound source will reflect sound and, depending on their material, location, and orientation may bias the results of the measurements. The intent of above specifications is to minimize the effects of all reflections except those from the ground surface. The accuracy of the field measurements depend on distance, reflecting objects, reflections off the ground, vertical directivity, near-field effects, and instrumentation. The contributions of uncertainty due to reflecting surface can be calculated according to the procedure in annex B.

4.2 Mounting of apparatus

The warning sound source to be tested shall be located at or above the manufacturer's recommended installation height above the ground; see Figures 1 and 5 and corresponding text.

The recommended height to the centre of the warning device (acoustic centre) according to this part of ISO 13475 is 10 m above the ground. The mounting should be carried out in accordance with this part of ISO 13475 or the manufacturer's recommendations.

When the flat-plate measurement method is used (see 4.5), a tilt is recommended for sirens that are directional in the vertical plane. The tilt shall be at such an angle that the normally vertical siren axis is perpendicular to the direction to the microphone. If not tilted, the measured values shall be corrected using the vertical directional characteristics (see annex B).

Power supply conditions shall be in accordance with annex A.

4.3 Instrumentation

4.3.1 Acoustical instruments

4.3.1.1 Equipment for determination of the sound pressure level

The sound level meter or the equivalent measuring system, including the windshield as recommended by the manufacturer, shall fulfil the requirements of a class 1 or class 2 sound level meter according to IEC 60651 and IEC 60804. The diameter of the microphone shall be less than or equal to 13 mm, when using the flat-plate method (see 4.5.2).

4.3.1.2 Equipment for the optional determination of octave and one-third-octave-band spectra

The filters shall meet the requirements of IEC 61260, class 1 or class 2; parallel filters are preferred.

The equivalent continuous sound pressure levels shall be determined simultaneously in octave or one-third-octave bands with centre frequencies from 50 Hz to 4 000 Hz.

4.3.1.3 Calibration of the measurement set-up

The calibration of the complete sound measuring system, including any recording, data logging, or r.m.s. computing systems, shall be checked immediately before and after the measurement session at one or more frequencies using a sound calibrator. The calibrator shall fulfil the requirements of IEC 60942, class 1 or class 2, and shall be used within its specified environmental conditions.

If a difference of 1,0 dB or more appears between subsequent calibration sessions, the instruments shall be checked and the measurements shall be rejected.

4.3.1.4 Calibration of the equipment and its traceability

All equipment for sound measurements shall be checked regularly and shall be calibrated with traceability to national standards. Calibration intervals for sound calibrators should be 12 months and for other equipment 24 months.

4.4 Microphone positions

Microphone positions are chosen in accordance with the measurement method.

Windshields shall be used during all measurements.

The reference distance between the siren centre and the microphone is 30 m. The maximum distance between the siren and the microphone shall not exceed 50 m.

For optimizing the measurement distance, uncertainties arising from near-field effects and ground effects shall be taken into consideration; see annex B.

4.5 Measurement methods

4.5.1 General

Two methods are described: the flat-plate method and the horizontal measurement method.

The flat-plate method requires the microphone to be placed on a flat plate on the ground. This method results in a 6 dB increase of the sound pressure level via the controlled reflection of the plate (relative to the free-field value). However, in order to measure sound pressure levels of directive sirens, the main sound radiation pattern of the siren shall be directed toward the flat plate.

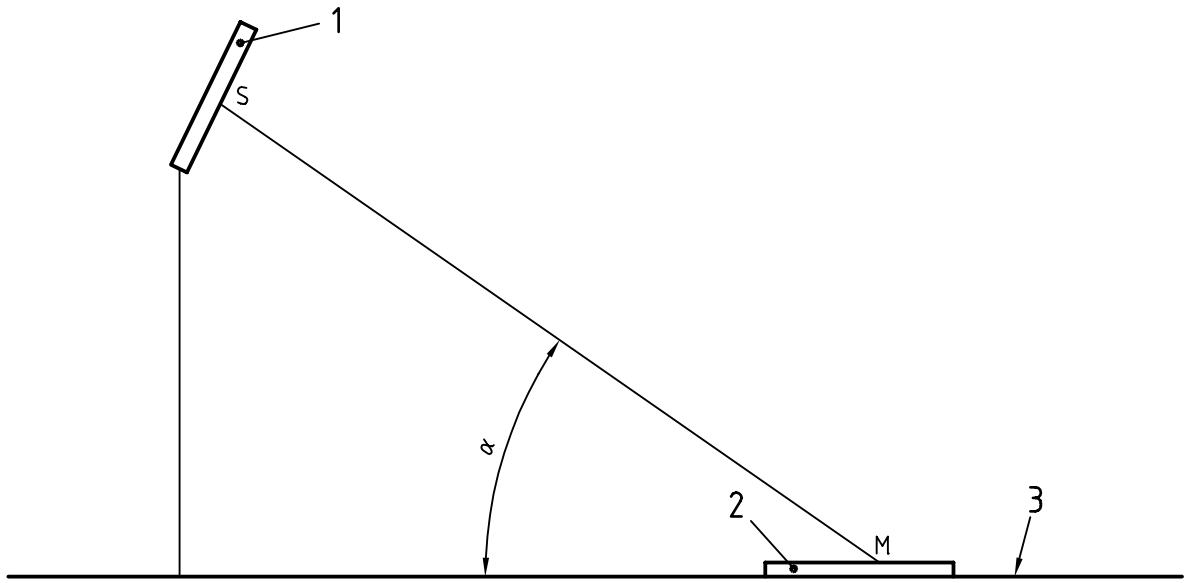
The horizontal measurement method specifies that the microphone be mounted at the same elevation as the warning device. This method results in a combined sound pressure measurement of both the direct sound path and the reflected sound path.

4.5.2 Flat-plate method

The measurement set-up is sketched in Figures 1 to 4. The microphone shall be placed on the plate according to Figure 1. The flat plate and the microphone position shall be in accordance with Figure 4. The microphone shall be fixed to the plate according to Figures 2 or 3. The plate shall be painted white to avoid thermal effects.

The angle α between the line SM, see Figure 1, connecting the microphone and the siren and the horizontal plane shall not be less than 10°.

Since this measurement method doubles the sound pressures relative to free-field measurements because of reflections from the plate, 6 dB must be subtracted from the sound pressure level measured ($L_{p,\mathrm{meas}}$) on the flat plate, according to 5.3.1.



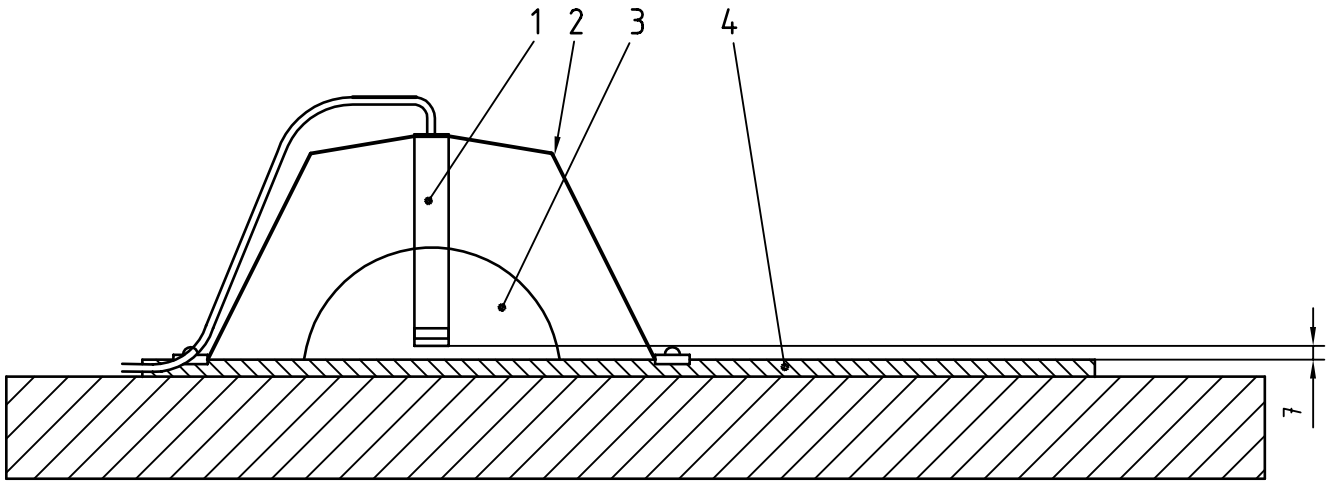
Key

1 Siren
2 Microphone
3 Flat plate

SM = 30 m

Figure 1 — Flat-plate measurement set-up

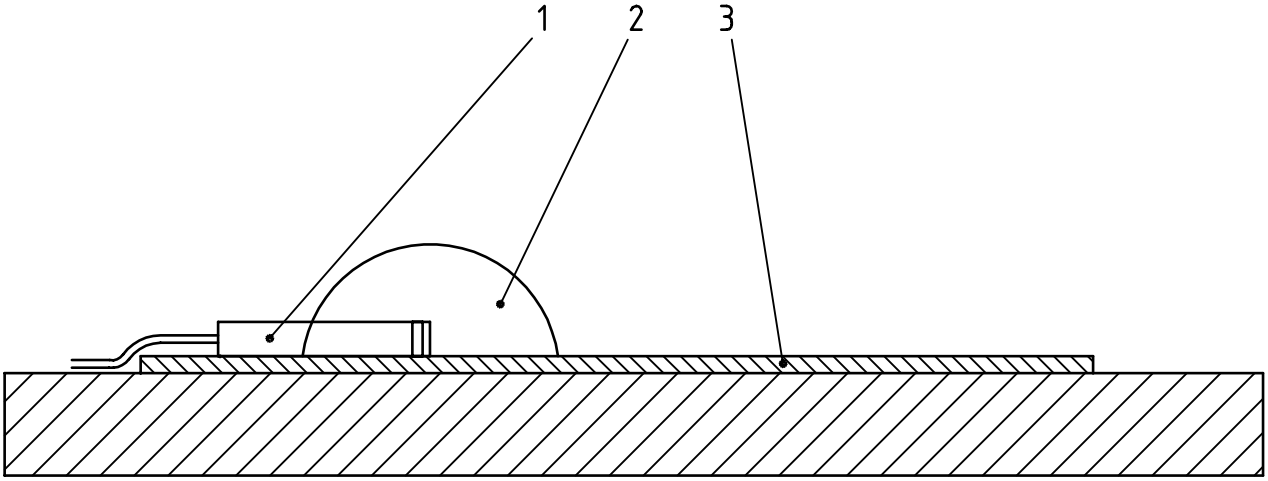
Dimensions in millimetres



Key

1 Microphone
2 Steel wire of 3 mm diameter, e.g. 3 pieces
3 Windshield
4 Metal plate, 2,5 mm thick

Figure 2 — Inverted microphone location — Side view



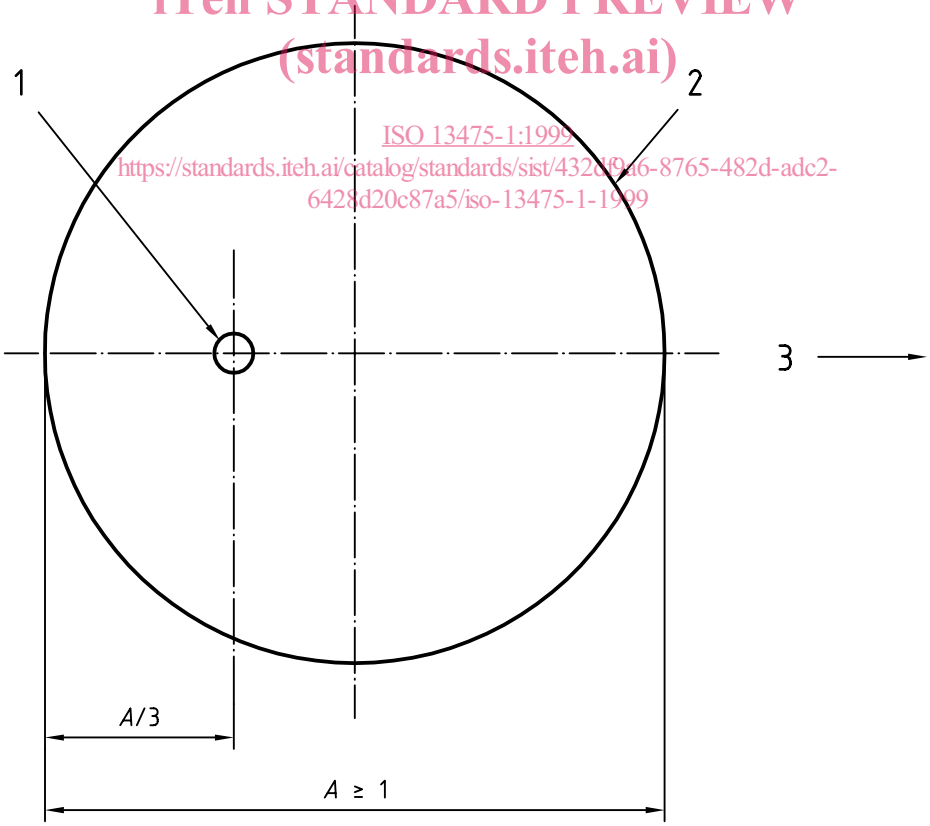
Key

1 Microphone
2 Windshield
3 Metal plate, 2,5 mm thick

NOTE Windshields are cut to purpose for this measurement.

Figure 3 — Microphone on its side

Dimensions in metres



Key

1 Microphone location
2 Metal plate, 2,5 mm thick
3 Warning device

NOTE Windshields are cut to purpose for this measurement.

Figure 4 — Position of microphone — Top view

4.5.3 Horizontal method

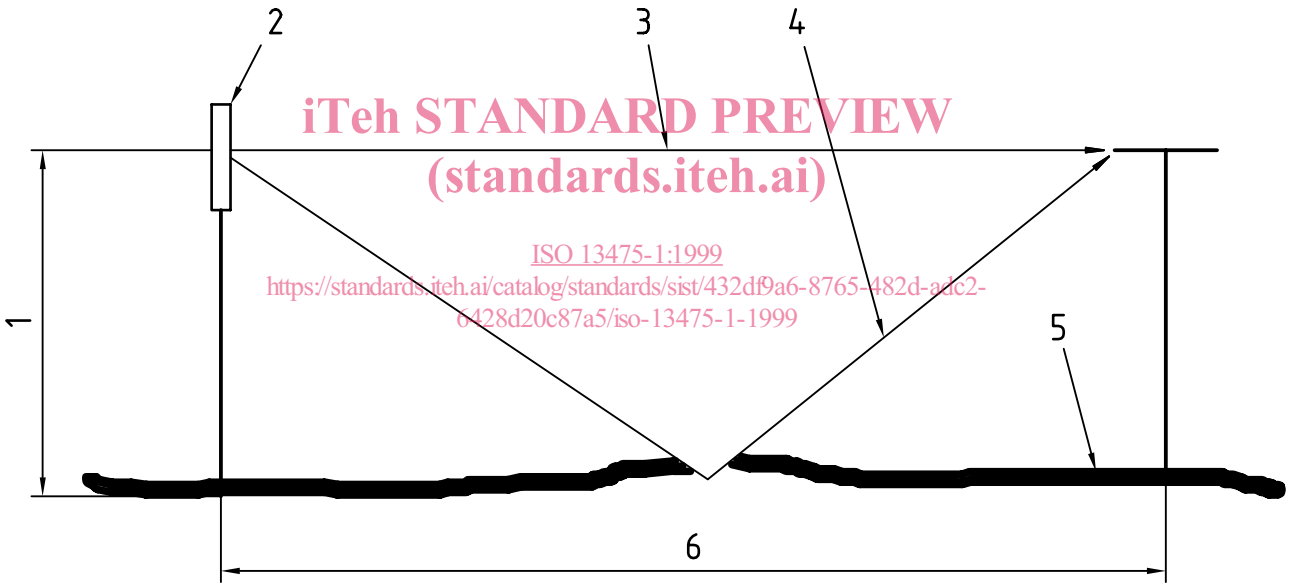
The measurement points for the horizontal measurement method are defined in Figures 5 and 6.

Figure 5 shows the microphone at a distance d from the warning device at the same elevation (sphere B in Figure 6). Figure 6 shows two additional microphone positions (spheres A and C) at 5 % of the measurement distance d above and below that point.

The maximum level $L_{p,\mathrm{Cmax,F},d}$ shall be determined according to the following procedure.

Move the microphone within each of the three spheres A, B and C with radius of 2 % of d. Determine and record the highest sound pressure level $L_{p,\mathrm{Cmax,F},d}$. At that same point record the $L_{p,\mathrm{Ceq},T,d}$ value. Of the resulting three pairs of data, the lowest pair of data shall be discarded and the average of the remaining two pairs arithmetically averaged, according to 5.3.2.

NOTE The results of the horizontal method tends to be 0 dB to 3 dB higher than those of the flat-plate method and the methods specified in ISO 13475-2. To reduce these systematic differences, refer to annex B.



Key

1 Elevation
2 Warning device
3 Direct wave
4 Reflected wave
5 Ground surface
6 Recommended distance 30 m

Figure 5 — Horizontal measurement method — General set-up